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Topic
Better Living

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Health & Wellness

Outsmart Yourself

Brain-Based Strategies to a Better You

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William & Mary

Transcript Book

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Dr. Peter M. Vishton is an Associate Professor of Psychology at William & Mary. He received his B.A. in Psychology and Computer Science from Swarthmore College in 1991 and his Ph.D. in Psychology and Cognitive Science from Cornell University in 1996. From 2000 to 2004, Dr. Vishton served as an Assistant Professor in the Department of Psychology at Northwestern University. He also has served as the program director for Developmental and Learning Sciences at the National Science Foundation and as a consulting editor for the journal *Child Development*.

Dr. Vishton has published articles in many of the top journals in the field of psychology, including *Science*, *Psychological Science*, *Experimental Brain Research*, *Teaching of Psychology*, and the *Journal of Experimental Child Psychology*. He is also the creator of the DVD *What Babies Can Do: An Activity-Based Guide to Infant Development*.

In addition to teaching, Dr. Vishton studies the perception and action control of both infants and adults. His interests include cognitive, perceptual, and motor development; visually guided action; visual perception; computational vision and motor control; and human-computer interfaces. Dr. Vishton's research has been funded by the Eunice Kennedy

Shriver National Institute of Child Health and Human Development and the National Science Foundation.

Dr. Vishton has presented his research at numerous conferences and invited talks throughout the United States and Europe. He has found a variety of evidence, among both children and adults, that the nature of sensory processing is altered by the actions we choose to perform. In essence, our intention to act on something changes how we perceive it. Dr. Vishton's ongoing work continues to explore how this aspect of the human senses develops and how the motor systems of the brain are involved in mediating the areas of the brain involved in perception.

With The Great Courses, Dr. Vishton has also produced *Scientific Secrets for a Powerful Memory*, *Understanding the Secrets of Human Perception*, and *Scientific Secrets for Raising Kids Who Thrive*. When he isn't exploring human cognition and action, Dr. Vishton enjoys spending time with his family, reading, and distance running. He has completed the Chicago Marathon twice and hopes to complete others in the future. ■

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INTRODUCTION

LECTURE GUIDES

Outsmart Yourself: *Brain-Based Strategies to a Better You*

Scope

Over the past several decades, cognitive neuroscientists have made immense strides in understanding how the human brain is organized and how the brain mediates our behaviors. This course describes many of these breakthroughs and demonstrates how this knowledge can be used to enhance our everyday lives.

A crucial foundation of this course is the fact that many of our decisions and behaviors are controlled by brain systems that function outside our conscious awareness. While these systems are tremendously significant to our everyday lives, they have many shortcomings. By hacking into these unconscious behavioral-control systems, we can change our behaviors to produce increased happiness, enhanced well-being, and positive outcomes.

For example, if you are eating a snack, most people presume the reason is that you consciously decided to eat that snack. However, many unconscious factors influence that decision to eat, such as how previous eating behaviors have influenced the neural system that controls hunger perception. We can consciously decide to eat or not to eat in a particular situation, but automatic, underlying brain systems control most of our behaviors.

This course applies the knowledge of cognitive systems to a wide variety of topics: procrastination, bad habits, dieting, sleep, phobias, depression, creativity, multitasking, persuasion techniques, anger, love, happiness, and the aging brain.

The human brain is the most impressive information-processing system that science has ever encountered. Much of its power comes from the brain's ability to perform many processes simultaneously. As astonishing as it is, however, the brain has limits. This course considers one significant bottleneck: Your brain can make only one decision at a time. By avoiding multitasking and instead creating situations in which you can engage in monotasking, you can improve your mental performance tremendously.

This course explores in depth the brain systems that mediate our emotions and considers how you can maintain and improve your close relationships to increase the love in your life. In addition, much has been learned about how your brain processes anger. By intentionally controlling your verbal and physical responses to that anger, you can substantially alter the course of your underlying emotional experience. Similarly, a few simple strategies can turn fear and anxiety into excitement and openness to new experiences.

The human brain is a physical organ that requires particular care to thrive. Sleep and dreaming are critical aspects of that brain-maintenance process. This course outlines the details of what your brain accomplishes while you are asleep and what happens when you disrupt specific parts of that sleep process. This knowledge leads to several easy strategies that will improve your memory and creativity and even your happiness. Simple meditation and imagery practice can augment these benefits as well.

In addition to considering how you can influence the function of your own brain, this course also explains how you can influence the brains of the people around you. We present a variety of techniques that can be used to persuade other people. In addition to actively using these techniques, you should be aware that others will try to use them on you.

This course adopts a skeptical, scientific perspective throughout. Each year, the self-help industry produces thousands of books filled with tips about how to boost your brain performance and achieve happiness. However, many of those tips are based on individual, anecdotal experiences rather than careful science and empirical evidence. This course focuses on proven scientific research and presents results from replicated studies. The course also suggests several strategies that students should use to become scientists themselves. By collecting data on your own experiences, you can more effectively change your behavior, influence your own mind, and outsmart yourself.

Lecture 1

Take Control of Your Automatic Brain

Experts in cognitive neuroscience and related fields have discovered a great deal about what our brains do when we are engaged in different types of behaviors. In this course, we explore many aspects of human thought and decision making using data and specific knowledge of how our brains actually work. In addition to educating you about how the human brain works, this course focuses on situations where knowledge of the brain can help with specific real-world challenges. Certain patterns of brain activity and associated behaviors produce better results than others. In these lectures, we focus on identifying these brain-based opportunities for behaviors with better outcomes.

The Brain

- The human brain is a network of about 100 billion interconnected neurons. The connections between those neurons—the synapses of the brain—number in the trillions. Everything you've ever seen, heard, thought, or done has emerged from the intricate patterns of chemical and electrical activity produced by the brain.

- A commonly repeated assertion is that we only use about 10 percent of our brains—an assertion that is almost certainly false. Scientists have developed a variety of techniques that are able to recognize and record the patterns of activity in the brain. Results of their studies demonstrate that even during basic, everyday tasks, nearly the entire brain is active.

- While it is clear that humans use far more than 10 percent of the brain, there is some truth to the notion that we only understand about 10 percent of what's going on in the brain. While cognitive neuroscience has learned a great deal about how the brain functions, the brain itself remains one of the great mysteries in all of science.

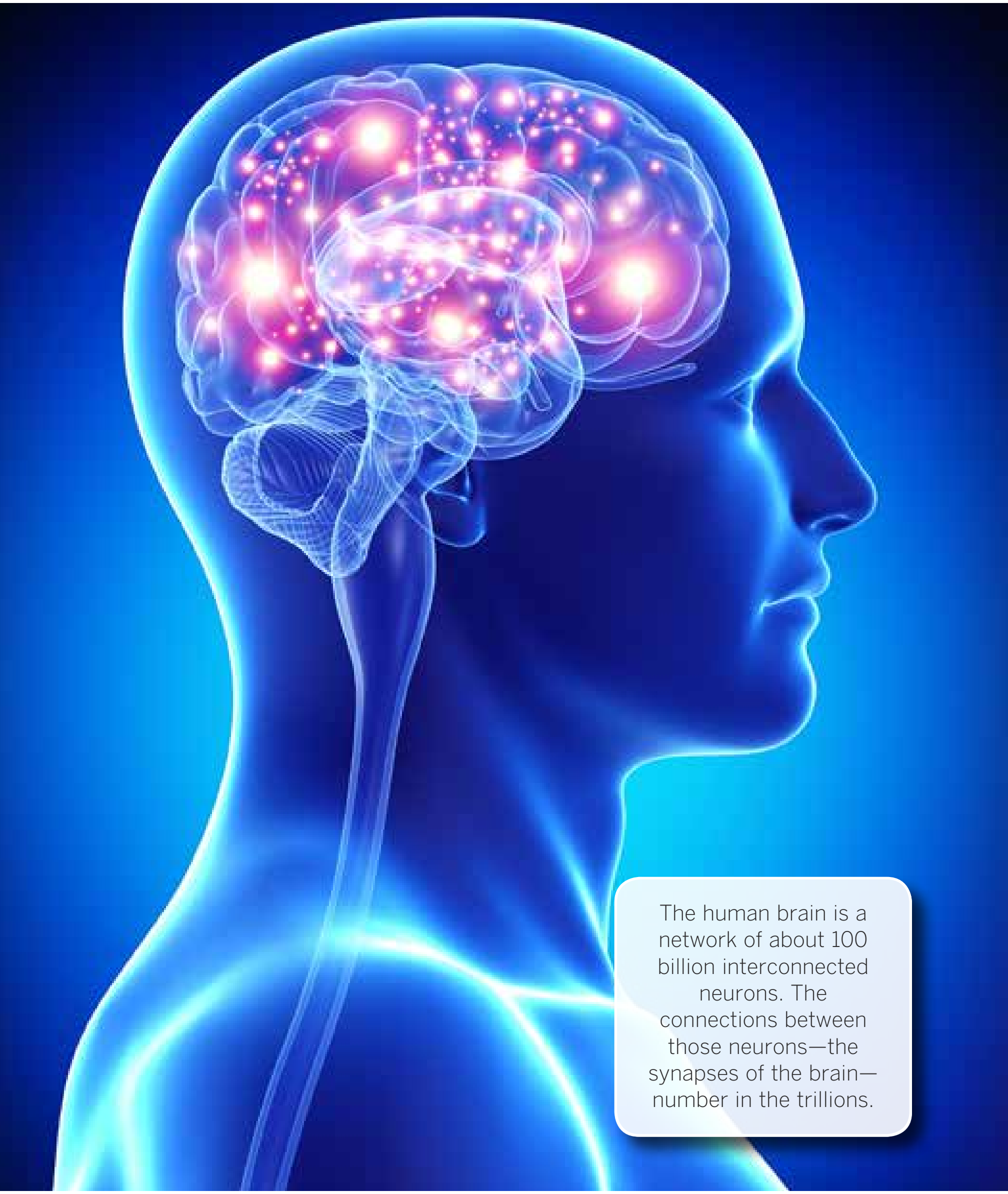
- The past few decades have seen an explosion in our understanding of the brain and how it mediates human behavior. Technologies such as functional magnetic resonance imaging (fMRI) have made it possible to watch the patterns of activation associated with real-time thinking.

The Intention-Behavior Gap

- Brain research has revealed a number of circumstances where the most effective strategies of behavior are counterintuitive—that is, while conventional wisdom and common sense suggest that one type of behavior is the best one to pursue, data from carefully conducted brain-based studies suggest that the opposite is actually the best way to go.

- An example of a counterintuitive strategy is the following: When you set a challenging, long-term goal for yourself, don't tell anyone about it (or tell as few people as possible). The fewer people you tell, the greater your chances are of actually achieving that goal. Research suggests that telling people about your goal won't increase the chance of succeeding. On the contrary, the more people you tell, the less likely that you will succeed.

- Peter Gollwitzer and his colleagues have conducted numerous studies of goal-directed behavior over the years. In one study, students were asked to commit to spending more time studying. In the control condition of that study, the students were then released and contacted later to assess how much extra studying they actually did. In the experimental condition, participants were asked to announce their intention to a group of their peers.



The human brain is a network of about 100 billion interconnected neurons. The connections between those neurons—the synapses of the brain—number in the trillions.

- The surprising result was that the participants who made the public announcement of their intention were significantly less likely to follow through on it. In one particular experiment, they studied for significantly fewer hours.

- Researchers describe the difference between people's plans and people's actions as the intention-behavior gap—the all-too-common disparity between what we intend to do and what we actually do. Announcing one's goals seems to widen that gap.

Benjamin Libet

- Brain research has determined that we don't consciously control our behaviors as much as we think we do. This is a counterintuitive idea, but it's central to much of modern brain science. While this brain research is not proof against the existence of free will, some philosophers do question free will based on the results of certain studies.

- Neuroscientist Benjamin Libet published a number of studies illuminating our understanding of how the brain functions. For a decade, Libet had attempted to understand how the brain produces the conscious experience. Libet worked with a large group of patients who were undergoing brain surgery. For many brain surgeries, the patient remains awake and aware throughout much of the procedure.

- During these procedures, with the permission of the patients, Libet would present brief, mild electrical stimulation to particular sensory regions. For instance, participants in one study would receive stimulation to the somatosensory cortex. This region registers the sensation of touch for different regions of the body.

- Libet's experiments suggested that for a patient to become conscious of something, 500 milliseconds (msec) of brain activity had to be produced—that is, half a second of brain activity. A very brief stimulus, such as a momentary tap on the hand, could produce activity in the brain, but if that signal was in some way interrupted before 500 msec had elapsed, conscious awareness of it would not occur.

Unconscious Decision Making

- The timing issue occupied many years of Libet's subsequent research. In 1983, Libet conducted one of the most fascinating and influential studies of the human brain. A participant in this experiment would watch a dot moving in a circle around a clock face. The task of the participant was simply to watch the dot and, from time to time, flex his or her wrist.

- The presumption of researchers at the time was that the wrist flexion started with a conscious decision to move. Once that decision was made, a signal was sent from some part of the brain to the motor cortex. The motor cortex then generated a command that was transmitted, via the cerebellum and the spinal cord, to the muscles in the forearm that controlled the wrist. Scientists believed that the order was the conscious decision first, then the motor command, and then the motion itself.

- Participants in Libet's experiment were wired with a variety of instruments. An electroencephalograph (EEG) placed on their scalp allowed researchers to record the tiny electrical activities produced by neural activity in the brain. A separate set of sensors recorded when the muscles were activated and when the movement of the arm occurred. After each movement, the participant would report when he or she first became aware of the intention to act.

- A very consistent pattern emerged when Libet examined the timing of this data. When we perform a movement like wrist flexion, the motor cortex builds up activity for about 500 msec prior to the onset of the action. When that buildup peaks, the signal is sent to the muscles, and the hand moves. But participants in the study only became aware of their decision to act about 200 msec before the action occurred.

- In other words, the motor cortex starts to create the action a full 300 msec before the participant decides to make the move. The data suggest that the brain makes a decision to act—but not a conscious one. A few hundred msec later, a message is sent to our conscious awareness, letting us know that the decision has been made. The decision has already been made before we become consciously aware of it. Our conscious experience of making a decision follows an unconscious process that is actually in control.

Alvaro Pascual-Leone

- Recent studies by Alvaro Pascual-Leone have confirmed the previous findings of unconscious processes. He used a technique called transcranial magnetic stimulation (TMS), which sends a jolt of electromagnetic energy through the skull to the cortex and causes a burst of activity. If that burst is sent to the correct spot in the motor cortex, for example, it's possible to make the arm twitch.

- Pascual-Leone asked participants to watch a screen and, when they were cued, decide whether they would twitch their left hand or right hand. After a delay of a few seconds, a second cue was delivered, at which point the participants made the movement they had decided to make.

- In some trials of this experiment, Pascual-Leone would deliver a TMS jolt to the part of the motor cortex associated with the participant's chosen movement. For a few key trials in this experiment, however, Pascual-Leone would deliver a jolt to the part of the motor cortex associated with the side the participant had not selected, causing the wrong hand to move.

- If our conscious experience of decision making is in control, this reversal should feel peculiar. But most participants had a very simple explanation of the experience: "I just changed my mind." The results of studies by Libet, Pascual-Leone, and others suggest that it doesn't feel unusual when our conscious mind is not in control of our actions.

The Role of Dopamine

- Studies by Libet, Pascual-Leone, and others were the first to demonstrate that the experience of conscious decision making happens after the real decision—an unconscious decision—is made. Their results suggest that consciousness simply goes along for the ride.

- Therefore, if you want to outsmart yourself—to change your own behaviors—deciding to change your behavior is only one very small step toward that goal. Ultimately, to alter your behavior, you have to influence the systems that are in control: the automatic and unconscious decision-making systems.

- Consider how this information is related to the counterintuitive tip: When you set a challenging, long-term goal for yourself, don't tell anyone about it (or tell as few people as possible). The fewer people you tell, the greater your chances are of actually achieving that goal.

When you decide to undertake a major goal, such as running a marathon, you probably have many significant conscious reasons for doing so.

- For example, when you decide to undertake a major goal, such as running a marathon, you probably have many significant conscious reasons for doing so. You might admire someone else who has accomplished a similar goal. Perhaps you have health reasons for pursuing the objective, such as improving fitness.

- A key motivating factor, however, is to experience that extraordinary sense of satisfaction derived from picking a difficult challenge and then overcoming it. Whenever you set a goal and achieve it, your brain gives itself a positive shot of pleasure. The brain delivers a shot of the neurotransmitter dopamine to the nucleus accumbens—a pleasure center of the brain.

- If you constantly tell people about your goal, however, you consistently get a little bit of that sense of accomplishment, that pleasurable boost. In a very real sense, you reduce your drive to achieve the goal.

Questions to Consider

1. There is evidence that we start to implement behaviors before our experience of consciously deciding to act. If you perform a set of actions that results in a crime, are you really responsible for it? Can you say that you didn't really decide to commit the crime?
2. Many of our daily behaviors seem to be performed on autopilot—outside our conscious focus. Are there any actions that could not be performed in this autopilot mode? What characterizes behaviors that do and do not require our conscious attention?

Suggested Readings

Eagleman, *Incognito.*

Mlodinow, *Subliminal.*

Take Control of Your Automatic Brain

Suppose you want someone to understand and respond to what you're saying, and you're in a noisy place. Talk into their right ear. There are stronger connections between the right ear and the left side of the brain, and it's the left side of the brain where language processing takes place for most people. Researchers asked people for favors in a noisy disco, and they received a lot more yes responses if they talked to the right ear than the left.

Suppose you very recently saw something unpleasant, something you'd prefer to forget. Play video games for a while. The full consolidation of experiences into permanent, long-term memories takes 24–48 hours. Research participants who played a video game called Tetris after watching a traumatic film experienced fewer intrusive memories during the subsequent week compared to participants who did not play the game. What if you've just seen something wonderful, something you'd love to remember? Avoid playing Tetris.

Want to get more done today? Pick the hardest thing on your to-do list and do that first. Human willpower and creativity, mediated by activity in your prefrontal cortex, are limited resources. The effort you expend starting with easier tasks, however nice that might feel, will reduce the probability that you'll have enough gas left in the tank to tackle large challenges later. The brain relies on glucose and oxygen to maintain its activity; as you use these up, the regions of your brain involved in self-control function less optimally.

The human brain is a network of about 100 billion interconnected neurons. The connections between those neurons, the synapses of the brain, number in the trillions. Everything you've ever seen, heard, thought, or done has emerged from the intricate patterns of chemical and electrical activity produced by this amazing organ. There's a commonly repeated myth that we only use about 10 percent of our brains. This 10 percent claim is certainly, certainly false. A variety of techniques have been developed that are able to sense and record the patterns of activity in a living, working brain. Those studies demonstrate that, even for basic, everyday tasks, almost the entire brain is active.

While it's clear that we use far more than 10 percent of our brain, there's some truth to the notion that we only understand about 10 percent of what's going on in the brain. Cognitive neuroscience has learned a great deal about how the brain functions, but the brain remains one of the great mysteries in all of science. The past few decades have seen an explosion in our understanding of the brain and how it mediates human behavior. Technologies such as functional magnetic resonance imaging, or fMRI, have made it possible to watch the patterns of activation associated with real-time thinking. We have the tools now to look under the hood while the brain is running, without opening the skull to look inside.

In this course, I'll discuss a lot of that science, and many of the fascinating discoveries that have been made. In the process, however, I want to teach you some great ways that we can apply this new knowledge in our everyday lives. My favorite tips are those that are counter-intuitive—that is, tips where our own, common sense, conventional wisdom thinking suggests that one type of behavior is the best to pursue, but data from carefully conducted, brain-based studies suggests that the opposite is actually the best way to go.

Here's a great example of one of those counter-intuitive tips. When you set a challenging, long-term goal for yourself, don't tell anyone about it—or, at the very least, tell as few people as possible. The fewer people you tell, the greater your chances of actually achieving that goal. This runs counter to how most people behave. If I think about it and decide that I'm going to run a 26.2-mile marathon, I'm quite likely to talk with people about it. For one thing, all that running work is going to take up a lot of time. As I build up my weekly mileage, it will become a bigger and bigger part of my day, a bigger and bigger part of my life. As I'm having conversations with my family, friends, and colleagues, it's likely it will come up.

As I talk to more and more people, I will have gone on the record with this goal. Many people have an intuition that this public declaration will make it more likely that you will accomplish the goal you've chosen. If I decide at some point after a few months of training that I don't really want to run that marathon anymore, I might be more likely to stick with it. If I quit, I'll have to deal with the shame of telling all of those people about my failure. Research suggests that telling people about your big goal won't increase the chance of succeeding at all. On the contrary, the more people you tell, the less likely that you'll succeed.

Peter Gollwitzer and his collaborators have conducted many studies of goal-directed behavior over the years. In a typical experiment, participants are recruited who are highly motivated to achieve some goal; they respond on a survey indicating a high level of motivation and commitment. In one study, students were asked to commit to spending more time studying. In the control condition of that study, the students were then released and contacted later to assess how much extra studying they actually did. In the experimental condition, participants were asked to announce these intentions to a group of their peers.

The surprising result was that the participants who made this public announcement of their intention were significantly less likely to follow through on it. In this particular experiment, they studied for significantly fewer hours. In some versions of this type of study, the goal intention is expressed to a group of peers; in other cases, to just a single individual. In some studies, the goals are about long-term careers and parenting plans; in others, about short-term plans. The basic result seems to hold across all of these different studies.

Now, this experiment focused on study habits. That's really different from training for a marathon. On the surface, it is, of course, but the two situations have a lot in common. In both cases, someone is highly motivated to do something, and making plans to change his or her behavior for an extended time in the future. In both cases, achieving the goal will result in great satisfaction. In both cases, it's a goal that either could be kept private or could be announced.

It's easy to think of many situations that have an underlying similarity to the aspirational goal of the students in this study: to plant a garden, to improve eating habits, to be more social. It seems reasonable to generalize this finding from the student study aspirations to other aspirational goals as well. Researchers describe the difference between people's plans and people's actions as the intention-behavior gap, the all too common difference between what we intend to do and what we actually do. Announcing your goals seems to widen that gap. Why should this be? Getting positive reinforcement and creating that public expectation about your big goal seems like it should help. Why doesn't it?

In answering these questions about why you should keep quiet about your big goals, I want to consider some things about how the human brain functions. In particular, I'll argue that you don't consciously control your behaviors as much as you think you do. This is a counterintuitive idea, but it's central to a lot of modern brain science.

Now I'm not going to argue that you don't possess free will, although there are philosophers who do argue this based on the evidence that I'll describe. For the moment, let's consider the smaller goal of figuring out how your brain decides to do something simple, not something hard, like running a marathon or not. Let's consider how your brain decides when to move your hand.

Right now, you're listening to a lecture about how the human brain functions and about how you can get better use of your brain. You might be sitting in a chair or driving a car or getting some exercise; you hear sounds, you smell smells, you see a surrounding environment. You are aware. You are conscious. One of the things that we associate with consciousness is that it drives our action choices. If I consciously choose to look at something or not to look at something, then my looking will do what I've consciously decided to do. If I find myself moving my hand, it is presumably because, a few moments before, I chose to move it, right?

By the late 1970s, Benjamin Libet was already an accomplished neuroscientist who was interested in these seemingly simple questions. He published a large number of studies illuminating our understanding of how the brain functions. For a decade, Libet had been fascinated with trying to understand how the brain produces this conscious experience that we all have. What does the brain do when it's conscious that it doesn't do when it's not?

Libet worked with a large group of patients who were undergoing brain surgery. For many brain surgeries, the patient remains awake and aware throughout much of the procedure. The brain has particular circuits that register pain—if you stub your toe or hit your thumb with a hammer, signals are sent from that body part to the brain that cause us to experience pain. However, when the brain itself is touched or even cut, there's no sensation of pain. As such, it can be very useful for the surgeon to have the patient awake as the procedure takes place. By stimulating some area of the brain and observing the patient's response, the surgeon can be sure about what an area does before making any cuts.

During these procedures, with the permission of the patients, Libet would present brief, mild electrical stimulation to particular sensory regions. For instance, participants in one study would receive stimulation to the somatosensory cortex. This is a region located near the top of your brain, a little more than halfway between the front and the back. This region registers sensations of touch for different regions of the body. If something touches me on the hand, it sends a signal to a particular spot in my somatosensory cortex. That activation corresponds to my experience of the sensation. If I stimulate that same region of the cortex, I'll feel something touch my hand, even if nothing actually does.

Libet's experiments suggested that, in order for a patient to become conscious of something, 500 milliseconds of brain activity had to be produced—half a second of brain activity. A very brief stimulus, say a brief tap on the hand, could produce activity in the brain, but, if that signal was in some way interrupted before 500 milliseconds had elapsed, conscious awareness of it would not occur. Note here that we can certainly perceive and become conscious of events that are far shorter than 500 milliseconds in duration. If there's a bright flash of light that lasts only 10 milliseconds, you'll see it, and be conscious of it, but when you become conscious of that light, it will be mediated by a burst of neuronal activity that's at least 500 milliseconds long.

This timing issue occupied many years of Libet's subsequent research. In 1983, he conducted one of the most fascinating and influential studies of the human brain ever. The design of the experiments itself was quite simple. The simplicity of the procedure is, I think, largely responsible for its tremendous impact.

If you were a participant in this experiment, you would watch a dot, moving in a circle, around a clock face.

Your task in this experiment is simply to watch the dot and, from time to time, flex your wrist. It's key that you don't decide in advance that you're going to flex your wrist, say, when the dot reaches zero or any other number in particular. Just watch the clock face, and when you feel like it, move your hand.

The presumption of most people—indeed, most researchers at the time—is that this process starts with a conscious decision to move, that the participant decides that, for instance, now is the time to flex the wrist. Once that decision is made, researchers used to believe that a signal is sent from some part of the brain, wherever the conscious decision has been made, to the motor cortex. The motor cortex then generates a command that's transmitted, via the cerebellum and the spinal cord, to the muscles in the forearm that control the flexion of the wrist. All of this happens very quickly, of course, but it happens in this order: conscious decision, then motor commands, then the motion itself. Or so we used to think.

While participants were performing Libet's simple task, they were wired up with a variety of different instruments. First, an electroencephalograph, usually called an EEG, was placed on their scalp. This instrument enables us to record tiny electrical activities that are produced by neural activity in the brain. A separate set of sensors would record when the muscles were activated and when the movement of the arm occurred.

After each movement, the participant would report when he or she first became aware of the intention to act—that is, where the dot was located on the screen at the moment that they decided to move. A very consistent pattern emerged when Libet examined the timing of this data.

When we perform a movement like a wrist flexion, the motor cortex builds up activity for about 500 milliseconds prior to the onset of an action. When that buildup peaks, the signal is sent to the muscles, and the hand moves. But participants in the study only became aware of their decision to act about 200 milliseconds before the action occurred.

For instance, a typical participant experience might be that he decided to move his wrist when the dot was next to the number 10 on the clock. About 200 milliseconds later, say when the dot was next to the number 15, the hand would actually move. But the readiness potential, the readiness potential associated with the action, occurred earlier than when the dot was by the 10. By the time the dot was by the number 5, as much as 300 milliseconds before the participant experienced the conscious decision to move, the decision had already been made.

If you think about this for a moment, something very counterintuitive is present in this data. The motor cortex starts to create the action a full 300 milliseconds before the participant decides to make it. The decision was made before the conscious decision was experienced. The conscious decision, it seems, isn't the decision at all.

Now, I presume that the participant is still in control of his or her actions here—that is, something in the brain is still controlling the behavior. But the conscious decision? That seems not to be what's driving the behavior. The data suggest that there's a decision made somewhere in the brain—not a conscious decision, but a decision to act. The part of the brain, wherever it is, sends a message to the motor cortex, telling it to act. A few 100 milliseconds later, a message is sent to our conscious awareness as well, letting us know that the decision's been made. But that conscious experience of the decision is just not what makes the choice.

In this particular study, the lag time between the decision process and the conscious experience process is about 300 milliseconds. Other studies using functional magnetic resonance imaging have suggested that, for some types of decisions, the lag time can be several seconds long. In studies like this, participants might be shown a series of images and asked to make some decision about them: "Take a look at these pictures. If the face seems trustworthy, then press the button in your left hand. If the face doesn't seem trustworthy, then press the button in your right hand." You lay there in the fMRI scanner and look at the faces. You ponder whether each face looks trustworthy or not. As you're pondering, activity begins increasing in either your left or right motor cortex, the one that will cause the right or left hand to press one of those buttons. At some point, this activity becomes great enough that it causes a movement of the hand.

But, well before the hand moves, indeed several seconds before you're even aware that you've made a decision, the person running the fMRI scanner can accurately predict the choice that you'll make. The decision has already been made several seconds before you become consciously aware of it. Your conscious experience of making a decision follows an unconscious process that's actually in control.

Some recent studies by Alvaro Pascual-Leone have really nailed this finding home. He used a technique called transcranial magnetic stimulation, often abbreviated as TMS. Using TMS, we can send a jolt of electromagnetic energy through the skull to the cortex and cause a burst of activity. If that burst is sent to the correct spot in the motor cortex, for instance, it's possible to make your arm twitch. If I stimulate a spot in the right motor cortex, the left hand twitches. For a corresponding jolt in the left motor cortex, the right hand will twitch. Our sensory and motor systems all, by the way, have this crossover or contralateral organization.

Remember that tip I mentioned about whispering into the right ear to access the language processing regions in the left half of the brain? That study conducted by Luca Damasi and Daniela Morzoli is another example of this crossover organization of the human nervous system. Neurons on the right side of the brain mediate perceptions and actions on the left side of the body, and vice-versa.

Pascual-Leone asked his participants to watch a screen, and, when they were cued, to decide whether they would twitch their left or right hand. They weren't supposed to move right away, just decide how they would move a few seconds later. After a delay of a few seconds, a second cue was delivered, at which point the participant made the movement they had decided to make. It's really simple, right?

OK. Firstly, you already know that we can tell how people are going to move before they do so. Indeed, it's possible to know how they're going to move even a few 100 milliseconds before they do. If you think about moving your left hand, even if you don't actually move it, your right motor cortex activates a bit. For many of the trials, Pascual-Leone didn't do anything but record these activations. Participants would get the first cue, they would decide to move one hand or the other, then the second cue would occur, then the participant would move—nothing surprising there yet.

In some trials of this experiment, Pascual-Leone would deliver a TMS jolt to the motor cortex that the participant had chosen to move. The participant would move, but, by and large, not even notice anything here. The experimenters were causing the hand movement by stimulating the motor cortex, but the participants were about to do that same thing themselves anyway.

For a few key trials in this experiment, however, when the signal to move was given, Pascual-Leone would deliver a jolt to the motor cortex that the participant had not selected. This would cause the wrong hand to move. Let's think this through for a second. The participant decides, "I'm going to move my right hand when I get that signal to move." Then the participant waits, the signal arrives, and, at the same time, a TMS jolt is delivered that makes the left hand move instead.

Now, if our conscious experience of decisions is in control, this should feel strange—really strange, to say the least. You've decided to do one thing, but your body has been hijacked and made to do something else. If you were suddenly not in control of your own actions, it should feel very, very strange. The strangest thing about the results of this study is that it doesn't feel strange at all—the participants don't even seem to notice that their brains have been hijacked. It's not at all strange to them that something else is in control of their decision-making.

Most participants have a very simple description of the experience. Why did you move your left hand? Your brain activity made it seem like you were going to move your right hand. Most participants had a nonchalant answer: "I just changed my mind."

In this experimental situation, it's clear that the conscious decision is not in control of the action—the experimenter is in control of the action. The surprising result here is that participants don't feel strange when they don't have conscious control of their own movements. These experimenters argue that this is because we aren't typically in control of those movements, even when we aren't hooked up to a TMS stimulator in this type of experiment. The results of the studies by Libet, Pascual-Leone, and others suggest that it doesn't feel unusual—indeed, that it isn't unusual—for our conscious mind to not be in control of our actions.

These were the first studies to show that the experience of conscious decision-making happens after the real decision, an unconscious decision, is made. Results like these suggest that consciousness goes along for the ride. Whatever you choose to do, at any given moment, happens largely unconsciously. What does consciousness do? Well, firstly, it seems to take credit for something it's not actually doing. Secondly, conscious experience seems to step in and tell a story after the fact. I moved my right hand; therefore I must have decided to move my right hand. My wrist flexed, I must have decided to do that. I decided to quit running—I guess that marathon goal wasn't so important to me.

There may be many factors responsible for these decisions, but they were factors that influenced processes that are not intentional, are not explicit, a process that isn't conscious in nature. If you want to outsmart yourself, to change your own behaviors, often deciding to change your behavior is only one, very small step toward that. Indeed, the important things that you do to alter your behavior have to influence the systems that are in control, that are making the decisions. Specifically, you need to do things that influence those automatic, unconscious decision-making systems. This course will described a lot of methods for doing just that. For instance, if you want to achieve a long-term goal, don't broadcast what you're trying to do.

Does this research on unconscious control mean that we have no conscious, intentional control over our own behavior? Even Libet wouldn't have argued this extreme position. Indeed, a lot of his follow-up work was devoted to characterizing the ability of participants to make a conscious decision to veto an action between the time when the brain starts to create it and when it actually occurs.

What I do want to argue is that automatic brain processes provide a really sensible explanation for these situations in which we decide to do one thing, but then actually do something else. I might consciously decide that I'm not going to eat cookies anymore, but the part of my mind, the part of my brain, that makes that conscious decision isn't the only driver of my behaviors. Indeed, it seems that it isn't the biggest driver of my behaviors on a moment-to-moment basis.

When I consciously decide to do something—cut back on cookies, exercise more, whatever—a part of my brain has changed. It's determined that I have a goal of changing my behavior. That's great, but it usually just isn't enough. My conscious experience is along for the ride with an enormously complex and powerful brain. So how do we change our behaviors? When someone does change their behavior, how do they do it?

Almost everyone periodically has the experience of doing something on autopilot, particularly for activities we do every day. Think about the last time you took a shower. Do you remember deciding to pick up the shampoo and wash your hair? Do you remember deciding to pick up a towel to dry off? If you're like most people, you just don't. The dozen things you did in the shower were decided and controlled with little or no conscious thought.

I drive the same route to drop off my kids at school and go to work almost every weekday morning. On Saturday, when I'm driving to the supermarket, I sometimes accidentally drive this same route. As I turn down the road toward my kids' school in these situations, I kick myself. What am I thinking? Well, I'm not—that's the problem. I'm not thinking, as usual, but this time, it's not a problem.

This unconscious control of our actions isn't always a bad thing. You probably thought about other things while you were unconsciously showering. When I accidentally drive to school on a Saturday, it's usually because I'm having a good conversation or thinking about some problem I'm trying to solve. If you can control your behaviors without conscious focus, it frees up that conscious thinking to do other things. Your unconsciously controlled mind isn't your enemy—it can be amazing. It's unfortunately not always in immediate agreement with your conscious thinking.

So, how is all of this related to our tip? If you decide to set a long-term, challenging goal for yourself, why is it important to avoid telling people about it? When you decide to undertake that goal, you probably have many important, consciously considered reasons for doing so. You might admire someone else who's accomplished a similar goal. Perhaps you have a mental or physical health reason for pursuing the objective. Maybe you want to improve your fitness, for instance.

One of the reasons, however, is almost certainly so that you can derive that wonderful sense of satisfaction that comes from picking a hard challenge and then overcoming it. When you do this, when you set a goal and achieve it, your brain gives itself a positive shot of pleasure.

Humans—most animals actually, not just humans—are born with a strong desire to influence the world around them. Even human infants show this tendency. When a baby's actions cause a predictable outcome, the baby does two things. First, whatever those actions are that caused the predictable outcome, the baby performs those actions again—a lot. Second, the baby gets really happy. Influencing the world around us is a fundamental human desire, a fundamental human drive.

When we choose to do something and then succeed in actually doing it, our brain delivers a shot of a neurotransmitter called dopamine to the nucleus accumbens—this is a pleasure center of our brain. When you decide that you want to achieve some goal, your body begins to prepare itself for that coming pleasure associated with the accomplishment. Until you succeed, you won't get it, of course, unless you somehow short-circuit things. If you tell people about your goal, and they give you associated positive support when you tell them, you get a little bit of that sense of accomplishment, a little of that pleasurable boost. In a very real sense, you reduce your drive to achieve that goal at all. It's great to set, pursue, and achieve big goals—there's nothing as inherently satisfying, perhaps anywhere else in life, so, by all means, set goals and chase them. If you want to improve your chances of achieving them, however, don't announce it.

Now it is possible when you tell someone about a goal, he or she may provide important support that will help you to achieve the goal. With the right person—a close friend, maybe a life coach—the benefit of that support might outweigh the costs associated with telling the person and reducing your brain's limited resources. So, there might be times when it is good to tell someone about your goals.

This course will explore a wide range of different aspects of human thoughts and decisions using approaches that exploit what is known about how our brains really work. Cognitive neuroscience and related fields have discovered a lot about what your brain does when you're engaged in different types of behaviors. During these lectures, I'll present a lot of those discoveries. You'll learn a lot of fundamental and sometimes leading edge information about how the human brain functions.

Along with making you more aware of how the human brain works, this course will focus on situations where this knowledge can help with specific, real-world challenges. There are times when some pattern of brain activity and some set of associated behaviors tend to produce better outcomes than others. One of the primary things that this course will focus on is identifying those brain-based opportunities for behaviors with better outcomes. I'll identify these opportunities as tips, tips that you can use to improve your own thinking, decision-making, behaviors—ultimately, I think this information can lead you to a happier, more fulfilled life.

Some of these tips may seem like common sense, but there's a lot of common sense advice that's not supported by scientific study. Sometimes, careful research contradicts common sense advice. Research can demonstrate that something very counterintuitive can lead to better outcomes. Moreover, sometimes, different pieces of commonsense advice contradict each other.

In terms of getting things done, you should never put off till tomorrow what you can do today, but don't cross that bridge till you come to it. In the domain of romance, opposites attract, but birds of a feather flock together. Familiarity breeds contempt, but home is where the heart is. So, even when a tip seems intuitive, knowing when and how to apply it can be just as important. I look forward to exploring this newer and deeper understanding of human behavior and the brain with you. The material is important and fascinating, and much of it's immediately relevant in our everyday lives. You can travel to the top of Everest or the bottom of the deepest ocean; you can even travel into the great unknown of outer space. You will, I firmly believe, find no greater beauty or adventure than you will in the inner space of the human brain.

Lecture 2

Beat Procrastination by Doing Nothing

Somewhere between 80 percent and 95 percent of people engage in procrastination on a regular basis. In fact, 50 percent of people report that they procrastinate consistently and that their procrastination frequently causes problems in their lives. An H&R Block survey revealed that procrastination-related errors cost taxpayers an average of about 400 dollars per year. Procrastinators also report feelings of distress, anxiety, and guilt. In this lecture, we suggest ways to outsmart yourself and reduce the frequency and severity of procrastination. These tips and strategies are based on an understanding of how the brain functions as it makes decisions and how the brain responds to different types of reinforcement.

Tip 1: Don't Just Do Something; Stand There

- To break free from the grip of procrastination, sit quietly and think for 15 to 20 minutes about what you are going to do. This tip may seem counterintuitive, but there is good evidence that it works. Sitting still can break the cycle of delay, distraction, and time wasting. Several studies that include an explicit relaxation period demonstrate that this practice reduces the frequency of procrastination.

- As we've already learned, a decision to do something does not necessarily lead to action. Something else is in control of many of our moment-to-moment choices and behaviors: the unconscious mind.

- Brain systems in the prefrontal cortex seem to control our intentional, planned behaviors. Consider what happens if this prefrontal cortex is damaged. One of the most famous patients in the history of neurology was Phineas Gage, who suffered a traumatic brain injury in his work as a railroad construction foreman in the 1800s. When he was 25 years old, there was an accident with dynamite, and a long metal rod went straight through his head and came out the back.

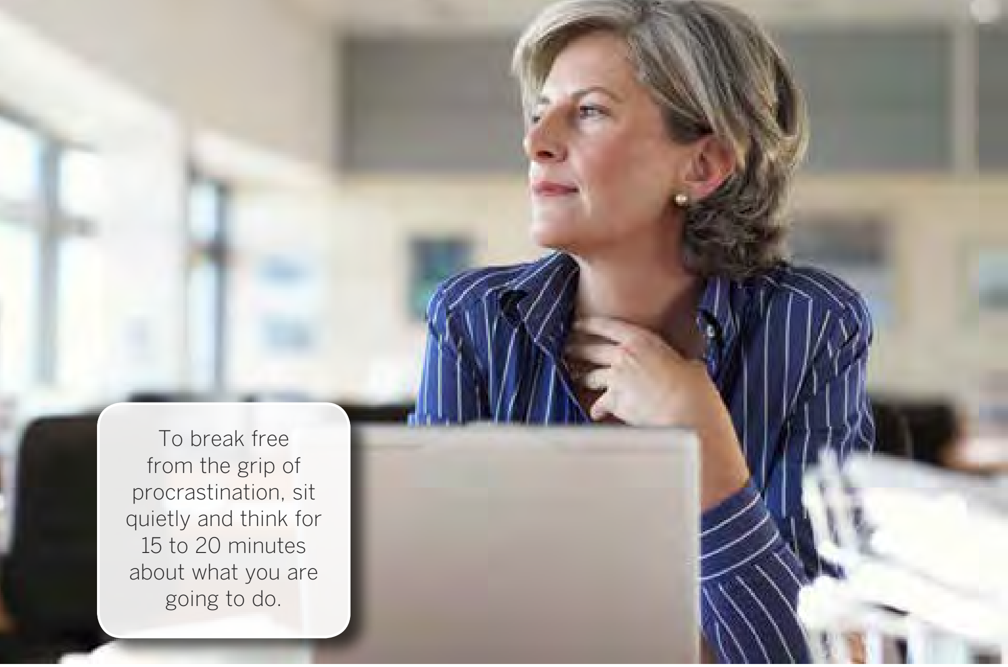
- Amazingly, Gage survived. His personality changed radically, however. The rod had severely damaged Gage's prefrontal cortex. Gage became lazy and lost his capacity for long-term strategic planning. The prefrontal cortex gives us the ability to make long-term work plans and stick to them.

- While the prefrontal cortex is vital, it is not the only system that regulates our decisions. Some researchers refer to an unconscious system of habitual, automatic behaviors that functions like an autopilot. The cortex participates somewhat in the release of these habitual, automatic behaviors, but the primary control of them seems to be based on circuits in subcortical regions of the brain. This unconscious habit system is particularly sensitive to immediate needs and short-term goals.

Procrastination and Anxiety

- Procrastination is often associated with anxiety. A number of studies have found that people who tend to be more anxious in general are more likely to struggle with procrastination. When procrastinators are interviewed about the tasks they avoid, they often spontaneously mention tasks where they have a fear of failure.

- The amygdala is a small region of the brain located deep in the medial part of the temporal lobe. The amygdala is a key part of the limbic system of the brain, which is strongly associated with many of our emotional responses to various stimuli. The limbic system structures are small in comparison to the larger cortex structures on the top and outer parts of the brain, but they are highly interconnected with other



To break free from the grip of procrastination, sit quietly and think for 15 to 20 minutes about what you are going to do.

parts of the brain. When you feel anxious, your entire nervous system changes the very nature of its function.

- Procrastination is associated with a great deal of activity; however, it consists of activity directed at less-important pursuits with an immediate reward. In fact, anxiety avoidance is a standard example of negative reinforcement. You feel a negative stimulus—the anxiety. You perform some behavior—procrastination—and the anxiety is reduced. This is a very easy habit to develop and a challenging one to break.

- There are two main reasons that the strategy of sitting and doing nothing for 15 to 20 minutes is effective in reducing procrastination behaviors. First, intentionally doing nothing will prevent you from engaging in avoidance behaviors that are the real grist of the procrastination mill. Second, as you sit and think about the work that you might do, the anxiety will likely abate.

Tip 2: Avoid Choking under Pressure

- A second strategy to reduce the frequency and severity of procrastination is to avoid feeling too much motivation to complete a task. Motivation is much like pressure, and too much pressure can lead to choking under pressure. Too much motivation can actually reduce the amount and quality of performance. Cognitive neuroscientists refer to this as the Yerkes-Dodson law.

- Imagine that you ask a group of experiment participants to shoot a series of basketball foul shots. You also give another group of study participants the same task under the same experimental conditions but with some extra motivation: one dollar for each successful shot. If people know there is some money on the line, they are likely to take the shots a little more seriously and probably make a few more shots. If you offer five dollars per shot to another group, you're likely to get even better performance. In general, more motivation results in better performance—but only to a point.

- If you bring in another group of participants and offer them 1 million dollars for every successful shot, they will likely not improve their performance above that of the five-dollar group. Ironically, the most likely outcome is that they will perform worse. With too much motivation, people choke under pressure.

- If you want to reduce your own tendency to procrastinate, it's a good idea to keep the significance of your work in perspective. While your work may be vitally important, the sun will still rise tomorrow morning.

Tip 3: Break Large Goals into Smaller Tasks

- A third tip for reducing procrastination arises directly from the concept of motivation. This strategy uses the pleasure center—one of the subcortical unconscious control systems that live deep inside the brain. If you want to reduce procrastination, break any large project into parts. As you complete these small parts, keep track of your progress. Even if the project itself isn't an enjoyable one, simply seeing yourself move closer to the finish line can produce pleasure.

- Humans act because of choices made by unconscious systems within our brain. Rat brains seem to work in the same way, especially under standard laboratory conditions. Rats respond to reinforcement. If you give a rat food whenever it presses a lever, then it will press the lever more frequently in the future.

- One of the central parts of the circuit involved in processing pleasure is called the nucleus accumbens, located in the basal forebrain, tucked up underneath the cortex near the front of the brain. Many of the neurons found there respond to neurotransmitters called dopamine and serotonin. Neurotransmitters are chemical substances produced by the body—many in the brain itself—that influence the function of neurons. Sometimes neurotransmitters can be excitatory, which means they cause a set of neurons to become more active. In other situations, a neurotransmitter will be inhibitory, reducing the activation of a set of neurons.

- The nucleus accumbens is linked to a variety of other areas of the brain that motivate particular actions. If a rat is hungry, this circuit will drive the rat to perform behaviors that it associates within finding food, such as searching and sniffing. If the rat learns to associate pressing a bar with getting food, then when the hungry rat presses the bar, the nucleus accumbens will be activated, and the rat will experience pleasure.

- Many neuroscientists who study learning and motivation describe the nucleus accumbens circuit as the driver of the whole system. The rat seeks food, water, comfort, other rats, and so on, but all its behaviors come back to a single motivator: the drive to release dopamine into the nucleus accumbens.

- Humans also have a nucleus accumbens—two of them, in fact, in the left and right sides of our brain—and many of our behaviors, particularly unconsciously controlled behaviors, are driven by a desire for dopamine in the nucleus accumbens. When you are hungry and feel the pleasure of a delicious meal, it is your nucleus accumbens dopamine-related activity that gives you that pleasure. In fact, the dopamine-related activity is itself the pleasure.

Celebrate Small Successes

- Consider another type of activity that gives us a shot of pleasure: controlling and affecting the world around us. If we perform some action, and the action causes something we intended to come to pass, we experience pleasure.

- The desire to control the world around us is very fundamental. In fact, even babies seem to experience it. If you put a baby into a crib under a mobile that shakes from time to time, the baby will watch and sometimes kick her legs. If you connect her leg to the mobile so that the mobile shakes when she kicks her legs, the baby will continue to kick. Even a three-month-old baby will learn the relation between action and an environmental outcome in just a few minutes.

- When we decide to take on some challenge and then succeed in accomplishing it, we get a boost of pleasure—a shot of dopamine-related activity in our nucleus accumbens. We don't, however, get that burst of pleasure while we're actually pursuing the goal. We get it when we accomplish the goal.

- Think of yourself as a rat! Imagine you have a big project, one that has been driving you to procrastination for a while. Completing the project will be a huge success and gain you a sizeable reward. Think of your reward, for the moment, as a big pile of rat kibble. Rather than leave all the kibble in one big pile at the end, this tip suggests that you should spread it out. Arrange it in a line between your current location and the location where you want to be.

- As you complete small subtasks, you will earn yourself little pieces of kibble—and receive the associated releases of dopamine to your nucleus accumbens. When you achieve those subtasks, make a point of celebrating them. Keep feeding your pleasure centers enough motivation to keep yourself moving along. Stay focused on the same project long enough so that you achieve the significant goal at the end.

Questions to Consider

1. Beta-blockers are medications that block the receptor sites for adrenaline and noradrenaline, neurotransmitters associated with anxiety. When people take beta-blockers, they tend to feel fewer effects of anxiety. Would it be effective for someone with chronic procrastination to take beta-blockers?
2. Steve Jobs was known to yell at his computer engineers to motivate them. Some people work better when they receive strong motivation like this; the performance of others greatly declines. How could you decide which type of motivation is best for another person? Which type of motivation is best for you?

Suggested Readings

Allen, *Getting Things Done*.

Tracy, *Eat That Frog!*

Lecture 2 Transcript

Beat Procrastination by Doing Nothing

In this lecture, I want to talk with you about procrastination. I'll talk about some of the reasons that humans procrastinate, and suggest some ways to break free from the stressful, counterproductive, vicious cycle of procrastination.

Most surveys reveal that 80–95 percent of people engage in procrastination on a regular basis. Fifty percent of people report that they procrastinate consistently and problematically, that their procrastination causes problems in their lives on a frequent basis. College students report that procrastination can occupy as much as 30 percent of their daily activities—that is, upward of a third of the things that they do each day are done while avoiding doing something else that they should be working on.

H & R Block did a survey that revealed that procrastination-related errors cost taxpayers an average of about $400 per year—that all adds up to hundreds of millions of dollars in overpayments. Procrastinators also consistently report feelings of distress, anxiety, and guilt about their procrastination. Someone might spend a lot of time doing fun things to avoid doing something unpleasant. As he does this, his performance will suffer because of it, and he won't even really enjoy those fun things. This is a big problem; there are a lot of people out there who suffer a lot with this.

Fortunately, there are things you can do to outsmart yourself here, things you can do to reduce the frequency and severity of your procrastination. Many of these strategies have been empirically tested and found to work. Much of that research connects directly to our understanding of how the brain functions, how it functions as it makes decisions about how and when to act, and how the brain responds to different types of reinforcements.

I can't promise you that the tips here will end your procrastination, but there's really good evidence that they'll reduce it. This will make you more effective at achieving your big, long-term goals. It will reduce the anxiety, guilt, and general distress that comes with procrastination.

OK, here's my first tip about what to do when you're having trouble getting started working on a project, how to break free of the grip of a particular bout of procrastination: sit quietly and think for 15–20 minutes about what you're going to do. This is a counterintuitive tip. If you want to get started doing something, doing nothing doesn't seem like it would help, but it often does. Usually, procrastination doesn't involve doing nothing. When I don't want to get started on writing a new lecture—just a hypothetical here, of course—I don't sit and do nothing. On the contrary, I find something that will engage me so I don't have to think about the thing I'm avoiding. I clean the kitchen. I organize my closet. I walk the dog. I alphabetize my bookcase and straighten all of the piles on my desk. Maybe I respond to some emails. Put this all together, and now a few hours have passed; I'm tired. The workday might be winding down. Maybe it would be best to get a fresh start on that lecture tomorrow. And voila, I've gone another day without working on the one thing that, ironically, is most important to me.

It might seem counterintuitive that the best thing to do to stop procrastinating is to intentionally do nothing for 20 minutes, but there's good evidence that it works. It can break this cycle of delay, distraction, and time wasting. Several studies that include an explicit relaxation period have obtained evidence that this practice reduces the frequency of procrastination. For instance, it was tried in college students who are asked to complete weekly writing assignments.

To understand why 20 minutes of quiet thought can stop the procrastination cycle, let's consider for a few minutes why procrastination happens in the first place. Procrastination, by definition, is a self-defeating behavior that involves putting off actions that should be performed promptly given existing goals and information. You think about what's most important to you, about what tasks are most worthy of your attention at any given time. You want to make progress on that task. You know that if you don't make progress on that task that you'll feel bad about it. As you consciously consider what you want to do, the correct choice is absolutely clear, no doubt. You then sit down—and do something else.

There's a lot of evidence that our behaviors are often not under our conscious control, certainly not the way we usually think they are. The experiments that come to mind there typically involve electrodes, brain activation, neuroimaging, and high-tech stimulation of the motor cortex. Those studies are really compelling, of course, but there's a source of evidence here that's almost as good. We decide to do something, but that doesn't mean that we actually will do it. There's something else that's in control of a lot of our moment-to-moment choices and behaviors: an unconscious mind.

Brain systems in the prefrontal cortex seem to control our intentional, planned behaviors. Consider what happens if this prefrontal cortex is damaged. Phineas Gage was a brain-injured patient from the 1800s, perhaps the most famous in the whole history of neurology. He worked as a railroad construction foreman. When he was 25 years old, there was an accident while he and his crew were working with dynamite to blast through some rock. A long metal rod, a tool called a tamping iron, was forced through his head at high speed. It passed entirely through his head, flew up, landed point first in the ground about 80 feet away.

Amazingly, Gage didn't die. Within a few days, he was again conscious and able to speak, able to move. But his personality changed radically thereafter. The tamping iron severely damaged Gage's prefrontal cortex. Afterward, he seemed very bad at controlling himself—he tended to behave very compulsively in social situations, for instance.

One of the things that's often mentioned in later writings about Gage's personality is that he became lazy. He could do a little work around his parents' farm, but never more than a half-day at most. His long-term, strategic planning was just shot. If he were around today, I'm quite confident he would be among the worst of procrastinators. When we make long-term work plans and stick to them, it's this prefrontal cortex system that seems to make it possible.

The prefrontal cortex is important, but it's certainly not the only system that regulates our ongoing decisions about what to do and not do. Some researchers refer to a more unconscious habit system that functions like a sort of autopilot. Think about your morning routine: you get up, maybe you walk to the kitchen, make some coffee, head to the bathroom for a shower, and so on. You almost certainly don't wake up and think about whether or not to do these things; they're just habits.

The cortex participates somewhat in the release of these habitual, automatic behaviors, but the primary control of them seems to be based on circuits in the subcortical regions of the brain, the part of the brain located under the cortex, near the middle of the brain. This autopilot habit system is particularly sensitive to immediate needs and short-term goals. If you're hungry, this is the system that will get you to the refrigerator. When you wake up and crave some caffeine, it's this part of your brain that gets you headed toward the kitchen. This system is particularly bad at using information about long-term goals, particularly goals for which the associated rewards or pleasures are delayed, for instance the rewards that come from completing a large, multi-week project, precisely the type of project that's especially subject to procrastination.

In terms of the human ability to plan and then execute long-term, goal-directed behaviors, most theories about the human brain consider that there are at least two very distinct systems. There's one associated with the prefrontal cortex—this is the place where our brains compute and plan those long-term goals. This is where that conscious calculation takes place about what's most important and what we should be doing.

Procrastination is often associated with anxiety. A number of studies have found that people who tend to be more anxious in general are more likely to struggle with procrastination. When procrastinators are interviewed about the tasks they avoid, they often spontaneously mention that those are tasks where they have a fear of failure. If there's something that causes anxiety for you—a fear of heights, fear of vicious tigers, fear of snakes; anything—then, when you're confronted with that source of anxiety, you can make yourself feel a whole lot better by simply moving away from it. If a big project is a source of your anxiety, then it's quite natural to feel a desire to avoid it.

There are particular neural systems associated with that stressful anxiety feeling. One of the critical components is called the amygdala. This is a small almond-shaped structure; it's located deep in the medial part of the brain's temporal lobe. The amygdala is a key part of the limbic system of the brain, which is strongly associated with many of our emotional responses to various stimuli. These parts of the brain I'm describing are small when compared to the much larger cortex structures located on the top and outer parts of our brain, but they're highly interconnected with other parts of the brain. They're connected to and modulate the function of the hypothalamus, the hippocampus, and a wide range of cortical regions. When you feel anxious, your entire nervous system changes the very nature of its function.

Now, when you are confronted with some anxiety-inducing stimulus—for instance, that project that you've been procrastinating—there are a wide range of things you could do to reduce that anxiety. And keep in mind, the drive to reduce anxiety is one of the most fundamental drives that we have—it's right up there with the drives for food and water. To reduce the anxiety, you could run out of the room to avoid the project. You could hide under a blanket. Or you could just find something else to distract yourself. Remember, people don't typically do nothing when they procrastinate. On the contrary, procrastination is associated with a great deal of activity, just activity directed at less important, more immediately rewarding activities.

The unconscious processes in your brain are very much subject to those basic principles of positive reinforcement and punishment. Actually, anxiety avoidance is a standard example of negative reinforcement. You feel a negative stimulus—the anxiety; you do some behavior—the procrastination; and the anxiety is reduced. This is a very easy habit to develop, and it's a challenging one to break.

Many procrastinators report—and I can certainly confirm this from my own personal experience—that they get to the end of a day and feel like they've been very busy. They know that they were active, that they worked very hard, maybe all day long. But when they look back on what they did that day, it can take a lot of effort to figure out just what it is that you did. A procrastinator will be able to tell you in great detail what he or she did not work on that day, but the tasks that actually filled the time are much harder to recall. This makes sense—most of them were likely chosen without any conscious thought.

There are two big reasons that this sit and do nothing for 20 minutes tip works to reduce procrastination behaviors. First, doing nothing intentionally will prevent you from becoming engaged in those avoidance behaviors, the avoidance behaviors that are the real grist of the procrastination mill. Second, as you sit, hopefully take some deep breaths, think about the work that you might do, the anxiety will likely abate, at least somewhat—maybe not completely. As it does, you'll eventually get to the task at hand. Once you've spent some time thinking about what you want to do and why, you'll be far more likely to actually begin doing it.

I have a second, very related tip for reducing procrastination here. To reduce the frequency and severity of procrastination, you should avoid feeling too much motivation to complete a task. To reduce procrastination in the people around you, you should avoid communicating too much motivation to them. The first tip that I described, the sit for 20 minutes tip, was aimed at reducing the anxiety that seems to be responsible for a lot of procrastination. This tip is really a different way of accomplishing that same goal. Another word for motivation is pressure, and too much pressure can lead to something that we often refer to as choking under pressure.

Usually we think of adding motivation as improving performance, but too much motivation can actually reduce the amount and quality of that performance. Cognitive scientists refer to this in terms of something called the Yerkes-Dodson law. Imagine that I ask a group of experiment participants to shoot a set of 10 basketball foul shots. Let's imagine that this group is good enough to make some, but not all, of the shots—say, an average of around 4 out of 10.

Now imagine that I give another group of study participants the same task, under the same experimental conditions, but with some extra motivation, just a little. Every time you make a foul shot, I will give you a $1 reward. That's not a ton of money, but it's a decent motivator. If people know there's some money on the line, they're likely to take the shots a little more seriously. The participants will focus a bit more and likely make a few more shots, let's say 6 out of 10. If I offer $5 per shot to yet another group of participants, I'm likely to get even better performance, maybe 6-and-a-half out of 10 on average. In general, more motivation results in better performance, but only to a point.

If I bring in another group of participants and offer them $1 million for every shot they make, they will likely not improve their performance above that of the $5 per shot group. Ironically, the most likely outcome is that they'll perform worse, maybe even worse than the no reward group, the one from the very beginning of the experiment. With too much motivation, people often choke under pressure.

This notion that too much motivation can be a bad thing shows up very directly in this domain of procrastination. If your boss tells you that some particular project is absolutely critical to the survival of the company, and also to your continued employment at it, that would represent some very strong motivation. Too much motivation, however, can lead to greater anxiety and thus more frequent procrastination. If you're giving someone else a task to perform, you should keep this in mind. Motivation, in the right amounts, is clearly good for promoting quantity and quality of work. Too much motivation and people will tend to feel anxiety that degrades that performance.

It's hard to quantify exactly what the right amount of motivation is for any given person in any given situation. In general, I can confidently tell you that it's possible to give someone too much motivation. If we want someone to get more done, it's natural to presume that we should give them as much motivation as possible. As you work with someone, you need to search for that just right level of motivation. In some cases, the best thing to say to someone, someone who seems stuck, is that they should relax—make some progress on that task today and that'll be fine. Ironically, for the right person, this "don't worry about it approach" might result in a whole lot more work on the project in question.

Now, we don't often get to choose how much motivation we're given. Indeed, the pressures of life often dictate that motivation. Sometimes things are important and pressure-laden just because they are, not because someone decided that they should be. In these situations, if you want to reduce your own procrastination, it's good to try to keep the work you're doing in perspective. It might be important, it might be very important, but no matter how badly things go with that work, the sun will still rise tomorrow morning. That might seem like it would reduce your motivation, and thus your likelihood of doing the work, but for a procrastinator, it can have exactly the opposite effect.

If you're feeling the pressure of something, maybe during those 20 minutes that you're sitting, take a few moments to think about other things that matter a lot in life, things not related to this problem task. Look at pictures of your family; think about other things you'll be doing later in the day that will bring you happiness, even if the work of the day isn't as great as you'd like it to be. That said, don't start sending emails to friends and family—email can be the worst of all procrastination strategies. But if you can reduce the feelings of pressure that you're feeling, you'll be more likely to start and far more likely to continue working on the important projects of the day.

My third tip for reducing procrastination comes very directly from this notion of motivation. This one goes directly to the pleasure center of the brain. This is one of those subcortical, unconscious control systems that live deep inside your brain. If you want to reduce procrastination, break any large project into parts, ideally small parts, parts that can be accomplished in a single work session of as little as 20 minutes. As you complete these small parts, keep track of your progress. When all the small parts are done, the project is complete. Even if the project itself isn't a pleasurable one, simply seeing yourself move closer to the finish line, when the unpleasant task will be done, this sense of progress can produce great pleasure.

As humans, we like to think that we choose to do things and then we do them. However, the reason that we do many things is because of choices made by unconscious systems within our brain. Rat brains seem to work in the same way, especially under standard laboratory conditions. Rats respond to reinforcement. If I give a rat some food whenever it presses a lever, I can be confident it will press the lever more frequently in the future.

When a rat experiences pleasure, we know a lot about how that's processed by their brains. One of the central parts of the circuit involved in processing pleasure is called the nucleus accumbens. It's located in the basal forebrain, tucked up underneath the cortex near the front of the brain. It has neurons that respond to a variety of neurotransmitters, but many of the neurons found there respond to the neurotransmitters called dopamine and serotonin.

Neurotransmitters are chemical substances produced by your body—many produced in the brain itself—that influence the function of neurons. Sometimes neurotransmitters can be excitatory, and cause a set of neurons to become more active. In other situations, a neurotransmitter will be inhibitory and reduce the activation of a set of neurons. If we release a bunch of dopamine into the circuits that connect through this part of the brain, the nucleus accumbens of the rat will become very active and the rat will feel intense pleasure. Actually a lot of very addictive drugs—cocaine, for instance—produce lasting activation in dopamine-sensitive neurons in the nucleus accumbens. If we instead introduce a burst of serotonin to these neural circuits, it will produce a sense of great satiation.

Now, we can create these feelings in a rat by electrically stimulating these sections of the brain, or by introducing drugs into the bloodstream that cause them to be activated. But there are many other things that cause these areas of the brain to become active. If the rat is hungry, the area will be activated by eating; thirsty, the area will be activated by drinking. The activation is less intense than if something like cocaine is used to activate the brain area, but it's still enough activation to motivate behavior.

The nucleus accumbens is linked to a variety of other areas of the brain, areas that motivate particular actions. If a rat is hungry, this circuit will drive the rat to perform behaviors that it associates with finding food, things like searching and sniffing. If the rat learns to associate pressing a bar with getting food, then when the hungry rat presses the bar, the nucleus accumbens will be activated and the rat will experience pleasure. Many neuroscientists who study learning and motivation of the rat would describe this nucleus accumbens circuit as the driver of the whole system. The rat seeks food, water, comfort, other rats, lots of things, but all of those come back to a single motivator: the drive to release dopamine into the nucleus accumbens.

Some studies have found that if you hook an electrical stimulator from a bar-press switch to the nucleus accumbens, the rat will press that bar to the exclusion of all its other behaviors. It will stop eating, drinking—everything. The nucleus accumbens seems to be a central, common pathway for motivating all actions.

Let's think about how this would apply to a rat in the wild, not a rat confined to a box in a lab with a lever. Imagine this particular rat is hungry. The desire for that nucleus accumbens dopamine shot will drive the animal to start foraging for food. Maybe there's food in an area near some trees—the rat runs in that direction and starts searching. If the rat finds a little food, then a little burst of dopamine is released, and it's likely to keep searching in that general area. If the rat searches for a long while and finds nothing, then the rat will change its strategy. Maybe that area over there by the building will have better results. If that fails, then another area will be selected, and so on. The animal is seeking food here, but at another, more basic brain level, the rat is seeking dopamine for its nucleus accumbens.

OK. These things are well established in rats. I should note that I've oversimplified things a bit; there are several other brain regions involved in this motivation circuit. The ventral tegmental area, located in the midbrain at the top of the brainstem is also critical, as are some areas of the prefrontal cortex. Even within the nucleus accumbens itself there are different types of neurons found in its core as opposed to its outer shell. There's a lot of complexity here, but while I've simplified things, the general argument I'm making here is very well established: rat behaviors seem to be almost completely driven by a desire to increase dopamine release in this motivation circuit. You can explain a lot of rat behaviors based just on this.

Now, for the last few minutes, I've been talking about rats, but I could restate almost all of those sentences and still correctly be describing humans. You have a nucleus accumbens—actually you have two of them, one on each the left and the right sides of your brain—and a lot of your behaviors, particularly those unconsciously controlled behaviors that we keep discussing, are driven by a desire for dopamine in your nucleus accumbens. When you're hungry and feel the pleasure of a delicious meal, it's your nucleus accumbens dopamine-related activity that gives you that pleasure. To get philosophical here for a moment, it wouldn't be incorrect to say that the dopamine-related activity is itself the pleasure—they are one and the same.

So what does this have to do with procrastination? Well, let me consider one other type of activity that gives us a shot of pleasure: controlling and affecting the world around us. If we perform some action and it causes something we intended to come to pass, we experience pleasure. It's different than the rush of a cold drink on a hot summer day, but it's a rush nonetheless.

The desire to control the world around us is very fundamental—even babies seem to experience it. If you put a baby into a crib under a mobile that shakes from time to time, the baby will watch and sometimes kick her legs. If instead you connect her leg to the mobile, maybe with a piece of ribbon, so that when she kicks her legs it makes the mobile shake as a direct result of her kicking her legs, the baby will kick, and kick, and kick. Even a three-month-old baby will learn this relation between the action and the environmental outcome in just a few minutes. And if you bring that baby back the next day and put her in the same crib, even if you don't connect the mobile to her ankle, she'll start kicking again. Three-month-olds learn this connection and continue to be motivated by it even a full day later.

Now, we're grownups, but that basic desire to control our surroundings is still there. When we decide to take on some challenge, and then succeed in accomplishing it, we get a boost of pleasure, a boost of dopamine-related activity in our nucleus accumbens. We don't, however, get that burst of pleasure while we're actually pursuing the goal; we get it when we accomplish the goal. If I pick a very large and hard to achieve goal, then when I achieve that goal, I'll get a big burst of pleasure. The problem, of course, is that if I'm not motivated enough, I won't ever get to the finish line.

Think about that wild rat again, the one searching for food in different areas. If we try one strategy and it yields success—that is, it gives us that dopamine shot we crave—then we'll tend to stick with it in the hopes of getting more. If we pursue some strategy, however, and it doesn't result in the boost of dopamine, we'll grow increasingly more likely to switch to another strategy, just like the rat.

Now, humans are better at self-control and goal-directed behaviors than rats, but it still means that it will get harder and harder to keep ourselves focused on the non-dopamine-producing task. And the more mental resources you're spending to keep yourself focused on a goal, the less mental resources will be available to pursue the actual work.

So, think of yourself as a rat. You have a big project, one that's been driving you to procrastination for a while. Completing that project will be a big success and give you a big reward. Think of that, for the moment, as a big pile of rat kibble. Rather than leave all the kibble in one big pile, this tip suggests that you should spread it out, maybe even arrange it in a line between your current location and the location that you want to be.

As you complete small subtasks you'll earn yourself little pieces of kibble, and receive the associated releases of dopamine to your nucleus accumbens. When you achieve those subgoals, make a point of celebrating them. Never underestimate the power of making a check mark on a to-do list. Even with the celebration, achieving the subgoals won't be enormously pleasurable experiences, but that's not what you need. You just need to keep feeding your pleasure centers enough motivation to keep them moving along, to keep them focused on the same project long enough that you can achieve that big goal at the end. Indeed, I think you'll find that the big pile of rat kibble at the end of your project doesn't seem substantially smaller even after you've scattered bits of it along the path to the finish line.

The time to employ a strategy to reduce procrastination is when that procrastination starts to impact you and your life negatively. If you're anxious and irritable because of a lack of progress, when you feel that the products of your work are suffering because of procrastination, then it's time to cut out at least some of that procrastination. That's true with almost anything, though. Learning to overcome procrastination can teach you to handle almost anything.

When you do decide to reduce your procrastination, the strategies I've suggested here can help. First, don't do anything for a few minutes. Ponder what you want to do before you start working. Second, break the task into small parts—ideally, very small—to get those dopamine boosts that come with a sense of completing something. Third, if you're feeling too much pressure, try to reduce your motivation by a bit—try to keep the task and the related pressure in perspective. The sun will still rise tomorrow even if you don't finish your work. Fortunately for all of us, the sun never procrastinates.

Train Yourself like a Dog

While habits can seem like minor, unimportant behaviors, in fact, they are significant activities that deserve our attention. The philosopher Aristotle noted, “We are what we repeatedly do. Excellence, then, is not an act but a habit.” Jim Ryun, one the greatest distance runners in American history, said, “Motivation is what gets you started. Habit is what keeps you going.” If we can fix our habitual tendencies, we can fix our lives. In this lecture, we consider how we can use the tools of cognitive neuroscience to alter our behaviors.

The Notepad Strategy

- Consider this simple tip—one that is startlingly effective for reducing the frequency of a bad habit. An effective strategy for behavioral training is to call attention to the problem behavior whenever it appears. An additional step is to write down the times when this problem behavior occurs and then read that list at the end of the day.

- Walk around with a notepad and pen. At the start of the day, write the date at the top of a page. Any time you engage in your problem behavior, don’t unduly criticize yourself . Just pull out the notepad and write down the time of day and a few words summarizing the details. If you’re trying to cut down on television, note the start and end time of the television watching. If you have a doughnut-eating habit, write down the time, place, and flavor of the doughnut. At the end of the day, as you are about to go to sleep, read over your list of incidents. Then, turn the page and put the notepad and pen away.

- Many programs aimed at objectives such as smoking cessation use the notepad strategy as a baseline task. You start by noting how much you actually smoke for one week, and then you start the intervention—perhaps chewing nicotine replacement gum or exercising to reduce cravings. The baseline procedure itself—simply noting the incidents—often has a very strong effect all by itself.

- Over short spans of time, by exerting our conscious will, we can immediately—often drastically—alter our behavior. That explicit control of behavior takes continual attention and a great deal of mental energy, however. As we get distracted by other concerns, the conscious control drifts away. As it does, the unconscious control takes over.

- Cognitive neuroscientists have identified several few reasons for the success of the notepad strategy. The most basic explanation derives directly from our knowledge about the unconscious processes that control behaviors. Since these unconscious processes are often in control of behaviors, you may not actually be aware of how often you engage in a particular habit. As you see the pages of your notebook filling up, you will tend to eliminate some of the unconscious repetitions of the behavior.

Self-Control as a Muscle

- Researchers have explored another technique of behavioral modification using the theory that self-control is like a muscle. After an exercise workout, the muscle will be fatigued and less useful; however, when it heals, it gets stronger.

- The same process seems to apply to our self-control. In one set of experiments, conducted by a team led by Mark Muraven, participants were recruited and asked to refrain from eating any sweets for two full weeks. The participants noted whenever they ate something sweet. The experiment was largely successful; participants reduced their sweet-eating habits. However, the most interesting result emerged when the participants came into the lab at the end of the two weeks to complete a stop-signal test.

- Participants in the stop-signal test watch a computer screen. If a rectangle appears on the right side of the screen, they quickly press a key with the right hand. If the rectangle appears on the left, participants quickly press a different key with the left hand. For a randomly selected 25 percent of the trials, however, a beep sounds when the rectangle appears. On those trials, and only those trials, participants have to ignore it and make no key press.

- This sounds simple, but the test pits one part of the brain against another. The visuomotor system learns the task very quickly, but when the beep sounds, the voluntary, conscious self-control system has to kick in and stop things. People who are better at stopping themselves from hitting the keys have better general self-control. What's interesting is that this self-control ability is improved after two weeks of avoiding sugary snacks. It seems that if you practice self-control, you improve self control—just like a muscle.

Development of the Frontal Lobes

- Several functional magnetic resonance imaging (fMRI) studies have characterized the location of the self-control ability in the brain. When people are engaged in successful stop-signal behaviors, the superior medial and precentral frontal cortices show greater activation. These frontal lobes are associated with such tasks as problem solving, creativity, and strategic thinking.

- The frontal lobes are also strongly associated with regulating the rest of the brain in impulse control and avoiding overly risky behavior. Areas in the frontal lobes are the latest sections to develop fully.

- In the past, neuroscientists believed that the brain was finished with its primary development by the late teen years; however, some recent work has suggested otherwise. Between 18 and 22 years of age, there is a surge of development in the frontal lobes. Specifically, there is a large increase in the production of myelin—a fatty insulating substance that increases neuronal efficiency. During this same period of time, people get much better at self-control in general. Most people presume that it is this increase in development of white matter that leads to a reduction in the high-risk, impulsive behaviors that are commonly associated with the teen years.

Alternative Behavioral Associations

- The human brain is remarkably effective at making associative links. In fact, making associative links is an unconscious tendency that we all share and that we cannot fully turn off. If you think about something that you don't want to think about, you are, in a sense, already thinking about it. The same process happens when we try not to think about engaging in some habitual behavior. Calling attention to the behavior will help. What's more, your inhibitory self-control ability will get stronger with exercise.

- Instead of turning off an existing associative link—which is impossible—you can create an alternative associative link and make it stronger. In other words, to stop a bad habit, you need to replace it with another behavior. The goal of this training procedure is not to temporarily change behavior but ultimately to change the underlying mental processes that drive a problematic habit in the first place. You need to create a new, automatic, unconscious process that will take the place of the problematic one.

- A great deal of research supports this strategy. A study conducted by Marieke Adriaanse and her colleagues asked participants to identify situations that triggered the performance of a bad habit—for example, "When I feel anxious, I tend to go to the kitchen for a sugary snack." In the next step, participants were asked to come up with an alternative behavior to pursue when the trigger showed up—for example, "When I feel anxious, I will eat an apple."

- The experimenters found that the focus on associating an alternative behavior with the trigger resulted in a greater reduction in the habitual behavior. The researchers also performed a variety of tests exploring

how this change occurred. The researchers determined that when you form an alternate intention—an alternate behavioral association with the trigger that usually causes a bad habit—your brain changes its internal association structure. After forming and practicing the alternate association, your brain starts to process the new action faster. If this happens quickly enough, that new behavior will tend to be triggered instead of the bad habit.

Positive and Negative Reinforcement

- Both positive and negative reinforcement have been proven to effectively shape behavior.
    - In positive reinforcement, something pleasant gets added to your experience after you perform a behavior.

    - In negative reinforcement, something aversive gets removed after you perform a behavior. (Note that negative reinforcement is not the same as punishment.)

    - In positive punishment, something negative is added to your experience after you perform a behavior.

    - In negative punishment, something positive gets removed after you perform a behavior.

- In general, to promote more general and long-lasting learning, most research suggests that you should focus on the reinforcement side of things. For example, imagine that you have a bad habit of leaving the television on when you leave for work, and you want to lessen the incidence of that habit. Make a contract with yourself: Starting tomorrow, if you remember to turn off the television, give yourself a cookie when you come home.

- Remember that you are not trying to change your conscious behavior. You are, to use the language of a behaviorist like B.F. Skinner, shaping the behavior of your unconscious action control systems. The cookie is for that part of your brain.

Self-Administered Reinforcement

- Over the course of several decades, a wide range of studies have been conducted on self-administered reinforcement. Students have used it to improve study habits. Dieters have used it to enhance healthy eating practices. People with phobias have used self-administered reinforcement to train themselves to deal with their fears. You can pick almost any practice, make a contract with yourself, and then change your behavior.

- One hallmark of behavioral shaping is that it can be a slow process. It might be several weeks before you reach the final behavior that you seek. Often, behavioral scientists who use these techniques to train animals to perform complex sequences of actions will employ a gradual shaping process.

- While the training process is slow, the good news is that once the new behavior is set, unlearning the training will also function slowly. Eventually, you won't have to reinforce yourself all the time; you will only require periodic reinforcement for good behavior.

Questions to Consider

1. Experiments suggest that our self-control can be increased if it is exercised—that is, it can be strengthened like a muscle. Should we train our children or grandchildren to build this self-control muscle from an early age? How would you do that?
2. Research suggests it's easier to stop performing a bad habit if you replace that habit with an alternate behavior. For example, it's easier to quit excess snacking if you decide to go for a walk whenever you feel like snacking. Do you think some replacement behaviors are better than others? What alternate behaviors would you suggest to someone who was trying to quit smoking, arguing with the kids, watching too much TV, or forgetting to take medication?

Suggested Readings

Duhigg, *The Power of Habit.*

Skinner, *Beyond Freedom and Dignity*.

Lecture 3 Transcript

Train Yourself like a Dog

Imagine you have an annoying, long-term houseguest. We'll call the guest Pat. Apologies if your name is Pat; all names have been changed here to protect the innocent. Pat is a good person, but Pat has some really bad habits. Pat smokes. Pat eats too much, especially too much fatty food. Pat rarely exercises. Pat has a bad habit of watching TV until very late at night. Pat may leave dishes in the sink too long, often overnight. Pat gets into arguments sometimes and holds a real grudge when the argument doesn't go well. Deep down, Pat's a good person. Actually, Pat doesn't intend to do any of these behaviors, they're just habits.

In fact, if you were to ask Pat about them, Pat would be the first person to talk about wanting to change. Pat doesn't want to be a bad houseguest; this is just Pat's behavior. Now, you don't want to go to a hotel and get away from Pat. You don't want to kick Pat out of the house. Pat has a lot of redeeming qualities, and Pat is your guest. What you really want to do is to train Pat, to alter Pat's behaviors in such a way that you can transform Pat into a good houseguest, someone you wouldn't mind spending time with, someone you might even look forward to seeing.

Think about what you would do. How might you use the tools of cognitive neuroscience to alter Pat's behaviors? My overarching tip for this lecture is to take this list of things, this list of methods that you could use to alter Pat's behavior, and then realize that the best way to alter your own behaviors will be to use them, not on Pat, but on you. I've talked a lot in this course about how much of our behavior is dictated by unconscious, automatic processes in our brain. Our decisions about what to do, what to eat, what to say, even how to say it, are dictated largely by subconscious processes, processes over which we usually exert little control.

Perhaps the best evidence for this comes from studies demonstrating that our conscious experience of choosing to do something typically comes after we start to do it, not before. It's not that we can't control our behaviors; indeed, the point of this lecture is that we can. It's just that most of the time we don't. Over short spans of time, by exerting our conscious will, we can immediately, often drastically, alter our behavior, but that explicit control of behavior takes continual attention and a lot of mental energy. As we get distracted by other things—and, inevitably, we always do—the conscious control drifts away. As it does, the unconscious control takes over again.

This lecture is about ways you can change the unconscious habits, so that, even when you aren't paying attention, your unconscious mental systems will do the things you'd like them to do. This houseguest we're discussing isn't just staying in your house; this houseguest I want you to ponder training lives in your head.

OK, let's get to a simple tip that's really startlingly effective for reducing the frequency of some bad habit—it could be smoking, it could be unhealthy snacking, it could be watching television too much; even something like arguing with your spouse over things that, in retrospect, seemed like pretty silly reasons for an argument. Let's aim our behavioral training at our bad houseguest, Pat. Say Pat had the bad habit. What simple thing would you do to try to stop it, or at least have Pat quit doing it so much?

One simple thing you might try is to call attention to the behavior whenever it happens. "Pat, you're eating all the cookies again, please stop." One additional step would be to write down the times when this problem behavior occurs, and then show that list at the end of the day.

A really simple and effective tip for reducing your own habitual behavior is to do this same thing: write it down whenever you do it—that's it. You can buy a little pocket notebook for this purpose. You can maybe even just fold up a 3 × 5 card or a sheet of paper and put it in your pocket. You'll also need to have a pen or a pencil devoted to this task that will ride around with you. Putting a notebook in your bag or using maybe a computer spreadsheet, that won't be effective here. You want this low-tech recording device to be something you can have access to anytime, wherever you are, within a few seconds of deciding to do so. Immediacy turns out to be key here.

So you walk around with a notepad and a pen. At the start of the day, write down the date at the top of the page then put it back in your pocket. Anytime you engage in your bad behavior, don't beat yourself up about it. Just pull out the notepad, write down the time of day, and maybe a few words summarizing the details of it—where you were, how long you did it, things like that. If you're trying to cut down on television, maybe note the start and end time of the television watching. If it's a donut-eating habit, write down the time, place, and flavor of the donut. At the end of the day, as you're about to go to sleep, read over your list of incidents, then turn the page, put them away.

That's it. Unlike most tips for trying to reduce bad habits, this one actually doesn't involve trying to quit; all you do is make a short notation every time you do it. Actually, many programs aimed at things like smoking cessation use this as a baseline task. You start by noting how much you actually smoke for one week, and then start the intervention, whatever that is, perhaps chewing nicotine replacement gum or exercising to reduce cravings. The goal in studies like that, of course, is to identify how people can reduce smoking below this baseline level.

But the baseline procedure itself, it turns out—just noting the incidents—often has a very strong effect all by itself. Cognitive scientists have identified at least a few reasons for this. The most basic comes directly from our thinking about these unconscious processes that control your behaviors. Since the unconscious processes are often in control of things, you may not actually be aware of how often you engage in a particular behavior.

If you're like most people, if you, say, you start writing down a note every time you watch television for another 30 minutes, you may be somewhat shocked to realize just how much time you spend on that activity.

Someone who's an habitual smoker, they feel a craving and they just walk outside to have a cigarette, often without thinking about it very much. Smokers sometimes report being a bit surprised at how quickly a pack of cigarettes seems to get used up. That's because, in a very real way, they didn't decide to smoke most of them. That unconscious, largely independent cranial houseguest did it for them.

When you make a point of writing down the incidents in which you engaged in your targeted bad habit, you force your conscious mind to be involved. As you do the thing, whatever that is, over the course of the day, you'll see the page of your notebook getting more full. Without even trying, you'll tend to eliminate some of the unconscious repetitions of that behavior, and it will be reduced in frequency.

There's another process that's promoted by this note-taking activity that several researchers have explored recently. The theory is, stated somewhat loosely, that self-control is like a muscle. When you exercise a muscle, you use up its resources—you beat it up a little bit. After the workout, the muscle will be fatigued and less useful, but it will heal. And when it does heal, it gets stronger.

The same thing seems to apply to our self-control. In one set of experiments conducted by a team led by Mark Muraven, participants were recruited and asked to refrain from eating any sweets for two full weeks: total stop. No gradual weaning off of them, just nothing sweet at all for two weeks. This is a challenging self-control task for almost anyone. The participants noted whenever they slipped and ate something they weren't supposed to, just like I've urged you to do for your bad habit. The participants were largely successful in accomplishing this two-week cessation; all substantially reduced their consumption of sugary foods.

The really interesting result emerged when the participants came into the lab at the end of those two weeks for testing. They completed something called a stop signal test. In this task, you watch a computer screen. If a rectangle appears on the right side of the screen, you press a key with your right hand, as quickly as possible. If the rectangle appears on the left, you sign this time with your left hand, again as quickly as possible. This is pretty simple, but there's an added wrinkle. For a randomly selected 25 percent of the trials, a soft beep sound is made when the rectangle appears. On those trials, and only on those trials, participants have to ignore it and make no key press response.

This sounds easy, but it pits one part of your brain against another. The visuomotor system learns this simple left versus right key press task very quickly, and then it gets faster and faster as it completes more and more trials. When the soft beep sound occurs, the voluntary, conscious, self-control system has to jump in—whoa, stop! Some people tend to be better at this task than others, and that's not that surprising. What is surprising is that the people who are better at stopping themselves from hitting those keys have better general self-control. When they decide to do things, to change their habits, they're significantly better at sticking with that decision.

What's even more striking is that this self-control ability is improved after two weeks of avoiding sugary snacks. When participants complete this test before and after a two-week period, they generally don't improve much. But, if they spent those two weeks engaging in a self-control behavior, like restricting their diet, they significantly improve in their stop signal test scores.

OK, I've urged you to be skeptical scientists in this course, and there's a control problem in this study. I've suggested it's the self-control aspects of the sugary snack avoidance task that leads to the improved performance on this stop signal test. Is it? Or is it the actual reduction in sugar intake that generates that improvement? The experimenters thought of this, and included other tasks that were demanding for self-control abilities.

For instance, some participants were randomly assigned to a handgrip task during the two weeks, instead of the sugary sweet-avoidance task. They were given a spring-loaded hand strength trainer; it's a V-shaped device. If you squeeze very hard, you can pull the two ends of the V together. Participants in this condition were told to squeeze it together and then hold it there as long they could until their grip muscles gave out and they physically couldn't hold it shut anymore. These handgrip participants would do this twice per day.

Just like avoiding sugary snacks, performing this intense exercise twice per day involves a lot of self-control. Especially after a few days, a week, your hand and arm are likely to be very sore. To push yourself through the physical discomfort involves a substantial amount of self-control. The handgrip participants show the same significant improvement on the stop signal test, the same one that the sugary snack avoiders did. It seems that if you practice self-control, you improve self-control, just like a muscle.

OK, back to our notebook and the process of reducing a bad habit just by writing it down. I hope I haven't oversold this method by the way. You do have to want to reduce the frequency of the habit. I'm presuming that you aren't grabbing the notebook and then going wild with that bad habit, trusting that the notebook will somehow magically eliminate your desire for it, whatever it might be.

Presumably you do want to quit the habit, and when you take the time to write down that note, even that brief amount of time, you're engaging in self-control. When you think about the need to take out the notebook, that the list of incidents will be growing longer and longer over the course of the day, you'll gradually come to resist it a little longer, and then a little longer still. Certainly, writing down every time you engage in some behavior makes you more conscious of it—that's a big part of why it seems to work. But you're also exercising your self-control muscles without really trying too hard, and improving your general self-regulation in the process.

There have been a few fMRI studies that have characterized where these self-control muscles are located. It's not surprising that when people are engaged in a successful signal stop behavior, the superior medial and precentral frontal cortices both show greater activation. These frontal lobes of ours are associated with a lot of things: problem-solving, creativity, strategic thinking. The frontal lobes are also strongly associated with regulating the rest of the brain in terms of things like impulse control and avoiding overly risky behavior. It's actually one of the last areas of the brain to finish developing.

We used to think of the brain as being finished with its primary development by the late teen years, but some recent work has suggested otherwise. Between 18 and 22 years of age, there's a surge of development in these frontal lobes. Specifically, there's a large increase in the production of myelin, a fatty, insulating substance that increases neuronal efficiency—an increase in this white matter right there in the frontal lobes. During this same period of time, people get much better at self-control in general. Most people presume it's this development that leads to the reduction in the high-risk, impulsive behaviors that are commonly associated with the teen years.

OK. What else can we do to improve Pat's bad habits—or, rather, reduce those bad habits? There's a member of my family who has a bad habit of picking at his fingernails. It's a grooming habit—you see a little irregularity in your fingernail, and you pick at it to make it smooth again. Unfortunately, sometimes that creates another little edge, so you pick at that. If you do this long enough, you end up with very sore fingers. It's a bad habit, one that I can certainly imagine our bad houseguest might have as well.

Whenever I notice the nail-picking behavior occurring, I say, "Hey, don't pick your nails." Sometimes I just reach over and touch his hand, make eye contact, and that's sufficient. He always stops when I call his attention to it, but I can see the internal mental battle it creates. The part of his brain that wants to pick those nails is still pushing him to do it. The only reason he's not picking at his nails is that now there's another mental process, probably those frontal lobes, holding that unconscious nail-picking process at bay.

It's very hard for a human brain to choose not to think about something. Let's actually try this. For the next 30 seconds or so, try not to think about pink elephants. OK, you're probably thinking about a pink elephant right now because I just said it, but clear that from your mind now—don't think about it. Let's try this for 10 seconds. Go.

If you're like most people, you just failed at this task. Most people start by thinking about something else. I've been watching tennis, so I thought about a tennis match, a fuzzy green tennis ball sitting on a tennis court. There's grass on some tennis courts. Hay is a type of grass. Sometimes hay is eaten by pink elephants. Oh well.

The human brain is remarkably good at making associative links between things, at finding those links even when they're somewhat remote. It's an unconscious tendency that we all have that we really can't fully turn off. If you think about something that you don't want to think about, you are in a sense already thinking about it.

The same thing happens when we try to not think about engaging in some habitual behavior. Calling attention to the behavior will help, and your inhibitory, self-control ability will get stronger with that exercise—we've established that. But there's a better way. Instead of turning off an existing associative link, which we can't really do anyway, you can create an alternative associative link and make it stronger, strong enough that it eventually takes over control of your behaviors.

Most people's intuitions about reducing a bad habit like this is to, well, just stop it. Actually, that's what we've talked about up until this point with that notebook method. Call attention to the behavior whenever it occurs and then reduce its frequency. This is effective, but what's much more effective leads to our next brain-based tip.

To stop a bad habit, you need to replace it with something else. The goal of this training procedure remember is not to just temporarily change behavior, but to ultimately change the underlying mental processes that drive a problematic habit in the first place. From this perspective, it's not enough to just prevent the behavior from being performed. You need to create a new, automatic, unconscious process that will take the place of the problematic one.

There's a lot of evidence supporting this assertion. One of my favorite studies of it was conducted by Marieke Adriaanse and her collaborators.

They asked participants to identify situations that triggered the performance of a bad habit. For instance: “When I am bored, sometimes I pick at my fingernails.” “When I feel anxious, I tend to go to the kitchen for a sugary snack.” “When I feel cranky, I am more likely to start an argument over something trivial.” It’s easy to think of these for any bad habit that you might have. It always starts with some trigger that gets that unconscious processing going.

OK, so people in this study identified their triggers—that’s an important step. The next step is the critical one. Rather than just deciding to not engage in the bad habit, the participants were asked to come up with an alternative behavior, and to intentionally pursue that when the trigger showed up. Something like, “When I feel bored, I will play piano.” “When I feel anxious, I will eat an apple.” “When I feel cranky, I’ll go for a walk.”

This is a true experiment that was conducted here, so half of the participants were assigned to this condition, the one in which they picked alternative trigger responses. The other half of the participants were randomly assigned to the control condition; they did not use this technique. The experimenters found that the focus on associating an alternative behavior with the trigger resulted in a significantly greater reduction in the habitual behavior.

The researchers also performed a variety of tests exploring how this change occurred. They presented participants in both the experimental and the control conditions with a brief presentation of the trigger word on a computer screen. So, in the example situations I described, the words might have been boredom or anxious. The trigger word would appear, then it would vanish, and then another word would appear. Sometimes, that second word was just scrambled letters—wasn’t a word at all, really. Sometimes the word was unrelated to the bad habit behavior. Sometimes the word was the bad habit. Finally, sometimes the word was the alternative behavior.

This is kind of a complicated design, but the results can be summarized pretty simply. When you form an alternate intention, an alternate behavioral association with that trigger that usually causes the bad habit, your brain changes its internal association structure. After forming and practicing the alternate association, your brain starts to process the new action faster. If it happens quickly enough, that new behavior will tend to be triggered instead of the bad habit behavior.

Many studies point to a particular region in the left temporal part of the cortex that's responsible for processing word meanings. In addition to recognizing the individual words, this region of the brain—our language system—processes the meanings of the words based on the things with which that word is associated. If you see word baseball and bat, the second word means a very different thing than if you see vampire and bat. When we read a word, it activates a whole host of concepts that are related to it. Again, it does all of this quickly and unconsciously.

In addition to activating words, it also seems to activate actions, actions that are associated with the word. If you read the word bored, you'll not be able to not think about behaviors that you tend to pursue when you're bored. When you feel that trigger sensation, the associated behavior just automatically enters your mind and influences your behavior.

So, with Pat the bad houseguest, you shouldn't just request a stopping of the bad habit behavior, you should suggest an alternative behavior and encourage ways to engage in that behavior instead. To change your own behaviors, you should do the same thing. Think through what you tend to be thinking about right before you engage in your bad habit. Then come up with a good alternative, something that would be healthier or just generally better. Envision the trigger feeling coming to you, and then imagine performing the alternative behavior instead. Some work suggests that it's a good idea to state these intentions aloud: "Whenever I feel cranky, I will go for a walk for 15 minutes." Writing it down might also help to make it more salient for you, might help you to cement that new association more strongly.

Actually, it might be a good idea to combine this with our notebook method. Write down not only when you did engage in the bad behavior, also write down the times when you felt the trigger and engaged in the alternative, better behavior. At the end of the day, as you review your notes, think through those associations again. Also, take a moment to praise yourself for the times when you did the right thing.

Actually, that self-praise leads to our next tip. If you want to change your houseguest's behavior, you might consider using positive and negative reinforcement to shape behavior. It can feel silly to use that on yourself, but there's good evidence that it works. Let's explore this in some more detail.

If, after you engage in some behavior—any behavior—something positive happens, it will reinforce the behavior. You'll be more likely to perform that same behavior in the future. If, on the other hand, after you engage in some behavior, something bad happens, it will punish the behavior. You'll be less likely to perform that same action in the future.

Positive reinforcement is when something pleasant gets added to your experience after you perform a behavior. If, when Pat picks up the laundry, I reward with a cookie, Pat will be more likely to pick up the laundry in the future. Negative reinforcement is when something aversive gets removed after you perform a behavior. Note that negative reinforcement is not the same thing as punishment, although many people think that it is. Now, let's think about negative reinforcement. Imagine that I give Pat an angry look every few minutes when the laundry is on the floor. If, after it's picked up, I stop giving angry looks, then I have removed something aversive in response to Pat's behavior. Pat will be more likely to pick up the laundry in the future.

Positive punishment is when something negative is added to your experience after you perform a behavior. If Pat puts dirty laundry on the floor, and I give an angry look afterward, Pat will be less likely to repeat that action in the future. That's positive punishment. Negative punishment is when something positive gets removed after you perform a behavior. Maybe I often smile at Pat and offer cookies. If, when Pat puts dirty laundry on the floor, I stop doing that, then I've taken away something positive. Pat will be less likely to perform that behavior in the future.

In principle, you can use any one of these four tools on yourself. At an informational level, they're all sort of the same, they're like flip sides of the same coin. In general, in order to promote more general and long-lasting learning, a lot of research suggests that you should focus on the reinforcement side of things. Imagine I have a bad habit of leaving the television on when I depart for work in the morning. I want to change my behavior to lessen the incidence of that habit. What I need to do is make a little contract with myself. If I remember to turn everything off when I go to work, starting tomorrow, I get to have a cookie when I come home.

That seems downright silly to me at some level. Why should I need to give myself a cookie to change my behavior? Shouldn't I just decide to turn the TV off when I leave? But remember, I'm not trying to change my conscious behavior. I am—to use the language of a behaviorist like B. F. Skinner—I'm shaping the behavior of my unconscious action control systems. The cookie isn't for the conscious part of my brain, that cookie is for the part of my brain that controls things unconsciously.

A wide range of studies has been conducted on self-administered reinforcement, that's what this is called—over the course of, really, several decades people have been studying this. Students have used it to improve study habits; dieters have used it to improve their healthy eating habits. People with phobias have used this type of system to train themselves to not avoid the thing that makes them afraid. You can pick almost anything, make that contract with yourself, and then change your behavior.

I should make two comments about how to use this most effectively. First, you shouldn't expect a change to take place overnight. One hallmark of behavioral shaping like this is that it can be a slow process. It might be several weeks before you reach that final behavior state that you seek. Often, behavioral scientists who use these techniques to train animals to perform complex sequences of actions will employ something called a gradual shaping process.

If you want to teach yourself the habit of eating healthy all day long, it might be best to start by training yourself to eat healthy for one meal of the day, maybe breakfast. Once you reliably achieve that—just getting one healthy meal accomplished—you could then focus on adding in lunch eating, and dinner and snacking perhaps last. This kind of training process is slow, but the good news is that once it's set, unlearning the training will also function slowly. Eventually, you won't have to reinforce yourself all the time, maybe just every once in a while. In order to maintain the learning, you should definitely maintain that at least periodic reinforcement for good behavior.

The reinforcer doesn't have to be a cookie, of course. Actually, if you're training yourself to eat healthier, it shouldn't be the reinforcer. You can reward yourself with anything that makes you feel good, maybe watch a favorite TV show, take a nice walk, maybe even just take a few minutes to sit and think about how great you are. A figurative pat on the back can be remarkably good as a positive reinforcer.

A second issue you should consider as you're undertaking this is the need for compliance with your contract. This is a persistent problem in this type of research in which people make this contract with themselves and then don't stick to it. Maybe I decide that I won't eat a cookie unless I remember to turn off the TV, but then I forget—I leave the TV on. That night, I just decide to have a cookie anyway. In some studies, up to 40 percent of participants report this sort of non-compliance with the strategy. Firstly, it's bad for the training for obvious reasons. Remember, it's your unconscious houseguest who learns from the reinforcement. If you give that reinforcement when it isn't warranted, it will dilute the positive benefits of the whole process.

In this lecture, we've considered a variety of ways to train your intercranial houseguest. If our unconscious mind functions independently, then the best way to alter its function is often to consider it as an independent entity, as if you're working to change the behavior not of yourself but of another person. By noting when you engage in a bad habit, even without trying to reduce it, you'll make the behavior more salient, and it will likely be reduced in frequency. By replacing the bad habit with some other positive behavior, and then associating it with a trigger that causes the bad habit, you can again further reduce any bad habit. Perhaps more importantly, you can increase the frequency of good behaviors.

Finally, by pulling out the big guns of positive and negative reinforcement, you can further shape your unconscious, habit-based behaviors to be whatever you want them to be. Habits can seem like small things, too unimportant to deserve much attention. When someone does something bad, they'll often play it off as "Oh, yeah, sorry, that's just a bad habit I have." When we talk about examples like turning off the TV, eating healthy snacks, it similarly seems like this isn't one of the biggest or most important of topics. But it is important.

Most of our behaviors, most of the actions that we perform in any given day, are habits. Aristotle said that, "We are what we repeatedly do. Excellence, then, is not an act, but a habit." Jim Ryun, one the greatest distance runners in American history said that, "Motivation is what gets you started. Habit is what keeps you going." If we can fix our habitual tendencies, we can fix our lives. We can make ourselves, our lives, whatever we want them to be.

Lecture 4

Clean Your Kitchen, Improve Your Diet

An estimated 45 million Americans have undertaken a weight-loss plan within a given year. What's more, the weight-loss industry accounts for about 33 billion dollars in revenue annually. Sadly, however, the obesity epidemic is still going strong. Roughly two out of three American adults are overweight or obese. In 1990, most states had fewer than 15 percent of adults in the obese range. Today, it's up to 25 percent or more. To complicate matters, obesity is associated with many other health consequences. In this lecture, we consider a number of strategies to address unconscious eating behaviors. You'll learn how to establish new habits that will help you maintain a healthful eating program even when your conscious thoughts are directed elsewhere.

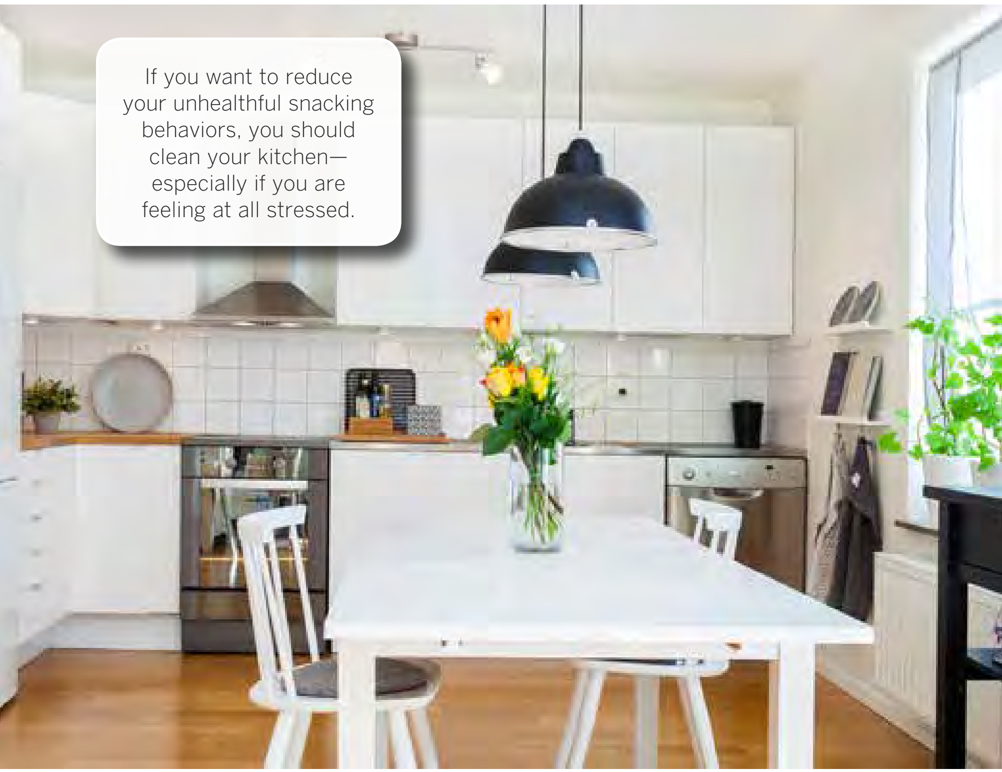
Clean Your Kitchen

- If you want to reduce your snacking, clean your kitchen.

- Brian Wansink and his research team conducted a study in which participants were asked to accomplish a simple writing task. The study took place in a kitchen environment where snacks were provided. For half the participants, the kitchen was clean and orderly: Dishes were washed, trash was out of sight, and other food in the kitchen was put away. For the other half of the participant group, the kitchen was in a chaotic condition: Furniture was placed haphazardly, papers were strewn about, and experimenters pretended to arrive late and scrambled to get organized as the study began.

- Even though the study lasted only 10 minutes, the participants in the chaotic kitchen consumed about 53 more calories. A pound of fat consists of about 3,500 calories of stored energy. Extrapolating here, this means that an extra pound of fat would be gained for every 12 hours spent in the chaotic kitchen.

- The Wansink study indicates that eating behaviors are, at least in part, influenced by the cleanliness and orderliness of the kitchen. While unconscious decision-making systems are outside our awareness, they dictate what we do, especially if our conscious mind is focused elsewhere.



If you want to reduce your unhealthful snacking behaviors, you should clean your kitchen—especially if you are feeling at all stressed.

Reduce Stress Levels

- Wansink and his colleagues interpret their findings in terms of the stress induced by a cluttered environment. In addition to the variable of the chaotic kitchen versus the clean one, the researchers also manipulated the stress levels of the participants. One third of participants were asked to write about a time in their lives when they felt chaotic and out of control. Another third of the participants were asked to write about a time when they felt particularly organized and in control. The remaining participants were asked to write about the last lecture that they attended.

- This mood-induction technique was successful. People who wrote about the times they felt chaotic and out of control tended to snack the most; people in the neutral condition writing about the lecture snacked somewhat less; and people asked to write about being organized and in control snacked least of all.

- The most interesting aspect of the study, however, was the interaction between two types of variables. The participants who wrote about feeling chaotic and out of control were affected substantially more by the chaotic kitchen.

- Based on this finding, we can refine the kitchen-cleaning tip: If you want to reduce your unhealthful snacking behaviors, you should clean your kitchen—especially if you are feeling at all stressed. The combination of feeling stressed and having a messy kitchen seems very likely to induce your unconscious decision-making processes to find and consume food.

Place Food in Opaque (Not Transparent) Containers

- Another strategy to reduce snacking is to put your food in opaque (not transparent) containers.

- Developmental scientists consider object permanence to be a crucial early accomplishment in the cognitive development of young children. Jean Piaget, often described as the father of developmental psychology, noticed that his infant son would reach for a favorite toy when it was placed in front of him. However, if Piaget covered the toy with a small cloth, his son would stop reaching for it.

- Piaget concluded that children lack the ability to maintain a mental representation of objects that they can't see. If an object was out of view, according to Piaget, then to the child it was as if the object had simply ceased to exist. According to later research, though, this interpretation isn't quite true. A variety of studies suggest that infants do know about objects even after they are hidden. While this later research indicates that children do have object permanence even at two or three months of age, it is still a challenge for children to initiate actions based on things that they can't see.

- This situation remains true even in adulthood. When snacks are placed out of sight, it's not that you are unaware of them. What changes is your behavior. Your inner child no longer reaches for food that is out of sight.

Packaging Research

- Raji Srinivasan and her colleagues performed a fascinating set of studies on how different types of packaging influence snacking behaviors. The researchers wanted to determine how much snack food was consumed by participants while they watched television. It's worth noting that most snacking behavior—most estimates indicate about 70 percent—takes place while people are watching television.

- Srinivasan was doing marketing research that was designed to help food companies select the best packaging to encourage consumers to snack more, not less. But those results work for our purposes here. If a particular type of packaging promotes more snacking, then people aiming to lose weight will want to avoid that packaging. Conversely, if some type of container results in less consumption, we should put our food into that container.

- In one of the experiments, participants were given colorful, sugary cereal to snack on while they watched television. For half the participants, the fruity cereal was in a transparent container; for the other half, it was in an opaque container. Not surprisingly, the participants with the transparent container ate significantly more sugary snacks—about 170 percent the amount that was eaten from the opaque containers.

- The researchers also found that the package didn't need to be completely transparent to generate these effects. Even if the package had a transparent window, that was enough. You didn't have to see all the food, you just needed to see enough to spur your unconscious appetite processes to reach out and start snacking.

Monitor Consumption

- The optimal food container for managing your consumption depends somewhat on the type of foods. Ultimately, the best strategy for reducing snacking and promoting healthful eating is to repackage the foods that you buy. Food manufacturers have developed a great deal of research and are highly motivated. They will likely have selected a type of packaging that will make you inclined to eat more of their product.

- For everything but the cookies in the Srinivasan study, opaque containers were best. They promoted less consumption of small sugary snacks and more eating of healthful—if less appealing—foods. The only food where transparent containers were more effective was with large cookies.

- The Srinivasan study suggests another strategy for reducing unhealthful snacking behaviors: Use containers to increase your ability to monitor how much you have eaten. Specifically, if you can do something to enhance your perception of how much you've eaten—even when you are consciously counting or weighing things—then you will be more likely to stop eating sooner.

Use Smaller Plates

- Human perception in general functions by comparing. The nature of neuronal sensory networks is to increase activation when a stimulus increases in strength and also to use that information to inhibit the activity of nearby neurons. Our sensory systems thus adapt and respond mostly to particular things in relation to one another rather than in absolute terms.

- Consider the classic visual display called the Ebbinghaus illusion. Two central disks are identical in size. One central disk is surrounded by small disks; the other is surrounded by large disks. Even though the projection of the two central disks onto the retina at the back of the eye is identical in size, most people perceive the one surrounded by small disks as larger than the one surrounded by the large disks. Our perception of an object's size is influenced by its relation to the images around it.

- There is a related pictorial illusion—the Delboeuf illusion—in which two identical disks are surrounded by different-sized circles. The effect of relative size applies here as well, with the disk inside the larger circle appearing smaller.

- Some clever researchers have found that the illusion even applies to food. Brian Wansink and his colleagues initially demonstrated this effect at an ice cream social. The experimenters presented participants with different-sized bowls and then recorded how much ice cream people scooped out for themselves. They determined that if you are placing food on a small dish, you will stop sooner than if you are putting your food onto a large dish. Your perception of the amount of food on your plate is based on how that amount of food compares to the size of the overall dish.

- The tip here is simple: If you are looking to cut back on your eating, one of the simplest, easiest strategies is to use smaller plates.

Apply Your Comparison Capability

- Consumption of sugary drinks has been identified as a strong contributor to our modern obesity epidemic. A 20-ounce sugary drink contains about 16 teaspoons of sugar. A 32-ounce sugary drink contains about 350 calories. What's worse, sugary drinks don't satiate hunger.

- Consider this illusion if you want to reduce your intake of sugary drinks. Given a choice of glasses of various heights and widths, people will identify a tall, mostly full glass as the one holding the most fluid. Conversely, a very wide glass that is mostly empty appears to have the smallest amount. This illusion holds true even when all the glasses contain the same amount of fluid.

- What this illusion very directly suggests is that you should choose to drink out of a tall, thin glass when you drink anything but water. Essentially, everyone falls for this illusion; in fact, in a study by Wansink and his colleagues, it was found that most professional bartenders fall for it too.

Questions to Consider

1. If you clean and organize your kitchen, you will tend to eat more healthfully. If you clean and organize your office or other workplace, how might that affect your daily life? How about cleaning and organizing your car?
2. Using small plates and utensils encourages people to serve themselves less food and thereby to consume less. A recent result suggests, however, that if you eat at a smaller table, you will eat more food. Why might that be? (*Hint*: Think about the size-contrast illusion.)

Suggested Readings

Kessler, *The End of Overeating*.

Wansink, *Slim by Design*.

Lecture 4 Transcript

Clean Your Kitchen, Improve Your Diet

Typically, about 45 million Americans report that they've undertaken a weight loss-focused, healthy eating plan within any given year. The weight loss industry accounts for about 33 billion dollars in revenue each year. Given the amount of resources dedicated to weight loss, you'd think that the U.S. would have made some progress.

Sadly, the obesity epidemic is going strong. Roughly two out of every three American adults are overweight or obese. In 1990, most states had fewer than 15 percent of adults in the obese range. Now it's up to 25 percent or more in most states. The problem is especially bad in the U.S., but it's relatively high in other English-speaking countries, as well. It's tragically ironic that while there are still people who suffer from malnutrition, even starvation, in some underdeveloped countries, more than 200 million adults worldwide are obese. Some estimates have put that number as high as 1 billion people.

Obesity has, of course, a lot of health consequences associated with it: heart disease, joint problems, diabetes. I don't need to give you the full list there, but it really goes on and on. Perhaps just as bad, there's good evidence that obese people suffer from discrimination in their workplace, even just in their community. Society generally frowns on obesity. We associate it with sloth, gluttony, even poor moral character. That's not fair, in my opinion. I'm going to start with the presumption that obesity is like an illness that we'd like to cure, a problem that we'd like to solve. If someone is overweight and doesn't want to change that, I hope this lecture won't be offensive. I certainly don't mean to add to that weight-based discrimination. But for anyone who would like to be able to maintain better control over their eating habits, there are some clear steps you can take.

Want to reduce your snacking? Clean your kitchen, and keep it clean. Brian Wansink and his research team conducted a study in which participants were asked to accomplish a simple writing task. The study took place in a kitchen environment. Snacks were provided while they completed the study—a plate of cookies was just placed nearby. It was made clear that they could have as many of those cookies as they wanted.

For half of the participants, the researchers cleaned the kitchen before they arrived. Dishes were all washed, all put away; trash was in the can out of sight; all other food in the kitchen was put away into the cabinets—this was a clean and orderly kitchen. For the other half of the participants, the kitchen was not clean and orderly. The experimenters described it as the chaotic kitchen condition. The tables and chairs were placed in haphazard positions all around the room. Papers were sloppily arranged in piles in various places around the kitchen. The experimenter even pretended to arrive late and scramble around to get organized as the study began.

The participants in the chaotic condition ate more cookies. They consumed about 53 more calories. This isn't all that much, but the study only lasted 10 minutes. If the study had continued for just one hour at this rate, we'd be looking at over 300 calories of extra snacking. A pound of fat consists of about 3,500 calories of stored energy. I'm extrapolating here: this means that an extra pound of fat would be gained for every 12 hours spent in the chaotic condition.

Why should a messy kitchen make you snack more? When I clean up my kitchen, my goals are about wanting it to look nice. I wash the dishes so the food won't dry up and be harder to wash later. I don't want bacteria to build up as the food decays on the dishes. At no point have I ever said, "Well, I'm trying to watch what I eat, I guess I'd better clean the kitchen."

Nonetheless, this study indicates that my eating behaviors are, at least in part, influenced by the cleanliness and orderliness of my kitchen. Those unconscious decision-making systems are outside of my awareness, but they dictate what I do, especially if my conscious mind is on something else. And when we do something routine, something like sitting in the kitchen doing some other task—paying bills, talking with my kids, reading the newspaper—when I'm in the kitchen doing anything other than eating or dealing with my food, my explicit, conscious thought is inherently on something else. It's rare that someone sits in their kitchen consciously thinking, "Don't snack, don't snack, don't snack." This is a perfect example of the situation in which your unconscious autopilot-type of decision-making takes control, takes control of what you actually do—in this case, control of what you actually do or do not eat.

Wansink and his colleagues interpret their findings in terms of the stress induced by a cluttered environment. In addition to the chaotic versus clean kitchen variable, they also manipulated the stress levels of the participants. So all of the participants, remember, worked on a simple writing task while they were in the kitchen. One third of them were asked to write about some time in their lives in which they felt particularly chaotic and out of control. Another third of the participants were asked to write about a time when they felt particularly organized and in control. The remaining participants were asked to write about the last lecture that they attended—that's sort of a neutral control condition.

Being out of control is an unpleasant experience. If you ask someone to think about a time when they felt out of control, their stress levels tend to rise. Conversely, when we feel in control, we tend to be more relaxed—less stressed. By asking people to call to mind times when they've been in control, their mood will tend to be rendered more calm. And for the group who wrote about their most recent lecture, their mood wasn't really expected to shift up or down very much; this was a more neutral condition.

This mood induction technique worked. People who wrote about the chaotic, out of control memories tended to snack most; people in the neutral condition snacked somewhat less; people in the calm mood induction snacked least of all. The most interesting aspect of the study, however, was the interaction between these two types of variables.

The participants who were in the stress-inducing condition were affected substantially more by the chaotic kitchen than were participants in the calm condition. Based on this, I can make this kitchen eating tip even more specific: if you want to reduce your unhealthy snacking behaviors, you should clean your kitchen. This is especially true if you are feeling at all stressed about things in your life. The combination of feeling stressed and having a messy kitchen seems very likely to induce your unconscious decision-making processes to go find and consume some food. By cleaning your kitchen, you can reign in that fiendishly hungry process in your brain.

When I think about strategies for steering your unconscious brain toward more healthy eating habits, I often try to imagine trying to curb someone else's unhealthy eating. Imagine that there was a young child—your inner child, if you will—hanging around with you. Wherever you go, the child is there with you. The two-year-old loves cookies—loves cookies, candy, ice cream, french fries, donuts. The two-year-old doesn't just have a little bit to eat and then stop. If something tastes good, the two-year-old will just keep on eating until he or she gets a tummy ache. Your unconscious eating system is a lot like a two-year-old.

It's worth noting that this inner two-year-old might be responsible for a lot of unhealthy eating, but, over the centuries, this two-year-old has been responsible for your ancestor's survival. This kid has been good to you. For most of the time that humans have been around, our species has been subject to periodic famine. Sometimes the hunters and gatherers went out looking for food and just had to come back empty-handed. If there was a long dry season or an especially long winter, that might happen for weeks at a time.

Your inner two-year-old wants to eat as many calories as possible. He wants to pack on some extra body fat, even a lot of body fat, if possible. If one of those famines unexpectedly shows up, that extra fat can save you from starvation. In an extended period of famine, the fat people in the community lose a lot of weight. The skinny people? They mostly die. Thank you inner two-year-old.

OK, so you have this inner two-year-old who still thinks like a caveman—cave-child. He follows you around and tries to eat everything he can. How do you control him? If it were a real life two-year-old, you'd likely tell him to stop eating. You might use a firm voice; maybe even threaten some punishment if he doesn't put down that donut right now. This is analogous to our explicit, conscious decision-making, decision-making about what and how much to eat. It works, of course. It works when you decide to start some new eating plan—that's exactly what you do. You think a lot about what to eat, and you maintain explicit control over the hungry two-year-old.

But, eventually, you'll probably start thinking about something else: work, play, reading, writing, talking. Other life demands will eventually occupy that explicit, conscious thinking again. And when they do, the two-year-old is set free to try again. So how can we control this inner eating monster? The tip about cleaning the kitchen is a perfect example of this. When the kitchen is more orderly, the two-year-old is less stressed and doesn't feel as hungry. You might not consciously feel much of anything, but that doesn't really matter. You cleaned the kitchen to reduce the cravings not of yourself but of that two-year-old.

A second tip to control him? Put your food in opaque containers, especially the sugary, high-calorie snacks that the eating system is most likely to crave. Developmental scientists often talk about object permanence as a key early accomplishment in the cognitive development of young children. Jean Piaget is often described as the father of developmental psychology. He noticed that his infant son would often reach for a toy that he liked when it was placed in front of him. But, if Piaget covered the toy with just a small cloth, his son would stop trying to get it. The cloth was small and light. It would have been very easy—in principle, anyway—for the child to pull that cloth out of the way and then grab the toy. But the child essentially never reached for the toy.

Piaget incorrectly concluded that children lack the ability to maintain a mental representation of objects that they can't see. If an object was out of view, according to Piaget, then to the child it was as if the object has simply ceased to exist. According to later research, this interpretation isn't quite true. There are a variety of studies based on simpler looking behaviors of infants that suggest that infants do know about objects, even after they're hidden. For instance, if I hide a toy under a cloth, but when I remove the cloth, the toy has magically vanished, or if maybe when I remove the cloth, now there are two toys where formerly there was just one. In either of these situations, a young infant looks at that display longer than if the expected single object is revealed.

This tendency to look longer when something unexpected happens suggests that children do have object permanence even at two or three months of age. But the children still don't reach for a hidden object until they're much older. Even then, it's always a challenge for children to initiate actions based on things that they can't see. This remains true even in adulthood. When snacks are placed out of sight, it's not that your inner two-year-old is completely unaware of the snacks. What changes is your behavior. Your inner two-year-old no longer reaches out for food that's out of sight.

Even as adults, our behavior makes it look as though object permanence—let's call it snack permanence—is affecting your eating behaviors. Raji Srinivasan and her collaborators did a fascinating set of studies on how different types of packaging influence snacking behaviors. The participants in their studies watched and made ratings about a series of videos on television. This was just a cover story task, actually. What the researchers were really interested in was how much of the available snack food was consumed by the participants while they were watching the television.

It's worth noting that most snacking behavior—most estimates say about 70 percent of snacking behavior—takes place while watching TV, so this is a really good context for a study like this. We snack away from the TV sometimes, of course, but if we can just curb snacking in front of the TV, that will be especially valuable. Also, the things that motivate TV snacking are likely to influence that other snacking as well.

Interestingly, Srinivasan was doing research more from a marketing perspective aimed at helping food companies select the best packaging to encourage consumers to snack more, not less. But that's OK for our purposes, too; we just have to interpret the data the right way. If a particular type of packaging promotes more snacking, then people aiming to lose weight will want to avoid that packaging. Conversely, if some type of container results in less consumption, which manufacturers would like to avoid, we can flip that around, and put our food into just that type of container. In one of the experiments, participants were given colorful, sugary cereal: Froot Loops. They were given that to snack on while they watched TV. For half of the participants, the fruity cereal was in a transparent container; for the other half, it was not, it was placed in an opaque container. Not surprisingly, the participants with the transparent container ate significantly more sugary snacks. A lot more, actually. With the transparent container, they ate about 170 percent the amount that they ate from the opaque containers. When you can't directly see the snack food, you will tend to unconsciously reach out and eat less.

What about eating Froot Loops directly from the box? It's an opaque container, right? Well, sort of. The box prevents you from seeing the food directly, the food that you'll actually put in your mouth, but it has plenty of cues that might attract your attention—and your hand. The box is colorful; it says Froot Loops in big, bright text. It even has pictures of pieces of the cereal on the outside. In these experiments, the opaque containers were plainly colored. The point here is that your unconscious eating system, your inner two-year-old, shouldn't get a clear reminder that the food is there. If you do snack directly from the box, these experiments suggest that you would eat a lot. Interestingly, when the food was plain Cheerios rather than colorful Froot Loops, this effect disappeared. It seems that the transparent food containers matter more for eye-catching, colorful food, and not as much for foods that are more plain—I think, not coincidentally, more likely to be healthful.

In a separate experiment, these researchers found that M&M candies exhibit the same pattern as the Froot Loops. If you can see the candies in a transparent container, you're likely to eat a lot more, about 158 percent of the amount you'd eat from an opaque container. So the effect seems to generalize to other sugary foods, this isn't just a study about Froot

Loops. The researchers also found that the package didn't need to be completely transparent to generate these effects. Even if the package had a transparent window on it, that was enough. You didn't have to see all of the food, just enough to know that it was there, enough to spur your unconscious appetite processes to reach out and start snacking.

The data get a little more complicated when the individual units of food are larger. When the snack food was cookies, amazingly the result went in the opposite direction. People ate about 28 percent less food from the transparent containers. What's going on here? Well, there's clearly something besides this snack permanence idea that I've suggested that's at work. Somehow, seeing the cookies makes you eat less rather than more. Srinivasan and other researchers think that we're able to more effectively monitor how much we've eaten if we can see that food—that is, if it's served in a transparent container.

So, if I give you 10 cookies in a clear jar, then after you take 3 of them, you might glance over and realize that the pile looks smaller than it did a few moments ago. If it's an opaque container that has those same 10 cookies—say, a paper bag rather than a clear jar—now you won't see the pile change size after each bout of snacking, after you eat each cookie. When you look at the bag and think about getting another cookie, the bag looks the same as it has all along. Unless you've been counting exactly how many cookies you've eaten, or unless you feel around the bag with your hand to count how many are left in there, then you won't have any way of monitoring your cookie consumption.

For foods that are presented in such a way that tracking the amount eaten is more challenging, this monitoring effect is less important. If you have a pile of tiny candies from which you've taken a few, the pile will look almost identical—if you eat a few more, still identical.

So, which type of food container is optimal for managing your consumption depends somewhat on the kind of food. We'll need to consider the kinds of food we have on hand as we're trying to decide what type of containers to use. Before I lay out some guidelines to consider, let me describe one more study with a different type of food: baby carrots. When this same procedure was used with the healthy vegetable snacks, rather than cookies or candy, the transparent packaging didn't cause more snacking. On the contrary, it produced substantially less. Participants only ate about half as many.

The researchers were surprised by this finding, but it's actually quite in line with our inner two-year-old theory of eating behaviors. Remember that this inner child wants to maximize calories, to pack on some fat in preparation for that potential famine of the future. Sweet things have a lot of calories. Fatty foods have a lot of calories. Baby carrot sticks? Not so many. Carrots are high in fiber and vitamin A, but it's a rare two-year-old who'll gorge himself on too many vegetables, even carrots. Carrots just don't look as delicious as cookies and candies. In fact, carrots can look a little unpleasant to many two-year-olds. It's not that carrots aren't colorful, they can be very pretty, but many two-year-olds with prior experiences of both carrots and candy just don't find the appearance of carrots as appealing. Hiding that appearance inside an opaque container ironically makes them more appealing, rather than less.

OK, so let's stand back and consider our set of findings here. Ultimately, what I'm recommending here is repackaging the foods that you buy. Food manufacturers are smart and highly motivated. They'll likely have selected a type of packaging that will make you inclined to eat more of their product. It's a pretty simple step as a consumer, however, to invest in some Tupperware, some clear plastic containers, maybe some opaque canisters. When you come home from the grocery store, as you're putting your food away, put various foods into the type of containers that will promote the most healthy eating.

What types of packages are best? For everything but cookies in this study, opaque containers were best. They promoted less eating of small sugary snacks and more eating of healthy, if less appealing, foods. The only food where transparent containers were better was with the large cookie food items. The study actually suggests another mechanism for reducing unhealthy snacking behaviors: use containers to increase our ability to monitor how much we've eaten. Specifically, if you can do something to enhance your perception of how much you've eaten, to make that salient, even when you're consciously counting or weighing things, then you'll be more likely to stop eating sooner.

Human perception in general functions by comparing things. If I'm in a dimly lit room for a while, my eyes adapt to the lighting. A moderately bright lamp might look really bright if it were switched on after I got used to that dimly lit room. If I instead went outside into a very bright, sunny environment for a while, I would then get accustomed to that. If the same moderately bright lamp were switched on after I adapted to that, it wouldn't look really bright any more. In fact, depending on the lamp, it might seem to produce barely any light at all, even though it's exactly the same lamp here, producing exactly the same amount of illumination.

This applies to almost all sensory information that our brain encodes. The nature of neuronal sensory networks is to increase activation when a stimulus increases in strength, but also to use that information to inhibit the activity of nearby neurons. Our sensory systems thus adapt to things, and respond mostly to particular things in relation to one another rather than in absolute terms. This applies to seeing, hearing, touching, tasting, and smelling—to all of our sensory systems. It even applies to our perception of how much food is in front of us and to our perception of how much we've eaten.

There's a classic visual display, it's called the Ebbinghaus Illusion. Two central disks are identical in size. One is surrounded by small disks. The other is surrounded by large disks. Even though the projection of those two central disks onto your retina is identical in size, most people see the one surrounded by small disks as larger than the one surrounded by large disks. Our perception of an object's size is influenced by its relation to the things around it.

There's a related pictorial illusion, the Delboeuf illusion, in which two identical disks are surrounded by different sized circles. The relative size effect applies here as well. The disk inside the larger circle appears smaller. Some very clever experimenters have found that the illusion even applies to food.

Brian Wansink and his collaborators initially demonstrated this effect at an ice cream social. Ice cream was provided in a self-serve fashion. People who attended the event would take a bowl at the beginning of the line then scoop their ice cream, as much as they wanted. The experimenters presented participants with different sized bowls and then recorded how much ice cream people scooped out for themselves.

Now, presumably carrying a small bowl doesn't make you less hungry. It certainly doesn't make you less hungry for ice cream. There's no clear, rational reason that this should have any effect at all, but it does. People with small bowls tend to take less ice cream. I guess this would make total sense if everyone was putting in as much ice cream as they possibly could. If they were filling their bowls to maximum capacity, then of course a smaller bowl will hold less stuff. But no one did that. The servings that people placed into their large bowls—if you were lucky enough to be randomly assigned to that condition—they would have fit into the small bowls, as well. People would scoop ice cream into that bowl until it looked like the particular amount was like the amount that they wanted to eat.

If you're making that decision as you put your food onto a small dish, you'll tend to stop sooner than if you're putting your food onto a large dish. Your perception of the amount of food on your plate is based on how that amount of food compares to the size of the overall dish.

The tip here is simple. If you're looking to cut back on your eating, one of the simplest, easiest things you can do is use smaller plates. Actually, there's some evidence that using smaller utensils as you eat it will also reduce the amount you consume. There is no direct, conscious, rational reason here again that this should happen, but to your unconscious reasoning system, size comparison clearly matters. When you use smaller plates, smaller utensils, the food looks bigger.

There's another illusion associated with Jean Piaget and his studies of children that applies here as well. It has to do with drinks rather than with food. When someone chooses to start a new healthy eating plan, something to reduce their calorie intake to lose weight, most people think about solid, chewable food. Drinks seem quite secondary to that whole process. But consumption of sugary drinks has been identified as a strong contributor to our modern obesity epidemic. If you drink a 20-ounce soda, you've consumed about 16 teaspoons of sugar. That's like eating three standard candy bars, just one right after the other. A 32-ounce fountain soda drink will contain about 350 calories. That's like eating a whole slice of meat lover's pizza, with sauce, cheese, pepperoni, ham, and sausage on top.

The calories themselves are more than most people realize, but perhaps the worst part of the sugary drink calories is that they don't satiate hunger. Most people can sip a 32-ounce soft drink and then still feel like they're ready to eat lunch or dinner. The calories just get added on top of the other things that a person was already going to eat. OK, so how can you reduce your intake of sugary drinks? Treat your inner two-year-old with a visual illusion.

A glass of juice can come in various shapes—for example, it can be short and fat versus tall and skinny. Which one has more fluid in it? And which one appears to have more? Given a choice of glasses of various heights and widths, people will pick a mostly full glass that is tall as holding the most fluid. Conversely, a very wide glass that's mostly empty appears to have the smallest amount. This occurs even when all of the glasses contain the same amount of fluid.

If you pour yourself a glass of juice or soda or wine, you're going to consume a certain number of calories. At the end, based on your consumption monitoring, you'll have a certain sense of satisfaction having consumed the amount that you chose to consume. What this illusion very directly suggests is that you should choose to drink out of a tall, thin glass when you're drinking anything but water. When humans try to perceive volume, they base that perception largely on the height of the stimulus.

When you put the same amount of fluid into a short, wide glass, it looks just like less beverage.

Essentially, everyone falls for this illusion trick, and your inner two-year-old continues to fall for it even if your conscious brain has learned otherwise. In one study conducted by Wansink and his colleagues, it was found that most professional bartenders fall for this trick, too. If you order a cocktail, the clear tip here is to ask for it to be served in a short, wide glass, short and wide as possible. For the same cost, you'll get much more to drink.

If your goal instead is to reduce the amount of calorie-rich drinks, then the tip to do here is the opposite. You should take out your tallest, thinnest glass and use that. You'll tend to pour less into it, and you'll feel just as satisfied when you finish drinking it.

In this lecture, I've considered some of the many ways that you can work to improve—in many ways reduce—your unconscious eating behaviors. By keeping your kitchen clean, you don't just improve the look of your house, you can improve how you eat the food there as well. By putting your high-calorie snack foods into opaque containers, you can decrease unhealthy snacking and boost healthy snacking. By serving your food on smaller plates and in smaller bowls, you can increase your sense of how much you've eaten. All of these techniques are habits that you can establish that will help you maintain a healthy eating program even during times when your explicit, conscious thoughts get directed elsewhere.

In the next lecture, we'll consider some of the other characteristics of your inner two-year-old and talk about how to further improve your unconscious eating habits. Many experts agree that the best diet is one that you don't realize you're on. By looking at how your brain mechanisms function in terms of hunger and satiation, we'll discuss how to create habits that support a healthy eating plan. In the meantime, if you're hungry, how about some carrots?

Lecture 5

Eat Slow, Eat Small, Eat Smart

Many experts agree that the best diet is one that we don't realize we are on. In this lecture, we look at a variety of studies dealing with how the human appetite and drive systems interact with reasoning and decision-making systems. By examining how the brain mechanisms function in terms of hunger and satiation, we'll explore how to create habits that support a healthful eating plan.

Leptin and Ghrelin

- If you are trying to cut down on the amount you eat, slow down during meals. Eat a moderate amount, and then take a break for about 20 minutes. If you are still hungry after those 20 minutes, you can have more; however, many people find that they just aren't as hungry as they thought they were.

- Consider some of the brain mechanisms involved in regulating hunger and satiation. Eating behaviors influence the amount of the hormones leptin and ghrelin that are released in the body. Leptin is produced by our fat cells. Ghrelin is produced by cells that live in our intestines.

- Fat is an energy-storage mechanism. In the body, excess energy is converted into fat. Then, when we run low on energy, fat is converted back into a form that can be used to power our cells. When your body starts storing energy, leptin is released by the fat cells into the bloodstream and eventually passes into the brain. Some of the leptin reaches the hypothalamus in a region called the ventromedial nucleus.

There, leptin binds with neuronal receptors and boosts activation of certain neural circuits. When these circuits are active, you feel full and typically stop eating.

- Ghrelin does the opposite. When your intestines finish processing food, they start making ghrelin. As time passes, they continue making more and more ghrelin. Like leptin, ghrelin makes its way to the brain, but ghrelin causes you to start feeling hungry again.

The 20-Minute Break

- Together, leptin and ghrelin regulate food intake; however, these hormones act slowly. From the time you start eating, the full impact of the food on ghrelin and leptin can take up to 20 minutes. If you give your body time to finish that process, you might find yourself quite satisfied with less food. On the other hand, if you eat steadily until you feel full, you will continue to feel more full for 20 minutes after you stop eating.

- Most people presume that if you are receiving a strong hunger signal from your body, it means that you are in dire need of a great deal of food. That just isn't true. If you are truly starving—that is, if you are cut off from food for 48 hours or more—you will feel periodic hunger, but most of the time the hunger signals disappear altogether.

Eat with Men

- To reduce your calorie intake, eat with men.

- Molly Allen-O'Donnell and her colleagues recently performed a set of studies in which they observed people ordering food in restaurants. When women ordered food in all-female groups, they tended to order and consume about 833 calories. When women ate with a man in the group, they ordered less—about 721 calories' worth. When there is a man around, women seem to eat about 13 percent less.

If you are trying to cut down on the amount you eat, slow down during meals. Eat a moderate amount, and then take a break for about 20 minutes.

- Interestingly, the effect was the same for men. Eating with at least one male in your group seems to lead to less eating. In these studies, when a man ordered food with only women around, he tended to eat about 1,162 calories. If there were other men in the group, the men consumed about 952 calories—about 18 percent less.

Positive Psychology

- Much of the history of clinical psychology has focused on how to fix people with problems. Researchers study groups of depressed people or populations of anxious people. This is a model of research that focuses on negative situations.

- A more recent body of work, however, has focused on studying the positive aspects of psychological well-being, rather than solely focusing on negatives. This school of thought, known as positive psychology, has revolutionized how researchers think about a variety of different aspects of human perception, cognition, and behavior. The general goal is to identify people who are thriving and then study what factors are associated with that well-being.

- For many decades, researchers have experimented with people who are overweight with the goal of changing their behavior so that they can lose excess weight. From the positive perspective, however, researchers spend their time studying people who are not overweight.

- When you ask people who struggle with a weight problem why they eat and what they choose to eat, you will get a lot of different answers: anxiety, boredom, depression. When you ask these questions of someone without a weight problem, the answers are much shorter and stunningly obvious: "I eat when I'm hungry." "I stop eating when I'm no longer hungry." "I think about what I feel like eating, and then I eat it."

When Hungry, Eat; When Not Hungry, Don't Eat

- Following is a weight-loss strategy on which both modern cognitive neuroscience and nutritional science clearly agree: If you are hungry, you should eat. Conversely, when you are not hungry, you should not eat.

- This doesn't sound like rocket science, but let's unpack those two statements. If you are hungry, your body is sending you a message that it has changed from a mode of processing incoming energy to one of needing more. Restricting your calorie intake is only a short-term solution. Unless you are willing and able to spend all of your waking hours focusing on controlling your eating, you will eventually slip.

- There's another problem with ignoring the hunger signal. The hormones leptin and ghrelin influence the hypothalamus, which regulates your internal sense of hunger. They also influence your body's metabolism. If you restrict too many calories, the hunger hormones will actually reduce the rate at which your body burns energy. Too much ghrelin will also activate the mechanism that stores energy in fat cells; therefore, you will use fewer of the calories that you eat and store more of them by enlarging fat cells.

- You can fight this process with physical activity, but unless you are planning to go to extremes, exercise can often prove to be a losing battle. Humans are too efficient at acquiring energy from our foods for exercise to work on its own. What's more, if you start a new exercise program, you will burn more calories, but the hunger system in your brain will be further stimulated. If you don't also regulate food intake, a number of studies have found that eating rises to meet the amount of extra calories burned.

Monitor Your Internal Set Point

- A number of neuroscientists have proposed that the human brain regulates body weight based on an internal set point. It's like a thermostat that regulates the temperature by turning on the heat or the air conditioning to keep the temperature relatively constant—only this thermostat regulates your weight and uses hunger to maintain your weight.

- Your body seems built to do this, but there are ways to hack the system and get around this internal regulation process. Eat when you are hungry. If you don't, then your unconscious regulatory systems will simply compensate and wait until you aren't paying attention.

- When you are hungry, eat a small snack, preferably one that is rich in protein and/or high in fiber. There is much research supporting these eating habits. One of the best examples is a study in which people were given servings of various foods of equal caloric value. After they finished, the participants rated how full they felt and how much it had reduced their hunger. The foods that win this competition are always high in fiber and protein. The losers are always foods highest in sugars and fats. Even if you consume the same number of calories, foods high in sugar and fat influence that leptin-ghrelin system to a lesser degree, resulting in less change in your perception of how hungry you are.

Reinforce Positive Associations

- As you alter your eating plan, several crucial areas of the human brain will come to the rescue. The most notable of these is the orbitofrontal cortex, located near the front of your brain just above your eyeballs. This area is activated by many different types of decision-making behaviors and especially by decisions about food.

- There are strong connections between the orbitofrontal region and areas of the brain associated with hunger. In fact, when you are hungry, this area of the brain is primed for activation. When any food-related stimulus appears, the orbitofrontal cortex reacts, but if you are hungry, it responds a great deal. This area of the brain seems to be a major player in decisions about what looks good to eat.

- It should be said that humans are impressively omnivorous. Every time we eat, our body does a little data collection. It encodes the flavors, textures, smells, and even the social context in which the meal occurred. Then, after the food goes into the digestive tract, it waits to find out what happens. If you happen to feel nauseated after eating, then your brain—in cooperation with your orbitofrontal cortex—concludes that those flavors, textures, smells, and social context should be avoided in the future. If, on the other hand, there is an agreeable outcome—that is, if the body gets a boost of energy and feels satisfied—then a positive association is made with the food.

- As you eat a food repeatedly, your brain forms associations with it just as it does with any other experience. If you are reinforced for any behavior, then you will be more likely to perform it again in the future. If you are punished, then you will be less likely to perform that behavior in the future. This flavor-preference learning system is always at work, every time you eat.

- There are many healthful foods that you can teach your brain to crave. When you are hungry, satisfy your hunger with something healthful. Every time you give your body that pleasurable experience of satisfying your hunger, you will appreciate the food you used to do so just a little bit more. If you do so long enough, you will almost certainly have an experience where you get a craving—a hunger-induced craving—for a healthful food.

Questions to Consider

1. You are headed to a dinner party and are worried that you will overeat. What might you do before arriving at the party to make that overconsumption less likely?
2. Both men and women tend to eat less at restaurants if at least one of their dinner companions is male. What factor(s) might be responsible for this effect? Is there any way to use those factors to produce healthier eating even if there isn't a male companion?

Suggested Readings

Allen, *The Omnivorous Mind*.

Wenk, *Your Brain on Food*.

Lecture 5 Transcript

Eat Slow, Eat Small, Eat Smart

How can our knowledge of the human brain help us to eat better and be more fit? Can cognitive neuroscience help you to stick to a healthy eating plan? In this lecture, I'll seek to answer these questions based on a variety of studies about how the human appetite and drive systems interact with reasoning and decision-making systems.

Your brain and body contain an impressively robust system for seeking out the proper calories and nutrition that it needs to survive and thrive. However, most developed countries and environments are places in which food is plentiful, very easy to get. Meanwhile, our biological systems have a few quirks that lead to overconsumption and weight problems.

Here's a familiar tip that overcomes one of these quirks. If you're trying to cut down on the amount you eat, slow down during meals. Eat a moderate amount, and then take a break, maybe for 20 minutes. If you're still hungry after those 20 minutes, you can certainly have more, but many people find that they just aren't as hungry as they thought they were after that pause.

Let's talk about some of the brain mechanisms involved in regulating hunger and satiation. I say some because there are about a dozen different mechanisms that have been identified in the human nervous system that contribute to this process. They all consist of negative feedback loops, however, with very similar information-processing structure. So once you understand one or two of them, you'll have a pretty good working knowledge of how the whole system functions.

Let's start with two hormones: leptin and ghrelin. Leptin is produced by the fat cells in our body. Ghrelin is produced by cells that live in our intestines. The amount of these hormones that get released are strongly influenced by our eating behaviors. Fat, remember, is this amazing energy storage mechanism that our body uses. Excess energy is converted into fat. When we run low on energy, fat is converted back into a form that can be used to power any cell in our body. Whenever our body starts storing energy, when it starts converting excess energy to increase the content of fat cells, leptin is released by the fat cells into the bloodstream.

The leptin travels through your bloodstream and eventually passes into the brain. Some of the leptin reaches the hypothalamus, in a region called the ventromedial nucleus. From there, leptin binds with neuronal receptors and boosts activation of certain neural circuits. When these circuits are active, you feel full and typically stop eating. Ghrelin does the opposite. When your intestines finish processing food, they start making ghrelin. As time passes, they continue making more and more ghrelin. Like leptin, ghrelin makes its way to the brain and causes you to start feeling hungry again.

Together, these systems regulate food intake. If you feel hungry or full, your eating behaviors will tend to behave accordingly. I should note that this is the system that drives that inner two-year-old that we talked about. These are mechanisms that drive your unconscious eating behaviors.

We often decide to eat for reasons other than hunger. If you're at a dinner party and the host puts out food for everyone, there are conscious, social propriety reasons to eat at least a little bit. But most of our eating, particularly our sense of how much to eat and when to stop eating, are regulated by this leptin and ghrelin system. Disruptions of these systems can have dire consequences, actually. The hormones were initially discovered in a strain of mutant mice who would just eat and eat and eat—they would get very fat in the process. Without that leptin to tell the mice that they were full, they just kept consuming more and more calories.

Several companies market leptin supplements that will create an artificial sense of fullness by introducing extra leptin into the bloodstream. This works in the short term, but the leptin system, like most others in the body, is adaptive. Coffee drinkers know all about how the body adapts. The first few times you drink coffee, the caffeine travels to the brain and produces a strong boost in arousal. But, especially if you tend to drink coffee at about the same time and about the same place every day, your brain learns that, and compensates for it. As the time for coffee approaches, as you smell the coffee brewing in the pot, your brain knows that the stimulant is coming. The brain then downregulates activity just enough that when the coffee arrives, it boosts you right back up to where you would have otherwise been.

Eventually, you need that coffee, not for a boost above normal levels of arousal, but just to maintain your typical level. If you're a heavy coffee drinker, skipping the coffee will sometimes produce a headache, as the brain inhibits its activity and you don't boost it back up with the coffee. The same happens with leptin supplements. They'll work for a while, but they'll quickly lose their effectiveness, and if you stop taking them, you'll be subject to a very strong hunger sensation.

OK, so leptin and ghrelin do a good job of telling your brain about what's going on in your gut. If the digestive process is done and if your fat cells are releasing energy into the bloodstream just to keep things going, there'll be very little leptin, and a lot of ghrelin, and your stomach may be growling. You will feel hungry. Conversely, if there's not so much ghrelin, but a lot of leptin, that means you still have food left in your digestive tract, and will likely not be thinking about food. If someone offers you a snack, you're more likely to say that you feel full.

How does this relate to the tip to eat slowly? Why would a 20-minute break in the middle of a meal reduce your food intake? This leptin and ghrelin system is great, but that system is slow. From the time you start eating, the full impact of the food on ghrelin and leptin can take up to 20 minutes. If you give your body time to finish that process, you might find yourself quite satisfied with much less food than you'd otherwise realize.

In fact, that 20-minute break in the middle of the meal may not turn out to be the middle of the meal at all. After the break, you might frequently come to realize that it was actually the end of your eating.

When you don't take this 20-minute break, when you instead eat continuously until you feel full, you'll continue to feel more full for 20 full minutes after you stop eating. I've had this experience a lot where I feel very, very hungry. Maybe I missed lunch and I've been doing some work that consumes a lot of calories, maybe running or walking around a lecture hall for several hours waving my hands around. I finally get to the table and start to eat. I'm so hungry that I wolf down a lot of food. After about 20 minutes of eating, I feel full and stop. Over the next 20 minutes, however, I realize what I've done. I feel more and more full—uncomfortably full. Eventually, I'm sitting somewhere groaning, feeling bloated, wishing I'd remembered this 20-minute break tip after the first few minutes of eating.

Most people presume that if you're receiving a strong hunger signal from your body that it means you're in dire need of a lot of food. It turns out that just isn't true. If you're truly starving, if you're cut off from food for 48 hours or more, you'll feel periodic hunger, but most of the time the hunger signals stop altogether. When you receive that strong hunger signal from your body, when the ghrelin and lack of leptin are stimulating the hunger centers in your brain, those signals are telling you that your body has some strong need for some food, not a strong need for a lot of food. There's an important difference there. The next time you feel really hungry, thinking that through might help you eat a more healthy amount.

If you're eating with other people, this is a good time to have a conversation, revisit the events of the day, maybe discuss plans for the future. This 20-minute break can actually be a really pleasant and valuable thing. The tradition of having a meal divided into a first course, then a second course, and so on, can have a similar effect.

Researchers have identified a lot of things that might be responsible for our modern obesity epidemic. There are a lot of studies that point to the dramatic increase in our use of corn-based sweeteners for instance, things like high-fructose corn syrup. Corn-based sweeteners are cheaper than the cane-based sugars that were more typically used in the past. Manufacturers like the lower cost, of course, since lower cost means greater profit. And corn-based sweeteners taste very sweet. A typical consumer either likes, or doesn't even notice, the difference in the taste.

The evidence on this is a little mixed, but some studies suggest that when you consume high-fructose corn syrup, it reduces your brain's normal response to leptin. You consume the calories, but your body doesn't signal an appropriate stop eating signal. If you have a resistance to leptin, over time, this leptin resistance can, in principle, lead to substantial weight gain. Similarly, the obesity epidemic might be caused by the rise of processed, sugary, fatty foods. And we spend more time in sedentary activities, things like working in front of computer screens, and playing in front of all sorts of video screens, more than we have in the past. The reduction in physical activity, especially during childhood, seems partially responsible.

There's another cultural change in our eating behaviors, however, that doesn't get discussed very often. Modern eating has become less and less of a social event over the past several decades. If you sit with your family and friends around a table for a meal, you eat. Of course you eat. But you also spend time talking, telling stories, jokes; just generally socializing.

If you eat like this on a regular basis, then the 20-minute break tip that I'm giving you now might not be all that important. If you have a social event three times a day—around breakfast, lunch, and dinnertime—and at that social event you happen to also have some food, then you're probably taking more than 20 minutes to eat already. As people in our society have drifted more in the direction of eating on the go, we aren't just missing out on the social event itself, we're typically eating more, almost always without even realizing it. So if you're eating, make sure you stop for 20 minutes to let your body catch up at some point early in the meal. Or make the meal a slower, social occasion in general. Either way, you'll eat less without having to suffer through any additional hunger.

There's a related tip that's emerged from a few recent studies: to reduce your calorie intake, eat with men. Molly Allen-O'Donnell and her colleagues recently performed a set of studies in which they watched people ordering food in restaurants. When women order food in all-female groups, they tend to order and consume an average of about 833 calories worth of food. When women ate with a man in the group, they ordered less, only about 721 calories. When there's a man around, women seem to eat less; about 13 percent less.

The researchers suggested some reasons why that might be, although to be honest it's mostly speculation. Perhaps women want to appear more ladylike and are thus less likely to really gorge themselves. Maybe women are socialized over the course of their lives to do this—that is, maybe they're just imitating what they've seen other women doing in the past. Maybe there's some ancient mating-related behavior in which women who appear to not need as much food are seen as more fit as potential mates.

Interestingly, the effect was the same for men. Again, eating with at least one male in your group seems to lead to less eating. When a man ordered food with only women around, he tended, in these studies, to eat about 1,162 calories. If there were other men in the group, the men consumed about 952 calories. Whatever the reason, that's about 18 percent less. Overall, there's a clear result here that's one of those surprising, unconscious things that influence our eating behaviors. If you eat with a male companion, you'll tend to eat less.

Most of the history of clinical psychology has focused on how to fix people with problems. If someone is depressed, what can we do to make them stop feeling that way? Let's find a population of depressed people and study them. How should we treat anxiety disorder? Recruit a bunch of people with high anxiety and run studies to see how to fix that problem, or at least substantially reduce it. This is a model of research that focuses on negative situations, and there's nothing inherently wrong with it. It's resulted in some amazing progress in treating any number of problems.

A more recent growth of work, however, has focused on studying positive aspects of psychological well-being, rather than only focusing on the negatives. This school of thought has come to be described as positive psychology and it's revolutionized how researchers think about a variety of different aspects of human perception, cognition, and behavior. The general goal is to identify people who are thriving and then study what factors are associated with that well-being. Makes sense, right?

OK, so from this positive perspective, how should we solve the problem of obesity? How can we best help people to lose weight when they want to? For many decades, researchers have experimented with people who are overweight, with the goal of changing their behavior so that they can lose excess weight. From the positive perspective, researchers spend their time studying people who are not overweight. When people with healthy weight select foods to eat, how do they do so? When someone with a healthy weight is eating, what makes him or her decide to stop?

When you ask people who struggle with a weight problem why they eat and what they choose to eat, you'll get a lot of different answers: "Sometimes I eat when I am depressed or anxious." "Sometimes certain foods can be very comforting to me." "Sometimes I eat when I'm bored." "Often, I look at the clock, and it says 5 pm, which is dinnertime for me, so I eat." Researchers often need a big form to capture all of these different answers.

When you ask these questions of someone without a weight problem, the answers are much shorter and, well, obvious: "Well, I eat when I'm hungry. I stop eating, well, when I'm not hungry." And how do you choose what to eat? "Well, I think about what I feel like eating, and then I eat it." Now, these svelte people aren't idiots. They've certainly heard of the notion of comfort foods, and it's not that they never eat too much for those non-hunger types of reasons, but healthy weight people tend to do those things a whole lot less than people who suffer with a weight problem.

I'm worried my next tip will be taken in the wrong way. In isolation, it might be a bad suggestion, but I hope you'll think it through and use it appropriately. OK, here's a tip on which both modern cognitive neuroscience and nutritional science clearly agree: if you're hungry, you should eat something. Conversely, when you're not hungry, you should not eat.

This doesn't sound like rocket science, but let's unpack those two statements. If you're hungry, your body is sending you a message, a message that it's changed from a mode of processing incoming energy to one of needing more. If you've ever tried a calorie-restricted eating plan—sometimes called a diet—you know this feeling well. The eating plan says you can eat a certain, prescribed list of items for breakfast, and then, when that's done, you're not allowed to eat anything else until lunch. Your inner two-year-old might want more, but your explicit, conscious mind can prevent him from taking control and having more to eat. I've already considered the notion that this is only a short-term solution. Unless you're really willing and able to spend all of your waking hours focusing on controlling your eating, you'll eventually slip.

There's another problem with ignoring this hunger signal. The leptin and ghrelin influence the hypothalamus, which regulates your internal sense of hunger. They also influence your body's metabolism. Your body seeks to maintain its weight, to store some fat in case there's a famine at some point in the future. And the way your body can tell when food is starting to grow scarce? Too much ghrelin and not enough leptin.

The hunger hormones will actually reduce the rate at which your body burns energy. For instance, they can make you feel sluggish, which causes you to move around less. Too much ghrelin will also activate the mechanism that stores energy in fat cells. So, if you're feeling hungry, you'll use fewer of the calories that you eat and store more of them by enlarging fat cells.

You can fight this process with physical activity—for instance, walking, running, biking, and other activities. But, unless you're going to go to extremes with that, it can often prove to be a losing battle. For every mile you run, for instance, you burn about 150 calories. Five miles? That adds up to 750 calories burned. Sadly, for most people interested in weight loss, you can eat that back with a couple of slices of pizza, an extra soda or two over the course of a day. We're just too darn efficient at acquiring energy from our foods for exercise to work on its own.

Don't get me wrong, there are lots of great reasons to exercise. Your brain even produces extra new neurons if you exercise regularly. But for weight loss, exercise alone rarely seems to be effective. Some studies have explored this in detail. If you start a new exercise program, you'll burn more calories, but the hunger system in your brain will be further stimulated. If you don't also regulate food intake, a number of studies have found that the eating rises to meet the amount of extra calories burned.

This all sounds a bit depressing. It's as if there's this system in your head that has in mind how much fat you're supposed to store. If you burn more calories than you consume, the hunger system gets turned on and stays on until you get those extra calories back. A number of neuroscientists have proposed that the human brain regulates its weight based on an internal set point. It's like a thermostat that regulates the temperature by turning the heat or air conditioning on and off to keep the temperature relatively constant, only this thermostat regulates your weight, and it uses hunger to maintain that weight.

Your body seems built to do this, but there are ways to hack the system, to get around this internal regulation system. My tip for this section was to eat when you're hungry, and by that I mean whenever you're hungry you should eat. If you don't, then your unconscious regulatory systems will just compensate and wait until you aren't paying attention. I said you should eat, but I didn't say what.

When you're hungry, eat a small snack, one that's rich in protein or high in fiber, or ideally both. This has been studied a lot. One of the best examples was a study in which people were given servings of various foods of equal caloric value, a 100-calorie snack for instance. After they finished the snack, the participants rated how full they felt—how much it had reduced their hunger. The foods that win this competition are always high in fiber and protein. The losers are always foods highest in sugars and fats. Even if you consume the same calories of foods, those foods influence that leptin-ghrelin system less, resulting in less change in your perception of how hungry you are.

Lean turkey, beans, raw fruits, a smoothie with some tofu mixed in—there are thousands of examples of foods that will, with only a small amount of caloric value, turn off that hunger response, as well as the resulting responses that your body makes. It might be that you'll need to have lots of these snacks. Even if you have, say, a 150-calorie snack to turn off that hunger 2, 3 times a day in between meals, it's a benefit in the long run when compared to gorging yourself on a high-fat, high-calorie binges at times.

Some researchers suggest preparing these snacks well in advance of when you need them. Take an apple, a Tupperware container of cooked beans, some carrot sticks, and a smoothie maybe in a shakeable container with you when you leave the house in the morning. Remember, that inner two-year-old isn't big on patience. If you have the snacks ready and, ideally, visible when you need them, you're far more likely to keep that inner two-year-old under control.

And as you alter your eating plan, several important parts of the human brain will come to the rescue. The most notable of those brain areas is the orbitofrontal cortex. It's located near the front of your brain, just above your eyeballs. The area is activated by many different types of decision-making behaviors, but especially decisions about food. There are strong connections between the orbitofrontal region and areas of the brain associated with hunger. In fact, when you're hungry, this area of the brain is primed for activation. When a food-related stimulus appears, the orbitofrontal cortex responds a little at any time. But if you're hungry, it responds a lot. This area of the brain seems to be a major player in your decisions about what looks good to eat.

It should be said that humans are impressively omnivorous. We aren't just carnivores, we're not just herbivores; humans will eat an amazing range of different things. Knowledge about just what is and is not good to eat isn't something we're born with. There are some inborn food preferences, of course. Babies like sweet things from the beginning, and even a newborn infant will make a clear aversion response if you present them with a sour or bitter stimulus.

But humans eat a lot of complex things. If you look across the planet, humans eat some things that, at first glance, aren't even clearly edible. Nattō is a dish common in Japan and Korea that consists of fermented soybeans—I believe that they're good for you. Lots of very healthy, happy people will swear that they're delicious, but if you've never had them before, they look and smell, well, rotten. In a sense, they are. They're left out for bacteria to consume them, multiply rapidly, and then consume them some more. How could someone find this delicious?

The nattō eaters of the world don't have a monopoly on this. There are dishes served the world over that some people find delicious, while others find disgusting: jellied moose nose, haggis, boiled bat paste, anything made with intestines. Compared to this, fresh carrot sticks start to sound pretty good.

Every time we eat, our body does a little data collection. It encodes the flavors, the textures, the smells, even the social context in which the meal occurred. Then, after the food goes into the digestive tract, it waits to find out what happens. If you happen to feel nauseous afterward, then your brain—in cooperation with your orbitofrontal cortex—concludes that those flavors, textures, smell, and social contexts, those are things to be avoided in the future. If, on the other hand, there's a good outcome—if the body gets a boost of energy and feels satisfied—then a positive association is made to the food.

As you eat something repeatedly, your brain forms associations with it, just like to any other experience. If you're reinforced for doing any behavior, then you'll be more likely to perform it again in the future. If you're punished, then you'll be less likely to do that thing in the future. This flavor preference learning system is always at work, every time you eat. The flexibility of the system to learn to like essentially anything has been responsible for humans' spread across the globe and responsible for them finding good foods wherever they went. Not all animals have this system, by the way. Pandas are born with a strong preference for bamboo shoots. If you take them away, they won't learn to eat other things.

Not so with humans. If, for some reason, you were to eat a pencil—don't do this, I'm just making a point here—if you were to eat a pencil, and some mad scientist could somehow sneak good things into your stomach shortly after you did, you would learn to crave pencils when you're hungry. The mad scientist would also have to take out the chewed up pencil so that it wouldn't make you sick afterward. After eating a few pencils when you were hungry, your orbitofrontal cortex would be primed for action. When you glanced over and saw someone writing with a pencil, you would unconsciously be drawn to that pencil. Your mouth would begin to salivate. You would crave having a good, solid bite of pencil.

There's a tip here, but it's a subtle one. I'm not so much suggesting that you do something. Rather, I'm suggesting that you think about this system, this unconscious flavor preference system, and give it enough time to work. Now, I don't think you want to teach yourself to crave pencils, but there are a lot of healthy foods out there—and not just carrots—that you can teach your brain to crave. When you're hungry, satisfy your hunger with something healthy. You might not enjoy a foodie-esque, deliciously pleasurable experience when you do, but keep doing it. Every time you give your body that pleasurable experience of satisfying your hunger, you'll like the food that you just used to do so just a little bit more. If you do so long enough, you'll almost certainly have an experience where you get a craving, a hunger-induced craving, for a healthy food.

I've never been a great lover of apples. They're OK, of course. As a kid, they were something that was included in my lunch box. Often, I carried that apple home with me at the end of the day. I would certainly eat an apple if I was ever really hungry and there were no other options, but there were always a lot of options that I would pick over the lowly apple.

Well, more recently, I've been eating a lot of apples. They're really healthy. They're really low in calories, they're high in vitamin C, there's a good amount of fiber in an apple—they're very good for you. When I'm really hungry in the afternoon, it's not that I never have an unhealthy snack, but I've gotten into the habit of eating an apple first. I can't tell you how many times I've said to myself, "I can still have something else after. What I'm going to have right now, though, is an apple."

Once I started eating apples regularly, two strange things happened. First, I turned into a picky apple eater. There are—and this sounds pretty obvious in retrospect—good apples and bad apples. Perhaps less obvious to me was the fact that there are good apples and great apples. If you get them at the right time, when they're ripe but not too ripe, they have that crisp texture. The flavor starts sweet, has a little sour, too, and then it gets sweet again as you chew it. Not all apples taste the same. As I ate a lot of apples, my sensory systems changed. My orbitofrontal cortex learned to appreciate apples in much greater depth.

The other strange thing is that, when I got hungry, there were times when I craved an apple. Not cookies, not a donut, but an apple. To be healthy, you need to eat healthy. If you eat healthier, you will be healthier. Sometimes that sounds like a prison sentence, as if you need to leave behind the pleasures of eating if you want to live longer and healthier. I can live longer if I don't eat bacon every day, but you might say, "Is a life without bacon really worth living?"

Research on eating behaviors and how the brain controls them are pretty clear. Eating healthier means eating differently, but it certainly doesn't mean eating without pleasure. The pleasure, remember, isn't in the food, it's in your head. Bon appétit.

The Myth of Multitasking

One of the greatest powers of the human brain is that it can perform many different processes in parallel. While modern computers are, in some respects, much faster and more accurate than the human brain in terms of sequential operations, artificial intelligence is only just beginning to approximate the extraordinary parallel processing that the human brain performs. In this lecture, however, we explore the "thrill of monotasking"—the sense of focus and clarity that comes from performing only one task at a time. Monotasking can expand the brain's capabilities, speed up reaction times, improve memory, enhance creativity, and even boost IQ. What's more, there are hidden costs to multitasking, in both the short and long term.

Classic Research on Multitasking

- Today, there is significant research on task attention that assesses how well humans do and do not multitask, along with some fascinating work examining how the brain implements multitasking behaviors. However, a large body of older literature explores just how many tasks someone can learn to do at the same time.

- In a classic experimental study, expert typists were given a document to type. At the same time, the experimenters played an audio recording of a voice reading some text aloud. The job of the typists in this study was to verbally shadow that audio recording. (Verbal shadowing is a task in which you repeat what the speaker says while he or she is talking.)

- It turns out that this was an easy task for an expert typist. Expert typists can type quickly and accurately while simultaneously performing verbal shadowing. It seems that the typing is so automatic that the typist can devote attention to the shadowing, and both activities can proceed at the same time.

- Imagine that the typist practiced the verbal shadowing over the course of several weeks or months. Presumably, the typist would eventually become expert at typing and verbal shadowing. If the typists became expert enough, they may be able to add a third, fourth, or fifth task.

Brain Utilities

- It's helpful that the human brain is so effective at multitasking because our modern world demands it. There is actually a feeling of pleasure that many people describe associated with multitasking. It can be invigorating to push your mind and body up near its maximum capacity for processing information.

- The problem is that when researchers carefully assess people's functioning during multitasking, significant reductions in performance are found. Perhaps most troubling is the fact that people are unaware of the drop in performance. While we feel as if we're doing our best work, we are actually performing poorly.

- The older research using the expert typists, cited above, hinted at some of the problems with multitasking. The typists could type written material while verbally shadowing; however, if the typists had to type dictated words, then the task became tremendously difficult.

- It seems that there are certain limits to how well we can process different information streams simultaneously. The human brain can perform many operations in parallel, but there are bottlenecks in that processing. Certain brain utilities that are essential to performing many behaviors can perform only one task at a time.

- The problems with multitasking emerge directly from the bottlenecks. You might feel as if you are performing more than one task at a

There is actually a feeling of pleasure that many people describe associated with multitasking. It can be invigorating to push your mind and body up near its maximum capacity for processing information.

time, but the research demonstrates that you are rapidly switching between two or more tasks to create the illusion of simultaneously performing two tasks at one time. That switch takes time and, it turns out, requires a substantial amount of brain resources to accomplish.

Information-Processing Bottlenecks

- Many studies comparing multitasking and monotasking involve giving a group of participants a particular task, such as writing or solving a set of problems. Half the participants engage in monotasking. The other half of the participants execute the same task and also engage in a monitoring task. The group that multitasks always performs substantially worse than the monotasking group.

- Hal Pashler has performed studies on the information-processing bottlenecks in the brain. A hallmark of many of his experiments is just how simple the tasks are. He demonstrates that even if you set up a pair of very simple tasks, if they both require the same underlying processing utility, then multitasking will produce clear differences in performance.

- In one study, researchers asked people to make two simple decisions at the same time. Every few seconds, the participants' computer emits a tone. If it's a high-pitched tone, they press a key with the left index finger. If it's a low-pitched tone, they press a key with the left middle finger. In the second task, a letter appears on screen. If it's the letter A, participants press a key with the right index finger. If it's the letter B, they press a key with the right middle finger.

- Somehow, these two tasks together are much more difficult than either of them individually. The reason is that the two tasks hit one of the key bottlenecks in your brain's information-processing system. Pashler also found that even when study participants were given a great deal of practice with the two tasks, the processes never got as fast as when the participant was engaged in a single-task condition.

- We can alternate between two tasks quickly, and with practice, that alternation can become very efficient, but there is never a time when the switching back and forth becomes instantaneous. What's more, there is never a time when you can truly be performing two tasks at the same time.

Distracted Driving

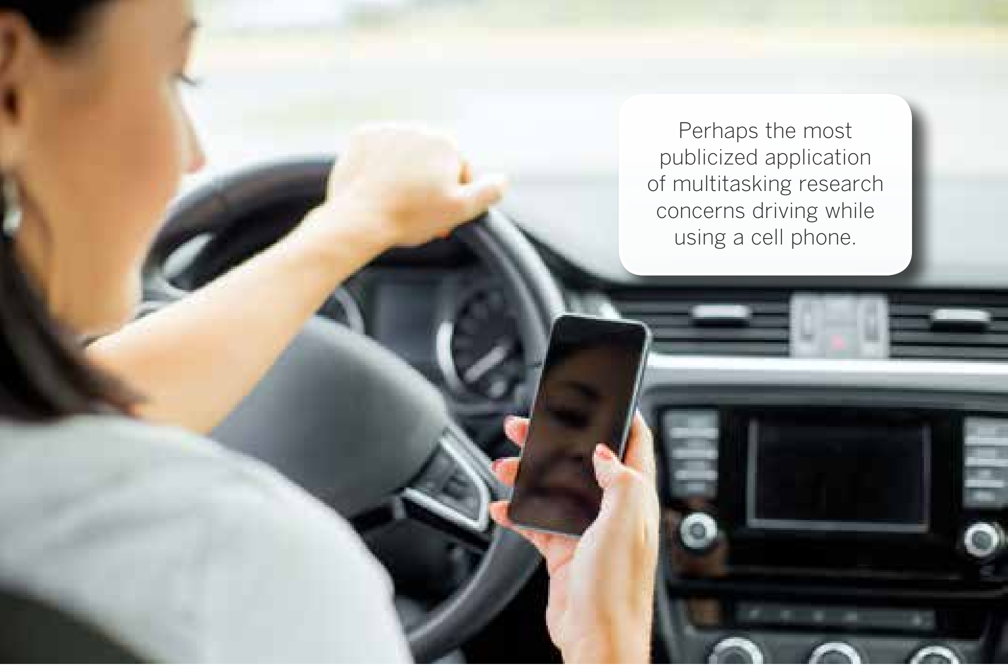
- Perhaps the most publicized application of multitasking research concerns driving while using a cell phone. Phone manufacturers and carmakers have addressed this problem with the hands-free cell phone. Although it is true that a fully hands-free system can enable you to keep your eyes on the road the entire time, several studies have found that the accident rate with hands-free cell phones is nearly as high as it is with handheld cell phones. The problem is multitasking.

- When it comes to processing sensory information and making decisions about it, the human brain is limited to one decision at a time. No matter how expert you are at the other parts of performing a task, the decision aspect remains a single-task bottleneck. When you are pondering or responding to the statements of someone on the other end of a phone or text exchange, you are making a lot of decisions.

- Every time you are making one of those decisions, you are not able to make visuomotor action decisions about driving the car. Those decisions have to wait until the bottleneck is freed up. We may be able to alternate between two or more tasks, but the switching always introduces a little delay. At 60 or 70 miles per hour, a little delay can translate into an accident.

How the Brain Multitasks

- In this section, we discuss how the brain actually implements multitasking, also termed rapid sequential multitask alternation. In the past, researchers believed that there was some sort of brain center responsible for multitasking. They envisioned it as a switching center



Perhaps the most publicized application of multitasking research concerns driving while using a cell phone.

that would store information for an ongoing task that was on hold. If we were going to build a multitasking computer, that would be a sensible component to include. But the human brain doesn't work that way.

- Whenever you engage in some task, you stimulate a network of areas of the brain and activate a large set of circuits that perform the calculations needed to support the work. If it's a spoken-language decision-making task, then the following main areas will be engaged: auditory cortex areas, the Wernicke area for processing speech, temporal cortex memory areas responsible for holding on to different sentence concepts, and the frontal cortex regions involved in intentional decision making.

- If you are also performing a task in which you are visually searching for something, such as a person's face, you will activate these areas: occipital cortex visual regions, face recognition areas in the right hemisphere, memory regions to consider where you've looked, and frontal cortex attention allocation regions to guide eye movements.

- Some of these areas are unique to one task or another. Inherently, however, some of the areas are involved in both tasks. As you repeatedly switch between the tasks, you ask these overlapping circuits to rapidly perform two separate actions for brief periods. That alternation produces interference.

- If you are multitasking, then, your brain just doesn't work as well. It will be more fatigued at the end of the day—which may contribute to the sense that you have achieved a great deal. The information processing that your brain will have accomplished will be of a distinctly lower quality, however. One small study found that if you administer IQ tests under conditions of typical technological distraction, there is a drop in scores of about 10 points. You are, in a sense, not as smart when multitasking as you are when you are monotasking.

Multitasking Makes You More Distractible

- One line of research set out to determine if people who were experienced multitaskers might be better at it than those who didn't regularly engage in the practice. Perhaps, the researchers speculated, multitaskers deal with brain challenges by getting better at task-relevant strategies. Specifically, the researchers hypothesized that experienced multitaskers might be better at focusing their attention on the key pieces of information that are most important for each task and filtering out the irrelevant information. However, the results of these studies demonstrated exactly the opposite. When you are multitasking, you are generally more distractible.

- Any environment contains potential distractions. We all learn to filter out these distractions and to keep our minds focused on the current task at hand. After a great deal of multitasking, however, our ability to filter out distractions is negatively impacted. If you multitask on a regular basis, simply keeping your attention on any one task becomes more difficult, not less.

- There are a number of solutions to these challenges, but they all revolve around the same strategy. You should practice doing only one task at a time—that is, single-tasking or monotasking. Think through the activities you want to do and pick one. Then, to the best of your ability, try to block out everything else before you begin working on it.

Questions to Consider

1. "Walking desks" that enable people to work while walking on a treadmill have become more popular recently. Getting exercise while also getting work done seems like a good idea, but is this multitasking? And if so, will the walking hinder the performance?
2. If multitasking reduces human cognitive performance, why do people report that it feels good to engage in multitasking? Is there an unconscious thought system that decides what feels good? And if so, what information is it using here?

Suggested Readings

Chabris, *The Invisible Gorilla*.

Pashler, *The Psychology of Attention*.

The Myth of Multitasking

It's often said that the greatest power of the human brain is that it can perform many different processes in parallel. You open your eyes and your brain processes incoming visual information—you don't have to choose to do so. While you're at it, you also touch, hear, taste, and smell. You do all of these things at the same time, in parallel—the processing just happens.

The same thing seems to happen for many actions that we perform. You can walk across the room while searching your pockets for your keys, while also having a conversation, while also pausing to say hello to a friend as they pass by. You do all of these things while, of course, continuing to see, touch, taste, hear, and smell.

The human brain has billions of neurons, hundreds of thousands of circuits, and they can process information in parallel. It's an amazing thing. Modern computers are, in some respects, much faster and more accurate than the human brain in terms of sequential operations, but those artificial computers are just starting to scratch the surface of this amazing parallel processing thing that the human brain performs.

In this lecture, I'm going to argue that you should try to limit the number of things that you try to do at the same time. My primary tip will be to explore the thrill of doing one thing at a time—single tasking or monotasking as it's sometimes called. I'll also argue that there are hidden costs to so-called multitasking, both short- and long-term problems that emerge when you try to do more than one thing at a time.

There's a large body of research now on task attention—assessments of how well humans do and do not multitask—along with some fascinating work looking at how the brain implements multitasking behaviors. But there's a large body of older literature that explored a fascinating set of questions that I want to describe first. With practice, just how many things can someone learn to do at the same time?

Now, when you first learn to perform some new task, it typically requires your full attention. Let's consider typing. I'm imagining here that you have a handwritten page of text and that you're given the task of typing it into a word processor. If you're just learning to type for the first time, you have to engage in a lot of intentional effort. You read the next word, the next word that you're going to type, then you think of the first letter, then you search the keyboard for that first letter, and then you press the button. You repeat this for all the letters of the word, and then repeat with the next word that you want to type.

If, during this initial typing practice, I were to ask you to perform some other task at the same time, you'd have a problem on your hands. Imagine there was talking going on in the background while you hunted and pecked your way through your typing job. Imagine that you were supposed to monitor that conversation and press a separate button anytime that person mentioned something about the human brain. As the person talked and you continued to type, one of two things would have to happen. One, either you'd have to stop typing every few seconds to listen to the conversation, or two, you would focus completely on the typing and miss some of those spoken comments about the brain.

This is all when you're new to typing, however. As you practice typing, it becomes easier and easier—it becomes more and more automatic, requiring less and less of your mental resources in order to proceed quickly and accurately. If you're practiced enough, maybe you can do both of these tasks at the same time, without either of them suffering in performance. Maybe you can process them in parallel.

In a classic study that still gets discussed by researchers in this area, expert typists were asked to do something very similar to what I've described here. They were given a document to type. At the same time, the experimenters played an audio recording of a voice reading some text aloud. The job of the typists in this study was to verbally shadow that audio recording. Verbal shadowing is a task in which you repeat what the speaker says while they're saying it.

To really get a sense of this, I'd like you to try it right now. I'm going to read three sentences, and you should repeat them aloud as I'm reading. This might feel strange, but I think you'll understand this better if you actually try the task. OK, so here we go: three, two, one. "The human brain is an organ that contains many billions of neurons." You're not doing it. Seriously, try with me. It'll just take a minute. OK, ready? You ready?

> The human brain is an organ that contains many billions of neurons. Every experience that we have results from the pattern of activity of those neurons. Our memories are encoded via changes in the structure of connections between these many neurons.

Well, hopefully you tried it. You followed behind what I was saying, usually a few words back, as I was reading the text. The task of the typists was to do that verbal shadowing task while continuing to type in text. It turns out this is an easy thing for an expert typist to do. Expert typists can type quickly and accurately while simultaneously performing verbal shadowing. It seems that the typing is so automatic that the typist can devote attention to the shadowing, and both activities can proceed at the same time.

What if the typist practiced the verbal shadowing for a few 100 hours, maybe over the course of several weeks or months? Presumably, the typists would eventually become expert at typing and verbal shadowing. If they became expert enough, could you add a third task? Maybe someone could type, verbally shadow, and solve arithmetic problems at the same time. Could you practice that and eventually add a fourth task? A fifth?

I remember reading these original papers and wondering if there might be no upper limit to this, except perhaps that we only have two hands and two feet. All that would be needed would be enough practice, and maybe you could organize your brain to perform completely separate tasks in parallel. Maybe you could write one paper with one hand while simultaneously writing another paper with the other hand on a different keyboard. As an overscheduled college student, this really sounded great to me.

These are arbitrary tasks that I'm discussing here. It's hard to think of a situation where one would want to type, verbally shadow, and solve math problems. These were arbitrary things that experimenters came up with to test the limits of human cognition and action control. That said, we do engage in multitasking behaviors a lot. We often engage in one primary task—say, writing something—while also engaging in a secondary task and a tertiary task as well. For instance, I might answer the phone when it rings and talk with a coworker. My computer periodically makes a beep, indicating that an e-mail has arrived. A little pop-up window appears, indicating who the e-mail is from and what the subject of the message is. So I'm also monitoring this incoming information and making decisions about whether or not I should stop writing and respond to it.

So it's a good thing that the human brain is so good at multitasking, because our modern world demands it. On the surface, especially based on this older research on multitasking with typists, multitasking seems like a pretty good thing. It seems far more efficient to do multiple things at once. To not do so would be to waste our natural ability. All we need to do is develop the requisite expertise, and perhaps we can do the work of two or more people. Thank you, technology.

There's a problem, however. We feel like we can do multiple tasks at the same time. There's actually a feeling of pleasure that many people describe associated with multitasking. It can be invigorating to push your mind and body up near its maximum capacity for processing information. The problem is, when we carefully assess people's performance during multitasking, significant reductions in performance are found. In some cases, the drops in performance can be really big. The drop in performance is bad, but perhaps the most troubling thing is how unaware we are of the drop. We can feel like we're doing our best work while actually performing pretty badly.

There's a part of that old research with the expert typists that actually gave some hint of this problem even at the time it was originally performed. The typists could type written material while listening to other words and verbally shadowing them. However, if the typists had to type dictated words while also trying to listen to other words and verbally shadow them, then the task became tremendously difficult. It seems that there are certain limits to how well we can process different kinds of information streams simultaneously.

The human brain can perform many operations in parallel, but there are bottlenecks in that processing. There are certain brain utilities, if you will, that are essential to performing many behaviors, utilities that can perform exactly one task at a time. The problems with multitasking emerge directly from these bottlenecks. You might feel like you're performing more than one task at a time, but the research shows that you are often just rapidly switching between two or more tasks to create the illusion of simultaneously doing two things at a time.

Think about the typical task of writing something while also monitoring your incoming e-mail. You're thinking about the topic of your writing, thinking about the global structure of the document you're composing, you're thinking about what to say next, and then composing that next sentence. This is a pretty engaging task that pulls from a variety of different brain resources. While you're doing that, there is that telltale bong from your computer that means an e-mail has arrived. You feel like you're continuing to write while you glance up and read that message. You decide the e-mail can wait and continue writing. It feels like you're doing those two things at the same time, but what you actually do is stop the thought processes that go with writing, you switch to thinking about the e-mail, and then return to the writing. That switch takes time, and it turns out it requires a substantial amount of brain resources to accomplish.

Many studies have involved giving a group of study participants an hour to do some primary task, say, writing or solving a set of problems. Half of the participants engage in monotasking—they just do the primary task. The other half of the participants also engage in a monitoring task, like monitoring incoming, very interesting e-mail messages. That group that multitasks essentially always performs substantially worse than the monotasking group. They don't feel like their performance was affected, but it essentially always is.

Hal Pashler has done a lot of the best studies on those information processing bottlenecks in the brain. A hallmark of many of his experiments is not how difficult the multiple tasks have been, but, on the contrary, how simple they are. If you set up a pair of tasks such that they are really easy, but the two tasks both require the same underlying processing utility, then multitasking will produce clear differences in performance.

One of my favorite of his studies involves asking people to make two very simple decisions at the same time. OK, imagine you're sitting in front of a computer. Every few seconds, the computer emits a tone. If it's a high-pitched tone, you press a key with the index finger of your left hand. If it's a low-pitched tone, you press the key under your middle finger.

Let's try a few of those now. Put your fingers on a surface in front of you. If you hear the high-pitched tone, press with the index finger. For the low-pitched tone, press with the middle finger. Pretty easy, right? If you practiced a few dozen of those, it would become very automatic. You could certainly do that task while feeling as if you could do something else at the same time, certainly something easy.

Well, let's try a second task. Every few seconds, a letter will be presented. If it's the letter A, press the imaginary key under your right index finger. If it's the letter B, press the key under your right middle finger. Let's practice a few of those. Again, a very easy task. If you practice a few hundred of those, even a few dozen, it becomes all but automatic.

Now, imagine we take these two very simple tasks and put them together. If you hear a tone, press the correct key with your left hand. If there's a letter presented, press the key with your right hand. Somehow, these two tasks together are much harder than either of them individually. It's like one plus one doesn't equal two. Instead, one plus one equals 4 or 5.

The reason for this is that the two tasks hit one of the key bottlenecks in your brain's information processing system, one of those utilities that can only do one thing at a time. It's the part of your brain that makes a decision about a particular piece of incoming sensory information. If high tone, then left index finger; if low tone, left middle finger. While that if-then process is engaged in one task, it simply cannot be engaged in another, even if that other process is as simple as: if A then right index finger; if B, then right middle finger.

It's interesting that this task is as hard as it is, but even more interesting is what Pashler found even when study participants were given a lot of practice with the two tasks. Certainly, people got better at the task. Practice anything enough times and you'll improve. Indeed, the responses in the multitask condition of the study became very fast. But the processes never got as fast as when the participant was engaged in a single task condition. There's simply an inevitable delay introduced if we have to switch back and forth between monitoring two different tasks. It's just an unavoidable aspect of how our brains are put together. Now, we can alternate between two tasks quickly, and with practice that alternation can become very efficient, but there's just never a time when the switching back and forth becomes instantaneous. And there is never a time when you can truly be doing two tasks at the same time.

Perhaps the most publicized application of this research in the real world has come in the domain of driving while using a cell phone. I hopefully don't have to tell you that it's a bad thing to drive while texting or talking on a phone, but, just in case, it is a bad thing to do. The extra risk of being involved in a car accident associated with using a cell phone while driving is even a little larger than the risk associated with driving while legally intoxicated. If you wouldn't drive drunk, you should certainly not drive while using your phone.

How does the cell phone create this problem? There are some obvious things that occur to most people. When you're reading and typing text messages on a phone, you have to look away from the road, at least for a few seconds at a time, right? If something happens up in front of your car during those few seconds that you're looking at your phone and not looking at the road, there's no way you can react. If the driver in the car in front of you slams on his brakes, you won't even start to react until you look back and see that car's brake lights. Even when you talk on a handheld cellular phone, you usually have to look down to dial the number or select the contact and hit send.

Phone and carmakers have addressed this problem; they've created hands-free cell phones. The idea here makes total sense. You create a phone that can respond to your voice commands—statements like "call Mom" prompt the phone to make a call to that person, to Mom. When an incoming call arrives, the hands-free phone states who the caller is and you can accept or decline that call. You can even have many devices read your text messages to you and, if you choose, to dictate a reply to be sent via that text message system. Problem solved, right? Unfortunately, no.

It is true that a fully hands-free system can enable you to keep your eyes on the road the whole time, but several studies have found that the increased accident rate stays almost as high with hands-free cell phones as it is with handheld cell phones. What's going on here? Why should the hands-free phone be almost as bad, even when your eyes can stay forward at all times? The problem? Multitasking.

The experiments we've discussed here apply very specifically to this situation, in at least two important ways. First, when it comes to processing sensory information and making a discrete decision about it, the human brain is limited to one decision at a time. No matter how expert you are at the other pieces of performing the task, the decision part remains a single-task bottleneck. When you're pondering the statements of someone on the other end of a phone or text exchange, you're making a lot of decisions. Should I respond now or keep listening? What should I say? Should I mention our last conversation or not? Lots and lots of decisions.

And every time you're making one of those decisions, you're not able to make visuomotor action decisions about driving the car. Should I hit the brakes? Should I change lanes? Those decisions have to wait until the bottleneck is freed up. We get very good at alternating between two or more tasks, but the switching always introduces a little delay. And at 60 or 70 miles per hour, a little delay can translate into the difference between avoiding a collision and having an accident.

I've described several times in this course some of the limitations of human decision-making. When we make short-term, immediate decisions, we tend to do so with our gut rather than after careful consideration. That unconscious decision-making process won't be thinking about studies of multitasking when the phone is ringing. Your unconscious mind will just be thinking about the immediate reward of learning who's on the phone and why.

The tip that emerges from this is simple. When you get into the car, before you turn the key to turn the engine on, press the button to turn the phone off, or at least to turn the ringer off. If there's some pressing call or message that you're waiting for, maybe one that's too important to wait until you complete your drive, then pull off the road—ideally, into a safe parking lot somewhere. Then turn the phone back on to check it. It might seem annoying, at least at first, to stop every half hour or hour for this purpose, but that annoyance is well worth the safety of yourself, your passengers, and the other people on the road.

There's a question that I often get when I describe this research to people. Shouldn't it be the case that talking to an actual person sitting in the car next to you is also a problem? If your attention is on an in-person conversation, shouldn't that create a dangerous multitasking situation as well? Until very recently, my answer to this involved a bit of hand waving.

There have been a lot of studies showing the problem for cell phones, but very few have addressed other non-cell phone distractions.

In principle, it should create a problem. The lack of a study showing the problem could be caused by at least one of two or three things. First, perhaps it's mentally more taxing to have a conversation with a disembodied voice, the kind of voice you interact with on a phone. Maybe that creates a bigger problem than the in-person conversation. Second, however, it could just be that researchers haven't studied this particular problem, certainly not in the same detail that they've studied the situation with cell phone usage.

The National Traffic Safety Board recently published results from an ongoing study in which dashboard cameras were installed into the cars of thousands of volunteers. The researchers looked at about 1,700 videos taken in the moments leading up to a reported crash by teenage drivers. In 60 percent of the cases in which an accident happened, the driver was distracted. In 15 percent of the cases, it wasn't the cell phone that was the distraction, but rather one or more of the passengers in the car.

Now, I'm not a teenager anymore, but it's reasonable to presume that this finding applies to me as well, and to you, too. The information processing bottlenecks associated with multitasking aren't something that you just outgrow. As someone who takes long trips with my family in the car, the thought of not talking with them while I drive sounds pretty unpleasant, but the data here suggests that I should minimize that. If I'm embroiled in a conversation about something—that is, if I'm having a good conversation—then I'm multitasking. And when I'm multitasking, I'm putting everyone in danger.

I also find myself realizing that some of you are probably listening to this lecture while driving your car. You're listening and processing the information, but I'm not asking you—most of the time, anyway—I'm not asking you to make decisions and produce actions. As long as you're just listening, there should be no need for task-switching. It's not surprising, for this type of reason, that there aren't any studies relating listening to the radio, for instance, to increases in car accidents. Tuning the radio? Selecting a station? This is a decision-making process. But just listening without making decisions should be fine.

I want to finish today by talking about how your brain actually implements multitasking. Actually, I should more correctly say rapid sequential multitask alternation, but that's a mouthful. I'll continue calling it multitasking, but you know what I'm talking about when I use that term now.

One prediction that researchers used to make, that now seems clearly wrong, is that there might be some brain center responsible for multitasking. Perhaps this would be sort of a switching center that would store information from an ongoing task while it's on hold. If we're ever going to build a multitasking computer, that would be a sensible component to include, but in the human brain, it doesn't work that way.

Whenever you engage in some task, you activate a network of different areas in the brain. It's a large set of circuits that perform the calculations needed to support that work. If it's a spoken language decision-making task, for instance, then obviously you'll need to activate auditory cortex areas that will increase in activity, along with Wernicke's area for processing speech, temporal cortex memory areas responsible for holding onto different sentence concepts, and the frontal cortex regions, things involved in intentional decision-making. Likely, other areas are engaged as well, but you get the idea.

If you're also doing a task in which you're, say, visually searching for something, like a person's face, you'll activate occipital cortex visual regions, face recognition areas in the right hemisphere, memory regions to consider where you've looked, and frontal cortex attention allocation regions to guide those eye movements, and other areas, as well.

Some of these areas are unique to one task or another, but, inherently, some of the areas are involved in both tasks. As you repeatedly switch between these two tasks, you rapidly ask these overlapping circuits to do two different things for brief periods. That alternation produces interference, maybe like rapidly switching the gears of your car between drive and reverse. It works—the car moves forward when you put it in drive and backward when you put it in reverse—but it doesn't have the time that it would ideally need to build up efficient speed in either direction.

If you're multitasking, then, your brain just doesn't work as well. It will be more fatigued at the end of a workday, which may actually contribute to that sense that you've accomplished a lot, but the information processing that it will have accomplished will be of a distinctly lower quality. One small study found that if you administer IQ tests under conditions of typical technological distraction, there's a drop in scores of about 10 points. You are, in a sense, not as smart when you're multitasking as you are when you're monotasking.

One line of research set out to see if people who were experienced multitaskers might be better at it than those who don't regularly engage in the practice. Perhaps, the researchers thought, multitaskers deal with these brain challenges by getting better—better at task-relevant strategies. Specifically, maybe experienced multitaskers are better at focusing their attention on the key pieces of information that are most important for each task, and, conversely, filtering out irrelevant information. The results of these studies demonstrated exactly the opposite. When you're multitasking, you are generally more distractible.

Any work environment contains potential distractors—people walking by in the hallway, the low hum of the lighting fixtures, the periodic fan noise when the ventilation system kicks on. We all learn to filter these distractions out, to keep our mind focused on whatever happens to be the current task at hand. After a lot of multitasking, however, our ability to do this is negatively impacted. Your attention will be more readily, involuntarily drawn to those small, irrelevant noises and movements. If you multitask on a regular basis, just keeping your attention on any one task becomes more difficult, not less.

There are a number of solutions to these challenges, but they all revolve around the same thing. You should practice doing one thing at a time.

Sometimes this is referred to as single-tasking, or monotasking. Think through the things you want to do and pick one—one. Then, to the best of your ability, try to block out everything else before you begin working on it.

This sounds very simple, and in a way it is, but it can feel very uncomfortable the first few times that you try it. Turn off your e-mail program. Turn off the phone ringer. Many phones now provide an option to block all but the most critical numbers—maybe your spouse, your children's school, and your boss, for instance. Shut the door. Maybe even hang a sign on your door that says something like, "Please Do Not Disturb Until" some particular time, maybe 30 minutes or an hour later.

It might even make sense to tell your colleagues what you're going to try. If there's a particular group of people who are likely to call or knock on your door, explain that you're going to try to focus on one particular, important task for some big chunks of time. If you are needed, but it can wait for 30 minutes or so, request that they send you an e-mail. You can even set up your e-mail to automatically reply with some information about your schedule: "I plan to address incoming e-mail messages each day between 9 and 10 am and then again from 4 to 5 pm. If this is more urgent, please call" and then some contact who can knock on your door.

To try this, you'll need to figure out how to best fit this plan into your particular situation, but almost everyone can arrange for at least some monotasking time each day. As I mentioned, it can feel strange, even uncomfortable at first, but there's a strange thing that happens. After you do it for a while, it feels surprisingly good. You'll likely notice two things. First, you'll get a lot done, a lot more than you otherwise would have. Second, your work will be of a better quality. You will, according to a range of different kinds of evidence, be more creative, efficient, and just plain smarter than you would be if you were engaged in that typical task-switching activity.

I hope you'll experiment for yourself with what I describe as the thrill of monotasking, along with the sense of focus and clarity that comes along from doing that one thing. Imagine that a genie appeared and offered to magically change, to boost your brain's capabilities for a few hours. The spell would speed up your reaction times, improve your memory, boost your creativity—it would even boost your IQ by 10–20 points. How excited would you be? Well, you don't need a genie; you can access this spell whenever you want. Just turn off distractions, focus on one task, and there's good evidence that your brain will almost magically improve.

Lecture 7

Future You and Better Decisions

To improve your reasoning capability and make better decisions, a very effective strategy is to engage in mental time travel. Having a brief visit with your future self as you ponder what to do can result in a happier, healthier, and even wealthier future you. In this lecture, we examine strategies derived from research that will help us make better decisions—for example, keep your list of options short (around six items), keep the consequences of decisions concrete, and make decisions about categories in a progressive fashion.

Temporal Discounting

- Humans have a tendency to engage in temporal discounting—that is, we prefer to receive rewards sooner rather than later. In fact, we will often choose a smaller reward sooner over a larger reward later.

- From an economics perspective, there is some value to temporal discounting. If someone gives you some cash today, you could invest it, and it might increase in value over time. While temporal discounting is, in principle, sensible in small amounts, hundreds of studies have found that the human brain uses a temporal discounting rate that is far too high. If we can compensate for that tendency, our reasoning can be substantially improved.

- Humans use temporal discounting not only with money, but with a broader class of choices, situations, and behaviors. For example, consider the decision between spending the day relaxing or spending it working. The pleasure of relaxing is the small but immediate reward here. Reducing our tendency to engage in temporal discounting can reduce the likelihood of making the wrong choice. Mental time travel can help.

Your Future Self

- Several researchers have described the mental process of reasoning through a decision as a negotiation between the present you and the future you. In some cases, we are very willing to incur costs that must be paid back by another person—a future you.

- Brain imaging work conducted by Dan Gilbert and his colleagues has revealed quite a bit about how the brain mediates these internal negotiations. The area of the brain crucial to this process is termed the ventral medial prefrontal cortex (VMPFC). The VMPFC has many connections to the amygdala and is involved in reasoning about emotion-laden stimuli. More recently, this region has been found to be heavily involved in self-referential processing.

- Using functional magnetic resonance imaging (fMRI), the researchers determined that when people think about themselves, there is a substantial surge of activity in the VMPFC. About six seconds after that increase in activity, there is a surge of blood flow in the region. If the person is thinking about other people, activity in this region of the brain drops.

- Participants in the Gilbert study were scanned in an fMRI while they made judgments about how much they would enjoy a range of pleasant tasks. In some cases, the participants judged how much they would enjoy doing this task within the next 24 hours. In other cases, the participants judged how much they would enjoy doing the task in the future, defined as "this time next year." In addition to ratings of how much they would personally enjoy particular tasks in the present and the future, participants also made ratings of how they thought some other person would enjoy the task.

- The experimenters determined that when participants think about themselves in the present, the VMPFC is very active. When participants think about others, either in the present or future, this VMPFC activity is significantly reduced.

- Here's the interesting part. When participants think about themselves in the future, VMPFC activity drops. That is, they use the same brain systems involved in reasoning about other people. It's as if the brain, at a very fundamental level, thinks of the future you as someone else.

Mental Time Travel

- Participants in the Gilbert study also completed a temporal discounting test, where they were offered various pairs of rewards and asked to select one. They were also given the choice between an immediate reward with no delay and a reward in several months. Based on many of these preference judgments, the experimenters could infer a monthly temporal discounting rate for each participant.

- A fascinating pattern emerges when you look at the brains of the people with low and high temporal discounting rates. Some participants were so patient that they were willing to wait a month for even a small increase in the reward. They showed much smaller reductions in VMPFC activity when they shifted from thinking about their enjoyment of present and future tasks.

- The impatient participants were those who were willing to wait a month only if the monetary reward was much greater. This impatient group showed very large reductions in VMPFC activity.

- The data imply that when the patient participants thought about their future selves versus their present selves, their brains treated them very much the same. Conversely, the brains of the impatient people thought about their future selves in much the same way that they thought about other people, as strangers.

- Future discounting behavior is a problem that leads us to nonoptimal reasoning and decision making. Any choice is driven by a weighing of the positives and negatives associated with it. If something negative is pushed into the future, it doesn't actually make it any less negative. If we can make that negative someone else's problem, however, then it does make it less of a problem for us. Unfortunately, our brains think of our future selves as this someone else. This illusion leads to the reasoning problems.

- Fortunately, there are a variety of ways to outsmart yourself here—that is, ways to outsmart your present self—as you are pondering what to do next. One of the easiest strategies is to take a few minutes to think about the immediate future—that is, engage in mental time travel. Travel forward in your mind to the end of the day. Look back on the day you spent. Consider how you would feel if you spent the day one way. Think about how you would feel if you made the other choice.

Make Firm Decisions

- As we make choices, we take advantage of some opportunities and inherently leave others behind. That can be an unpleasant experience. It's quite common for people to ponder the "road not taken" in their past. Sometimes, we resist closing doors and instead seek to keep our options open as much as possible. While freedom of choice is something we value greatly, several recent lines of research suggest that there is such a thing as too much freedom of choice. In fact, when people are given too many options, they often report being less satisfied with the outcome. Some refer to this as analysis paralysis.

- Consider this study by Jack Brehm. The study begins with participants viewing a selection of six posters of famous paintings. The participants' task is simply to rank these posters from their most favorite to least favorite. After the participants rank the posters and fill out a questionnaire, the experimenter offers them a gift. The two posters that are offered as a gift are whichever posters the participants picked

When people are given too many options, they often report being less satisfied with the outcome. Some refer to this as analysis paralysis.

as their third favorite and their fourth favorite. As you would expect, most people pick the poster that was their third favorite.

- The participants are sent home and, after a delay of a few days, they are asked to come back to the lab again and re-rank the posters. Something very consistent happens: The poster that they picked—the third favorite—moves up in the rankings. The poster that was not picked drops in the rankings—on average, from fourth down to fifth place.

- In other words, once you decide on some option, your brain shifts its future preferences to perceive whatever you have chosen as being more positive. Whatever options you specifically have not chosen seem to decline in positivity.

- If you want to be happier with the decisions you make, then you should make them firmly, and then stick with them. If two choices seem to involve the same risks, benefits, positives, and negatives, then greater satisfaction can be obtained by confidently staying with one selection.

Reduce the Options

- Another way to improve your reasoning about different choices is to do less of it. While we have a strong desire to maximize our options in life, we should, whenever possible, reduce the number of options to a relatively small number—around six seems ideal. Across a variety of studies, when the choices are limited to six or fewer, human decision making seems to function more optimally.

- Research supporting this strategy starts with a simple study performed by Sheena Iyengar and her colleagues when she was a graduate student at Stanford University. There was a grocery store nearby that sold 348 varieties of jellies and jams. The experimenters set up a tasting booth to let people try different jams.

- Half the time, the experimenters set out samples of 24 different jams. Half the time, the booth only had 6 jams available to try. Many more people stopped to try jam when there were 24 to try; however, when there were only 6 jams offered, the customers were far more likely to buy jam. With the 24-jam display, about 3 percent of visitors purchased jam. With the 6-jam display, 30 percent of customers made a purchase.

Make Consequences Concrete; Create Categories

- In addition to reducing the number of options, Iyengar and her colleagues also recommend making the consequences of decisions concrete. For example, in studies in which people are asked to imagine specifically what their life will be like in the future, they tend to save and invest more. These studies provide more evidence for the benefits of mental time travel.

- Another way to proceed with reasoning about decisions and keep the number of choices low is to make decisions about categories in a progressive fashion. Say that you are deciding where to take a vacation. One way of narrowing your master list from hundreds to six would be to divide your options into categories first, such as geographic location. Then, choose the type of trip, such as hiking, beach, or city tour. Now, your original master list of hundreds of potential trips has been winnowed down to a small number of possibilities.

- By progressing in terms of small numbers of categories, a complex decision can be broken into a sequence of stepwise decisions that fit well within the constraints of the human brain.

Questions to Consider

1. When you think of the future, the brain reasons about it as if the future you is a different person. Are there other situations in which you might think of yourself as another individual?
2. Too much freedom of choice seems to create problems for human decision making. Might this also be true in terms of how modern people—living in the world of Internet dating—select romantic partners?

Suggested Readings

Ariely, *Predictably Irrational*.

Kahneman, *Thinking, Fast and Slow*.

Lecture 7 Transcript

Future You and Better Decisions

In order to reason better about your actions and decisions in general, it can be a very good thing to spend a few minutes engaging in mental time travel, having a brief visit with your future self as you ponder what to do in many situations. Imagine being your future self. This can result in a happier, healthier, and quite literally wealthier future you.

Let me offer you two choices. I can give you $10 right now or $30 tomorrow. Which would you prefer? Almost everyone would pick the $30 tomorrow. How about $10 now or $30 next week? How about $10 now or $15 next week? Now we're getting closer to equivalent choices for many people. Humans engage in a process called temporal discounting. We prefer to receive rewards sooner rather than later. We prefer this so much that we'll often choose a smaller reward sooner over a larger reward later.

Before I talk about all of the things that are problematic about temporal discounting, I should note that, from an economics perspective, there is some value to temporal discounting. If someone gives you some cash today, you could invest it and it might increase in value over time. It's also the case that having money today provides flexibility that might have value. And if you use that money to purchase some durable goods—maybe a tennis racket—then you get to start enjoying that item right away.

There's some validity to temporal discounting, but what cognitive neuroscientists have found is that we engage in far more temporal discounting than makes sense as an economic calculation. For instance, if you invest $10 today, you'd be lucky to turn it into $10 and 50 cents by the end of the month. Yet, in order to wait a full month, most people want that reward to be at least $14 before they'll opt for the delay option.

While temporal discounting is, in principle, a sensible thing in small amounts, hundreds of studies have found that the human brain uses a temporal discounting rate that is far too high. If we can compensate for that tendency, our reasoning can be substantially improved. Note, by the way, that this effect doesn't just work for these relatively small amounts of money—they key is the relative amount of money. So, the same would be true if we talked about $1,000 now versus $1,400 in 30 days.

Temporal discounting happens with cash rewards like the $10 here, but also with a broader class of choices, situations, and behaviors. Should I spend today relaxing and playing, or should I spend the day working? The pleasure of relaxing and playing is the small, immediate reward here. The working will produce rewards as well, hopefully much greater rewards in the form of money, career advancement, and, hopefully, a sense of satisfaction with what's accomplished. Those are greater rewards, but they're inherently delayed relative to the immediate fun of playing today.

So, to draw a parallel to the experiment I've described, the "play now" choice is like the $10 immediate gift. The "work now, enjoy more later" is like the $14 gift after 30 days. Perhaps the most interesting aspect of this process is that we often reason through a decision like this, and realize that, deep down, we want to take the bigger, delayed reward, but then we don't. If I eat this giant ice cream sundae right now, I just know I'm going to regret it later. I know that the best thing to do is to resist the momentary, immediate pleasure of the eating in order to promote the far more pleasurable goal of being fit and healthy in the long term. Then, maybe, I pick up a spoon and dig in.

Reducing our tendency to engage in temporal discounting can reduce the likelihood of making this kind of choice. Mental time travel can help. Just project yourself forward about 20 minutes here. See what that future will look like, and feel like. There's an empty ice cream bowl there, you've already eaten it. That immediate pleasure is now past. How will you feel?

By pondering that, even briefly, you'll more heavily weight this future situation as you make decisions in your present.

Several researchers have described this mental process that goes on, this sort of conflict, in terms of a negotiation process, a negotiation between the present you and the future you. In some cases, we're very willing to incur costs that have to be paid back in a sense by this other person, this future you. Brain imaging work conducted by Dan Gilbert and his colleagues has revealed a lot about how the brain mediates these internal negotiations. A key part of the brain for this process is referred to as the ventral medial prefrontal cortex: the VMPFC. The name sounds quite precise, but there's some debate as to just where the boundaries of the VMPFC region are located based on anatomical features. But the VMPFC is generally located near the front of the frontal lobes, tucked under at the bottom of the frontal cortex region. Frontal here refers to the front, obviously. Prefrontal refers to the front of the front.

VMPFC has many connections to the amygdala. It's involved in reasoning about emotion-laden stimuli. More recently, this region has been found to be heavily involved in self-referential processing. If you were lying in an fMRI scanner and I asked you to think about yourself and your life, to think about what type of person you are, about your experiences, your likes and dislikes; think about your particular abilities and your particular goals. As you think about all of those things, there'd be a substantial surge of activity in that region of the brain. About six seconds after that increase in activity, there'd be a surge of blood flow into that region.

Recall that the fMRI precisely records the amount of blood flow to different regions of the brain, so we can see what parts of the brain are affected when you perform particular types of reasoning behaviors. When you're thinking about yourself, this increase in activity in the ventromedial prefrontal cortex can reveal that you're doing so. If, instead, you're thinking about other people—about other people's experiences, abilities, likes, dislikes, and so on—the activity in this region of the brain would drop, revealing that you are thinking less about yourself and more about other individuals.

The participants in the Gilbert study that I'm describing now were scanned in an fMRI while they made judgments about how much they would enjoy a range of pleasant tasks. The ratings were from one, for not much at all, to four, for very much. In some cases, the participants judged how much they would enjoy doing the tasks within the next 24 hours. In other cases, the participants judged how much they would enjoy doing the tasks in the future, where the future was here defined as this time next year.

In addition to ratings of how much they would personally enjoy particular tasks in the present and in the future, the participants also made ratings of how much they thought some other person would enjoy the task. A photo of this person was shown to provide a visual reference, but no detailed information about this person was provided.

OK, so the design allows us to look at what the brain does when you're making judgments about the potential enjoyment of you and of others, both in the present and in the future. Let's start with you in the present. The VMPFC is very active in this condition—no surprise there. When you think about others, either in the present or the future, this VMPFC activity is significantly, substantially reduced.

Here's the interesting condition: when you think about you in the future, the VMPFC activity drops. You use the same systems involved in reasoning about other people. In terms of how your brain ponders your future self, this notion of a negotiation between the present self and the future self perfectly matches this brain imaging data. It's as if the brain, at a very fundamental level, does think of the future you as someone else, rather than as the person whom you'll become.

OK. The participants in this study also completed a temporal discounting test. They were offered various pairs of rewards and asked to select one. The rewards varied in size between $10 and $30. They also varied in terms of delay between immediate reward with no delay and several months of delay. Based on many of these preference judgments, the experimenters could infer a monthly temporal discounting rate for each participant.

Given the choice of $10 right now or some larger amount after 30 days, what larger amount would result in an equal preference for the two?

For the average participant, this value was $14.27. Given a choice between $10 right now and $14.27 in 30 days, participants would choose each one about 50 percent of the time. But, this monthly discounting rate varied a great deal across participants. For one participant, it was as low as $10. That is, he didn't care if he received his $10 now or in 30 days. For some participants, it was as high as $25. They wanted $25 if they were going to be forced to wait 30 days to get it.

A really fascinating pattern emerges when you look at the brains of people with low and high temporal discounting rates. Some participants were so patient that they were willing to wait a month for even a small increase in the reward. They showed much smaller reductions in the VMPFC activity when they shifted from thinking about their enjoyment of present and future tasks. The impatient participants were those who were only willing to wait 30 days if the monetary reward was much greater. This impatient group showed very large reductions in VMPFC activity.

The data imply that when patient participants thought about their future selves versus their present selves, their brains treated them very much the same. Conversely, the brains of the impatient people thought about their future selves in much the same way they thought about other people, the same way they thought about strangers whom they only knew by seeing a photograph.

This future discounting behavior is a problem—it leads us to engage in non-optimal reasoning and decision-making. Any choices is driven by a weighing of the positives and negatives associated with it. If something negative is pushed into the future, it doesn't actually make it any less negative, the negative is just delayed. Now, if we can make that negative someone else's problem, then it does make it less of a problem for us. Unfortunately, our brains think of our future selves as this someone else. This illusion is what leads to the reasoning problems.

Fortunately, there are a variety of ways to outsmart yourself here—ways to outsmart your present self, I should say. One of the easiest is to take a few minutes as you're pondering what to do next and think about the future—not the distant future, just a future you who exists in a few hours, or tomorrow. Many financial analysts plan for the future with complex spreadsheets that implement specific temporal discount functions. You enter the values of various benefits and costs and consider the accrued values associated with the passage of time. You could, in principle, do this in terms of your everyday decisions, but I don't recommend that. The time and energy involved would likely greatly outweigh the benefits, except perhaps for the biggest of decisions. And there's an easier way: mental time travel.

OK, mental time travel isn't the same thing as H. G. Wells's *Time Machine* time travel, but in some ways it's much better for our purposes. Thinking about what to do today? Maybe making a choice between running some important errands or napping in front of the television? Imagine that it's the end of the day—travel forward to that time. Look back on the day you spent. The sun is setting, you've finished dinner, it's time to wind down for the day and get ready for the next one. See that moment through your own eyes. In a few hours, you won't have to imagine it; you'll be seeing the world from this perspective. Imagine what that will look like, and what it will feel like.

How will you feel if you spent the day in one of the two different ways? How will you feel if you made the other choice? Now, I don't know what the better decision is here—that depends on you, the errands, and probably what's on the television. But by engaging in the mental time travel, by seeing the world through those imagined future self's eyes, your decision-making will be improved and you'll be more satisfied with whatever you did choose.

As time passes, we make choices and produce behaviors. As we do so, we take advantage of some opportunities and inherently leave others behind. That can be an unpleasant experience. It's quite common for people to ponder roads not taken in their past, and where they could have taken them, so we often resist closing doors and instead seek to keep our options open, to keep them open as much as possible. Freedom of choice is something we value greatly, but is there such a thing as too much freedom of choice?

Several recent lines of research suggest that the answer is yes. When people are given too many options for what to do, they often report being less satisfied with the outcome. Some people refer to this as analysis paralysis. And when you analyze the choices that they do make, there are some consistent biases that create problems rather than solving them. I won't be arguing in this lecture that you should somehow sign yourself up to have no choices. What I'd like to suggest is that you can make better decisions and enjoy the fruits of those decisions more if you do two things.

First, given a range of options, make a firm choice, and make it as soon as is reasonably possible. Second, once you've made that choice, commit to it. As much as possible, prevent yourself from thinking further about the road not taken. If you can, create disincentives to prevent yourself from going back and revisiting that choice.

Let's start by considering a simple study associated with Jack Brehm. Some fascinating extensions of that work have come recently from Dan Gilbert and his research team as well. He conducted the studies with art print posters, but other researchers have explored it with a variety of other kinds of materials. The study is about choosing a poster, but there's a lot of reason for us to suppose that it applies to choices about houses, cars, and jobs as well, perhaps even our choices about whom to marry.

OK, the study begins with a participant viewing a selection of posters, the prints of famous paintings: Van Gogh's *Starry Night*, Munch's *The Scream*, Vermeer's *Girl with a Pearl Earring*, and three others: six total posters here. The participants' task is simply to rank these posters from their most favorite to their least favorite. The cover story for this study is that it's about art, perception, and personality. Participants don't know at the start of the study that it's really an experiment about decision-making.

OK. After the participant makes their choice and fills out a questionnaire, the experimenter offers them a gift. “We have some extra copies of some of these posters, and we’re almost done with this experiment. Would you like one? Actually, we don’t have copies of all of them, just these two.” The two posters that are offered as a gift are whichever posters the participant picked as their third favorite and their fourth favorite. As you would expect, most people pick the poster that was their third favorite. They just told the experimenters that they liked it more than their fourth favorite, so that makes sense.

The participants are sent home, and, after a delay of a few days, they’re asked to come back to the lab again and re-rank those five paintings. Something very consistent happens. The poster that they picked—this was formerly their third favorite—moves up in the rankings. The average shifts up to somewhere around number two in the average subsequent ratings. The poster that they did not pick, it drops in the rankings, from its initial position as the fourth ranked poster down to around fifth place on average.

Once you decide on some option, your brain shifts its future preferences to perceive whatever you have chosen as being more positive. Whatever options you specifically have not chosen, those options seem to decline in positivity.

One thought you might have here is that perhaps having that painting at home and looking at it on the wall for an extended period makes it seem better. Maybe a mere exposure to the poster that was chosen causes it to seem better than it was at first. That wouldn’t explain the drop in preference for the option that was not selected, but it’s still a reasonable thing to consider. At least some of the effect might be explained by this, but the same effect is shown by anterograde amnesics.

When someone suffers damage to their hippocampus—perhaps due to illness, stroke, or substance abuse—they often lose the ability to create new, explicit, long-term memories of things they experience. An anterograde amnesic can still remember things from their distant past, from events that took place before the hippocampal damage occurred. They can also remember things on a short-term basis. If I ask someone with anterograde amnesia to remember a list of seven words, for instance, he'll typically be able to recall them a few seconds later. But if I leave the room and return 10 minutes later, and then ask him to recall the words, he won't remember them at all. He likely won't remember that there was a list of words. He won't remember even meeting me earlier.

Why is this relevant to the effect of making firm decisions and sticking with them? Because simply making a particular choice changes the anterograde amnesic's future preferences as well. The experimenter in this case asks the amnesia patient to rate six posters from best to worst. The experimenter then offers one of the posters as a gift, whichever was ranked third or fourth. The amnesic patient picks number three, just like most people. The amnesic then puts the poster away and the experimenter leaves the room for about 30 minutes.

The experimenter returns and has to reintroduce himself. The amnesic doesn't remember meeting him or participating in the study 30 minutes earlier. The experimenter asks the amnesic participant to rate the posters, and the preferences change. The third-ranked poster moves up toward the top position. The not selected poster moves down in the ranking. Owning the third-ranked poster somehow makes it more desirable for the anterograde amnesic, even though he doesn't know that he owns it. It's not the owning that matters here, it's the fact that the poster was chosen in the past that makes it seem better.

One last piece of the argument for this first tip: experimenters have added one extra wrinkle to this type of study on several occasions. Participants rank a range of choices, then the gift selection process is completed, just as in those previous studies, only this time the experimenter asks the participant, "Are you sure? Is that definitely what you want?" Most participants say yes, but the experimenter continues, "OK. Just in case you change your mind, I'm going to contact you in a few days to make sure that you don't want to change your selection. If you do want to switch, it's no problem at all."

The participant leaves with the chosen item, but also with an option. The participant leaves while still retaining the freedom to come back at any time and choose something else instead. This lack of commitment, it eliminates the shift in preference associated with a choice. The chosen item doesn't get more attractive; the not selected item doesn't drop in positivity.

If you want to be happier with the decisions you make, then you should make them—make them firmly and then stick with them. Now, if future information becomes available that indicates you definitely have made the wrong choice, that a different decision actually would have been much better, then by all means go ahead and switch your choices. But that doesn't characterize how most hard decisions are made. If two choices seem to involve about the same risks, benefits, positives, and negatives, then greater satisfaction can be obtained by firmly staying with one selection. Mental time travel into the future? There's evidence that this activity is a very good thing. Mental time travel backward to previous decisions? There's good evidence that this activity can be a very bad thing.

Another way to improve your reasoning about different choices is to do less of it. We have a strong desire to maximize our options in life. This seems like a good thing—how could it not be? My counterintuitive tip here is that you should, whenever possible, reduce the number of options you have to a relatively small number—around six seems ideal. Across a variety of studies, when the choices are limited to six or fewer, human decision-making seems to function more optimally.

Where should we go on vacation this year? You could start by generating a long list of dozens, even hundreds, of possible destinations and then start narrowing that list down until you have only one left. That would be the winner; that would be your choice. What kind of car should I buy? I could similarly start by considering several dozen options. How should I invest my savings? There are thousands of different ways to do that.

An alternative approach that works better in most situations is to quickly generate several options, between about 5 and 10, and then stop coming up with more ideas, just choose from that short initial list. You'll likely feel uneasy as you do this. Just think of the hundreds, the thousands of options that you're dismissing without careful consideration. The perfect vacation, the perfect car, perfect investment fund might be out there, and you just eliminated it from consideration. But there's good evidence that you'll make better decisions and be more satisfied with the outcomes if you limit your choices to a short list of options.

The research supporting this counterintuitive view of the world starts with a simple study performed by Sheena Iyengar and her collaborators, actually when she was still a graduate student at Stanford University. There was a grocery store nearby that sold an amazing variety of different jellies and jams—348 different kinds. The experimenters set up a tasting booth to let people try different jams. Supermarkets often use this free sample method to encourage people to buy their products.

Half of the time, the experimenters set out 24 different jams. Half of the time, the booth only had six jams available to try. Many more people stopped to try the jam when there were 24, and they obviously stayed at the booth longer, but when there were only six jams offered, the customers were far more likely to actually buy jam. With the 24-jam display, about 3 percent of visitors purchased jam. With the 6-jam display, 30 percent of customers made a purchase.

Now this is just jam, but the basic effect has been found in the domain of many more important decisions. For instance, many employers offer different retirement plans to their workers. In some cases, there are thousands of different options. In some cases, there are just a few. When there are fewer options, several things happen. First, the employees are far more likely to actually make a choice. When there are many options with many different features to consider, there's a sense that substantial time should be invested in the decision. Maybe we should even try to be like Thomas Edison, systematically working through hundreds of options in order to come up with a really great light bulb. Faced with many choices, most people overestimate how much consideration is really needed, and then underestimate how much time would be required to perform all that detailed investigation. The result? In many cases, it just doesn't get done.

In one study conducted by Iyengar, an employer was studied who made matching contributions to their employees' retirement funds. By delaying enrollment in a program by several months, the employees forfeited those months' contributions. Making any choice, even if they made a random one, it would sometimes be better than making no choice at all. And limiting the options that you consider will increase the chance that a choice is made.

Second, there's evidence that, as our reasoning about choices grows more complex and more extended in time, various biases would have more of an effect, not less. The temporal discounting errors that people make, for instance, will tend to grow larger as a decision process is extended, leading to less optimal decisions. We humans are also overly risk averse when we consider the possibility of losses. As a reasoning process is extended in time, risk aversion increases, and not in a good way. In Iyengar's studies, when a very large number of plans are offered, people are more likely to choose plans that are somewhat lower in risk but much lower in terms of return.

Third, people tend to be less satisfied with the choices that they've made. We just finished talking about how continuing to ponder options not chosen can lead to a lower satisfaction, especially when there's a potential to change that choice in the future. The more choices there are, the more roads not taken there are to ponder, and the greater that dissatisfaction becomes. Of course, these problems may compound one another. If a choice never gets made, that will be deeply unsatisfying. Based on a wide range of evidence like this, we can conclude that there is such a thing as too much choice. By reducing the number of options you consider, you can decide faster, better, and more happily.

In addition to cutting the number of options that you're going to consider down to a small number quickly, Iyengar and her colleagues also recommend making the consequences of decisions concrete. For instance, in studies in which people are asked to specifically imagine what their future life will be like in the distant future, they tend to save and invest more. She doesn't describe it as using the same words, but what she's describing here is really more evidence of the benefits of mental time travel.

One other way to proceed with reasoning about decisions and keep the number of choices low is to make decisions about categories in a progressive fashion. Let's consider choosing where to take that vacation. A problematic method would be to start with a large master list with dozens of possible trips to take, and then to start narrowing things down. I've presented reasons here that you should somehow limit your choices to a few possibilities, approximately six or seven.

Well, one way of narrowing your master list from hundreds down to six would be to divide them into categories first. You could do this by geographic location perhaps. Where should we go? East Coast of the United States, West Coast, Mexico, or Europe? That's only four options to consider, and well-suited to human reasoning. OK, let's say we pick Mexico. Do we want to go to on a hiking trip, stay at a beach, or visit a city? That's only three things—easy. Let's say we decide on a city visit. OK, now your original master list of 100 potential trips might only include a small number of trips that involve spending time in a city in Mexico.

Ultimately, research on this suggests that the best reasoning will take place when you never actually make that initial, long master list of vacation possibilities at all. By progressing in terms of a small number of categories, a complex decision can be broken into a sequence of stepwise decisions that fit well with the constraints of the human brain.

My example here is about a specific choice, like where to go on vacation or what health plan to purchase. But this concept applies to longer-term, ongoing reasoning as well. For instance, if you make a to-do list for the day, you'll periodically need to make choices about what to do next. If you write a bucket list of things to do at some time during your life, then you'll periodically face the choice of which of those items to pursue next.

The work of Iyengar and her collaborators suggests that a couple of things should be done to best use to-do lists. First, these lists should be short, around six items at most. If there are dozens of things to do on your list, you'll be substantially less likely to actually do anything on it. Your reasoning will be more difficult, less optimal, and you'll be less satisfied with whatever you do choose.

Second, Iyengar's work suggests that, if the list must be long, then it's a good idea to break it down into small numbers of categories, each of which could contain its own shorter list of specific items. You might break it down by time or location. Maybe most important and less important would be a good category to use.

If you ever finish your to-do list, there's no rule that says you have to stop doing things. You can always think of more things to do at that point, and perhaps make another list. And note that, if you ever finish your bucket list, you don't automatically kick the proverbial bucket. You just make a new list and continue on.

Lecture 8

How to Become an Expert on Anything

For most people, their level of achievement and expertise in a domain is not predicted by any innate characteristic—physical or mental. It is, however, predicted by their level of experience and training. Here, we argue that the difference between experts and novices is not talent but practice—that is, the difference is quantitative, not qualitative. In this lecture, we explore how to develop expertise using a number of strategies, such as the 10,000 hours of practice, deliberate practice, the significance of feedback and mentors, achieving efficiencies in information processing, the quiet eye, and avoiding *Einstellung*, or "mechanization of thought."

Aptitude Tests

- It is crucial to remember that even if you fail the first few times that you try to master something, that is not a predictor of your potential ability in that realm. There have been a number of studies aimed at predicting how adept someone will eventually be at some set of tasks. We usually call them aptitude tests. An IQ test is basically an aptitude test for later academic performance.

- Aptitude tests are used to try to assess people's talent, ability, or aptitude for various skills. The impetus behind the use of aptitude tests is an implicit belief that is not supported by modern research on expertise, however. The implicit belief is that the aspects that will make you expert at something are already present in you at the time of the initial aptitude test.

- The data do not support this. In the entire multi-billion-dollar industry that is aptitude testing, the correlations that are found between talent and performance are consistently very small. The SAT predicts about nine percent of the variance in freshman grades. That is, if you know a student's SAT score, you will be about nine percent more accurate at predicting performance than if you just took a guess.

10,000 Hours of Practice

- Innate talent does not provide a reliable prediction of overall performance. Practice does.

- Obviously, the more you practice, the better you become. What is not obvious is that no matter how much you have practiced, additional practice will always continue to produce more improvement, even after you've practiced for thousands of hours.

- Anders Ericsson and his research team have conducted some of the most detailed research on expertise. They've studied experts from many different domains: doctors, athletes, musicians, chess players. Across all these varied fields, a number of trends stand out.

- One trend is that the most rapid improvements arise as you are starting to learn something new. That is, in your first 100 hours of practice, you will improve by a certain amount. In the next 100 hours, you will still improve but will show less of an improvement than for those first 100 hours. Every 100 hours, you will continue to improve but will improve less than the previous 100 hours.

- As this process develops, many people perceive a plateau, which can create a sense that you are no longer improving. But it is extremely clear from dozens of studies that the upward progress toward better performance continues. The law of diminishing returns is at work here. The more you improve, the more energy you need to invest to improve further. But the returns never diminish all the way to zero.

- When practice time increases, however, improvement becomes more rapid. According to Ericsson and his colleagues, a significant measure is cumulative hours of practice. In general, across a remarkably wide range of endeavors, expertise in some domain is achieved with 10,000 hours of practice. If you have practiced something for 1,000 hours, you are likely to be proficient but not an expert. Something about that 10,000-hour number seems to represent a level of extraordinary achievement of mastery.

Deliberate Practice

- A variety of researchers have studied how experts practice and work and identified four principles that you should follow as you seek mastery. Ericsson coined the term deliberate practice to define these four principles:
  1. When you engage in deliberate practice, you should focus your attention on the work with the intention to improve—that is, to be

better after you perform the practice than you were before you started.

2. Your practice should be targeted to your current level of skill. A task should be difficult enough to be challenging but not so difficult that it is impossible.
3. After you attempt something, you should have access to immediate, informative feedback. The only way you can know when you have happened onto a process that works is if you are told which attempts were hits and which were misses.
4. Repeat the third step multiple times per practice session. Go over the same task again and again until it is clear that you have achieved mastery.

- Feedback is especially significant when you are beginning a new type of task. Before you invest too much time practicing on your own, find someone who is already an expert to give you instruction. An expert instructor will not only speed your initial improvements in your new endeavor but also lay a foundation for continued improvement.

Efficiencies in Information Processing

- Some of the best cognitive neuroscience work on the development of expertise comes from some elegant studies performed by Isabelle Gauthier, Michael Tarr, and their colleagues. The researchers were interested in two questions: how the brains of experts differ from the brains of novices, and how the brains of novices change as they become experts.

- To address both these questions, they had to invent a novel task—one in which all participants would be novices. The participants would then practice and become experts. The researchers created a family of 3-D structures that they called Greebles. Each Greeble was given a particular name and categorized as part of a particular family. Participants in these studies would view individual Greebles and attempt to guess their individual and family names.

- Initially, of course, the participants did very poorly. The number of individuals and families was large enough that this task required a great deal of practice. At various times during this training process, the participants practiced while they lay inside a functional magnetic resonance imaging (fMRI) scanner. The experimenters characterized the participants' pattern of brain activation as they viewed Greebles and attempted to identify them.

- If someone's performance is especially expert, you would expect that they would be harnessing tremendous brain power. You might speculate that the participants, as they grew faster and more accurate, would have developed ways to recruit more brain regions to better support their performance. The results were exactly the opposite.

- When participants were first learning to recognize Greebles, a broad expanse of the visual cortex and surrounding brain regions were boosted in activation. As expertise was developed, however, less of the brain exhibited boosts in activation. The areas that remained active became more active, but less cortical real estate was involved.

- Similar results have come from studies of other types of experts. For instance, Christopher Jannelle and his colleagues studied rifle shooters, comparing the brain activity of experts and novices. In the moments leading up to the trigger pull, the experts showed a marked increase in activity in their left hemisphere and a marked decrease in right hemisphere activation. For novice shooters, both hemispheres remained generally active. A variety of studies like this suggest that expert performance doesn't involve more brain activation; rather, experts are more efficient at processing information.

The Quiet Eye

- Related data from studies of eye-tracking movements of experts also fit the theory of efficiency in information processing. Joan Vickers was the first to characterize this phenomenon associated with experts: the quiet eye.

- As we move around in the world, our eyes jump from place to place, scanning our surroundings. About three times per second, on average, we make one of these abrupt eye movements. Most of the movements are controlled outside of your conscious awareness, but as you focus on some task, you direct your eyes to the most relevant areas.

- Experts exhibit remarkably long eye fixations leading up to when they perform some action. As they are about to act, their eye movements stop—sometimes for nearly a second. This is the phenomenon of the quiet eye.

- Becoming an expert seems to involve moving the eyes less, not more. Just as the patterns of brain activity in experts suggest less information processing, the changes in eye-scan patterns suggest experts are picking up less information as well. Becoming an expert, it seems, is about learning where the most relevant information is and where it is not.

Einstellung, or "Mechanization of Thought"

- As you practice some endeavor and attempt to become an expert and achieve mastery, you will naturally gather information and develop neural circuits to process that information. Initially, this will likely be done in a very conscious fashion. As you practice, however, the task will become more automatic and will switch from more broad activation and conscious control to more focused activation and unconscious control.

- Cognitive neuroscientists have found evidence for what they call *Einstellung*, which is German for "setting" or "attitude." For brain researchers, it is usually defined as a "mechanization of thought."

- If a researcher gives participants a number of problems that can all be solved using basically the same technique, two things happen. First, the participants get adept very quickly. They might not even be able to articulate the trick that they are using, but their brains will discover it. Second, if you give these participants a new problem, one that cannot be solved with this same technique, they will find the new problem very difficult to solve. In some studies, the experienced participants were worse at solving the new problems than people who had no practice at all.

- When you start to learn a new skill, you bring tremendous mental flexibility with you. As you become more skilled, however, you get faster but also become less flexible. Therefore, at the beginning of your learning process, it is especially helpful to have an instructor to nudge you in the right direction, get you focused on sources of information that are the most important, and to keep distinctive biases you have in your initial performance from becoming problematic.

Questions to Consider

1. Talent plays some role in determining how well someone performs a task, but the amount of experience-based improvements can play a larger role. Could someone have a talent for learning new skills? How could you measure such a talent? How could someone best make use of it?
2. What would you recommend to parents or grandparents as they encourage (or perhaps discourage) a child from undertaking a new endeavor? How might the child's talent, preference, and personality influence your recommendations?

Suggested Readings

Ericsson, *Peak*.

Gauthier, Tarr, and Bub, *Perceptual Expertise*.

Lecture 8 Transcript

How to Become an Expert on Anything

Someone who has a lot of expertise and ability just knows the right thing to do to solve some problem or achieve some goal. He or she doesn't even seem to think about it at times, the insights just come to them in a moment of inspiration. Most people assume that truly impressive levels of performance are associated with talent. We presume that the primary predictor of how good someone will be at anything is this talent. Practice matters, of course—no one would disagree with that—but there's now a lot of data suggesting that practice, the amount and type of practice, is the thing that determines how good you will be at anything.

If there's something that you really like, something you want to be really great at, studies of expertise suggest that you can be. You should pick activities to pursue based on how much you like them, not based on how good you are at them the first few times that you try them.

Some people are just really good at certain things. It seems that they were just born that way, or at least born with the physical and/or mental abilities that enabled them to quickly reach a really high level of performance. If they're children, we sometimes refer to these super-talented people as prodigies. Certainly innate, congenital abilities matter. It's not a mistake that the average NBA player is a lot taller than the average person. It's not a mistake that the average world-class marathon runner tends to be relatively smaller than the average person and possess a high percentage of a particular type of muscle called slow twitch muscle fiber.

It may be that there are physical, genetically specified characteristics of neurons that are different among very talented people. So it might be that there is such a thing as brain talent, in the same way that we think about physical talent. Now, I don't want to argue in this lecture that talent does not matter, but there's a wide range of research that suggests that talent matters a whole lot less than we think it does. Most of people's overall level of achievement and expertise in any particular domain is not predicted by any initial characteristic, physical or mental. It is predicted by the type of practice and the level of experience and training that they have.

OK, so a first tip about developing expertise is embedded here. If you try something and it doesn't go very well the first time, or first few times, you shouldn't use that to predict your potential ability in that realm. There have been a lot of studies aimed at predicting how good someone will eventually be at some set of tasks. We usually call them aptitude tests. An IQ test is basically an aptitude test for later academic performance.

If you wanted to make your own IQ test, from scratch, you would start by developing a list of questions that you think require intelligence in order to answer them well. You would then give that test to a large group of people. Based on the data you collect there, you would determine which of your questions correlate positively with academic performance—with grade point average, for instance. Now if some of your questions aren't correlated with school grades, then you get rid of those questions and come up with some more. And repeat. Eventually, you'll have a test where you can take someone's score and make a prediction about what their ultimate academic GPA will be.

I should say that, while it gets a bit more complicated, this is how every IQ test ever produced was developed—how they continue to be developed today, in fact. The SAT and ACT tests that high school students take every year is generated in exactly this fashion. For those two, instead of high school GPA, the grades from the freshman year of college are used as the "to be predicted" variable. This basic method has been used frequently to try to assess people's talent, their aptitude for various skills: football success, basketball performance.

In one study, the goal was to predict which people would become the best typists. We humans have a strong desire to predict the future, and this provides a tool for trying to do exactly that. Inherent in this frequent use of this method is an implicit belief that's not supported by modern research on expertise. The implicit belief is that the things that will make you an expert at something—or not expert—are already present, they're already present in you at the time of the initial aptitude test. If your ultimate ability to write poetry were based on something that was genetically specified, something present at birth and maybe in your very early childhood—if your ultimate poetry-writing ability were based largely on talent, then a testing system like this could work. We would just need to figure out a way to test for the presence of that talent, and that would tell us about your ultimate level of performance.

So we humans walk around with this implicit theory about talent and performance, which explains why we tend to use aptitude tests so often. I say that, because it certainly isn't the data that drives it. In the whole multi-billion dollar industry that is aptitude testing, the correlations that are found are very consistently very small. The SAT predicts about 9 percent of the variance in freshman college grades. That is, if I know a student's SAT score, I'll be about 9 percent more accurate than if I just make a rote guess. Attempts at predicting even things as simple as typing aptitude, those best versions of those tests predict about 4 percent of the data.

Talent is great, but talent is just not something that provides a good predictor of overall performance. What does? Practice. This is too obvious for me to offer it as a tip here, but the more you practice something, the better you get at it. There's no big news there. What is news is that no matter how much you have practiced, additional practice will always—and I mean always—continue to produce more improvement, even after you've practiced for thousands of hours.

Anders Ericsson and his research team have done some of the most detailed research on highly expert people. They've studied doctors, athletes, musicians, chess players—experts from many different domains. Across all of these different fields, a number of particular trends can be seen. First, the most rapid improvements you see come as you are starting to learn something new—that is, in your first 100 hours or so of practice. Your first 100 hours of practicing anything, you'll improve by a certain amount, hopefully a lot. In the next 100 hours of practice, you'll improve, but less than for those first 100 hours. Every 100 hours of additional practice, you'll improve less than the 100 hours previous.

Now, as this occurs, many people perceive a plateau. It can create a sense that you're no longer improving as you continue to practice. But it's extremely clear from dozens of studies that the upward progress toward better and better performance continues. The law of diminishing returns is at work here. The more you improve, the more energy you need to invest to improve further. But the returns never diminish all the way to zero.

Perhaps the best evidence for this comes from studies of what happens when someone who may feel as if they are on a plateau, some point of maximal performance, increases their practice time for some reason. For many expert pianists, for instance, this might occur when they make a decision that, starting now, they're going to make a career of performing on the piano. When the practice time increases, as they make this decision, suddenly improvement becomes more rapid.

One of the standard measures that Ericsson and his colleagues have collected is cumulative hours of practice. You have someone track the amount of time that they spend practicing each day for a while, along with some assessment of how much they've typically practiced in the past. You then basically multiply the number of practice hours per week by the number of weeks that they've been pursuing this particular activity, and voila! You can estimate, at least roughly, the total number of hours from their entire life that someone has performed some activity.

In general, across a remarkably wide range of endeavors, expertise in some domain is achieved with 10,000 hours of practice. Doctors, musicians, consultants, athletes, chess players—if someone has practiced something for 1,000 hours, they're likely to be good, but not someone you would classify as an expert. Even if the person seemed especially good at the task the first time they tried it, even if they seemed very talented, about 10,000 hours will still be needed to get to that peak level. Something about that 10,000-hour number seems to represent a level of remarkable, expert achievement.

With piano players, there are many ways to assess performance. One method that Ericsson has used is to calculate how quickly different pianists can hit multiple notes on the keyboard. The interstroke interval is a measure, in seconds, between when one note is struck and the next begins.

Now, there's no real artistry in hitting keys on a keyboard quickly. If anything were going to be a function of talent rather than practice, this might be it. But even with this relatively straightforward task, practice is a remarkably good predictor. If you calculate the log transform of the number of hours that each pianist has practiced, and similarly calculate the log transform of that minimal interstroke interval for those same pianists, a remarkably consistent relation emerges. As the old joke says: How do you get to Carnegie Hall? Practice, practice, practice.

So my first somewhat rambling tip here is to never consider yourself as unable to improve. If you enjoy something, and if you want to get better at it, keep practicing, and you will continue to improve. Actually, there's a little mini-tip in there as well. I've often been told that if you want to be happy, then you should find a job that you love doing. Even if you make a lot of money in some other profession, if you don't like it, you may doom yourself to a life of stress and unhappiness. This data provides some real support for that advice. If you want to be good at something, you have to do it a lot. To get to 10,000 hours, if you do something for 40 hours a week, you need to keep going for about 250 weeks—5 years. Five before you'll achieve true expertise. That's a lot of time to spend on anything that you don't like doing.

The advice I've been given is to find something you like to do so you'll be happy. I would say that you probably need to find something you like, even if you just want to be really good at doing it. If you find yourself competing with people who actually do like doing the thing you're forcing yourself to do, you'll likely find yourself losing a lot.

So practice is important, and there's no apparent upper limit to the improvement you can achieve with enough practice, at least not until you get to 10,000 hours. I've argued that the difference between experts and novices is not talent, but how much practice they've completed. That is, there's this quantitative difference between experts and novices, but not a qualitative difference. How should you practice? Is it enough just to spend 10,000 hours doing anything, or is there more to it? A variety of researchers have studied how experts practiced and worked to identify four principles that you should follow as you seek to become an expert—again, in almost anything. Ericsson coined the term deliberate practice to capture these.

OK, first, when you engage in deliberate practice, you should focus your attention on the work, with the intention to improve, with the intention to be better after you perform that practice session than you were before you started. Second, your practice should be targeted to your current level of skill. A task should be difficult enough to be challenging, but not so difficult that it's impossible to achieve regular success. With something like the piano, this is pretty intuitive. You want a piece that you can't play easily the first time through, but that's not so difficult that you're stuck slogging through it for months without success.

The third and fourth parts of this go together. Third—after you attempt something, you should have access to immediate, informative feedback of the results of your performance. If it's piano, you can just hear that feedback. In basketball, you can see if the ball went into the hoop or not. For something like accounting or industrial design, you'll likely need to seek an existing expert to give you that feedback. Regardless, you need that feedback to improve. Your brain tries to succeed every time. Sometimes it hits, sometimes it misses. The only way you can know when you've happened onto a process that works is if you're told which attempts were those that were hits, and which ones were misses.

The fourth part is to repeat step three multiple times per practice session. You should repeat the same task again and again until it's clear that you've nailed down how to do it. Then try a similar task. Repeat that one until you have it right.

There's a great story that Bobby Meacham, a coach for the New York Yankees, tells about seeing an 18-year-old Alex Rodriguez practice fielding. I'm not sure if anyone ever told him about deliberate practice, but he definitely did so a lot. A-Rod would have his teammates hit ground balls to his left, field them, and throw them to first. He would repeat this several times then move to ground balls to his right. He would systematically work through a range of situations that he might encounter in a game, attempting a play and then repeating it until it was right.

This story conveys really well, I think, what this deliberate practice concept aims for. Break your task discipline down into pieces, and then master those individual pieces. Then practice putting the pieces together. Get feedback with every attempt, and repeat. When researchers like Ericsson have studied experts, they've repeatedly seen them engaging in deliberate practice. It's just very fundamental to how we improve. Ultimately, the best predictor of success is not the sheer hours of practice, but the number of hours spent on deliberate practice. Just 10,000 of those and you'll be there.

I've hinted that for some disciplines, you need to find an expert to give you feedback on your performance. In some disciplines, however, it might seem like you can just go it on your own. If you can see or hear your own feedback, maybe you don't need anyone else. My next tip is to strongly disagree with that. If you want to achieve expertise, to shape your brain and body to high levels of performance, you should find an existing expert to serve as an instructor or mentor.

Receiving feedback about your performance is critical in developing expertise in any domain. This is true at almost every level of performance, but it's especially important when you're beginning a new type of task. This tip is simple: before you invest too much time practicing on your own, find someone who's already an expert to give you instruction. If it's a sport like golf, tennis, or skiing, get a few lessons. The same thing's true if it's a new instrument you're learning to play. If it's a new profession, find a mentor and discuss your work—not just the outcomes but the thought processes and actions that led to them. An instructor—an expert instructor—will not only speed your initial improvements in your new endeavor, but lay a foundation for continued improvement.

Some of the best cognitive neuroscience work on the development of expertise comes from some elegant studies performed by Isabelle Gauthier and Michael Tarr, and a variety of their other collaborators. They were really interested in two questions. First, how are the brains of experts different from the brains of people who are novices? And second, how does the brain of a novice change as he or she becomes an expert?

To address both of these questions, they had to invent a novel task, one in which all of the participants would initially be novices. The plan was to give them a complex visual, cognitive task in this domain. The participants would then practice, practice, practice, and become experts. Throughout the process, the experimenters periodically scanned the brain activity of the participants using functional magnetic resonance imaging.

OK, this task might seem a little silly on the surface, but stick with me. There are a lot of ways in which it's a really ideal analog to a wide range of different real-world endeavors. These researchers created a family of 3-D structures that they called Greebles. Greebles all have the same basic parts—they have a central trunk, two ears, and a frontal nose-like protrusion or two. These are all simulated objects, but most people describe them as having a biological quality. They're symmetrical and they have interconnected parts that look animal-like.

Actually, many of these characteristics are like human faces. All human faces have the same parts. We are able to recognize one person versus another based on relations between those parts—how big the eyes are, how far apart the eyes are relative to the size of the mouth, things like that. As with faces, if you study and practice recognizing Greebles, you'll get good at it. Each Greeble was given a particular name and categorized as belonging to a particular family. Participants in these studies would view individual Greebles and attempt to guess what the individual and family names were.

Initially, of course, they were terrible at this. All of the Greebles pretty much look, well, the same. It's only as you slowly learn things features such as the Plok family has downward pointing noses, and the Glip family has upward pointing noses—it's only as you learn these sorts of details that you start to get good at this task.

The number of individuals and families, the number of these Greebles, was large enough that this task required a lot of practice. At various times during this training process, as participants were improving, they practiced while they lay inside an fMRI scanner. The experimenters characterized their pattern of brain activation as they viewed these Greebles and attempted to identify them.

The results of these studies were strikingly different than what most people would have guessed in terms of expert performance. If someone's performance is especially expert, then you'd expect that they're harnessing tremendous brainpower. I would've guessed that participants, as they grew faster and more accurate, would've developed ways to recruit more and more brain regions to better support their performance. The actual results were exactly the opposite of this.

When participants were first learning to recognize Greebles, a broad expanse of the visual cortex and surrounding brain regions were boosted in activation. As expertise was developed, less and less of the brain exhibited these boosts in activation. The areas that remained active became more active, but less and less cortical real estate seemed to be involved in those computations.

Similar results have come from studies of other types of experts. For instance, Christopher Jannelle and his colleagues studied rifle shooters. They compared the performance and brain activity of experts and novices. Obviously, the experts were more accurate with their shooting; they achieved higher shooting scores in the tests that the experimenters gave them. They also exhibited different patterns of brain activation. In this case, the brain activity was recorded using an electroencephalograph, commonly known as an EEG.

In the moments leading up to the trigger pull, the experts showed a marked increase in activity in their left hemisphere, and a marked decrease in the right hemisphere activation. For novice shooters, there was a small amount of this, but both hemispheres remained generally active. A variety of studies like this suggests that expert performance doesn't involve doing more. In fact, quite specifically, it involves doing less in terms of brain activation, and presumably less in terms of information processing.

There are a lot of ways that this shift might occur, but a general result seems to be that experts know what information is important, what things they should be processing, and just as importantly—maybe more so—experts know what sources of information are not important.

There's related data from studies of expert eye tracking movements that fit this theory as well. Joan Vickers was the first to characterize and name this phenomenon associated with experts. She referred to it as the quiet eye. As we move around in the world, our eyes jump from place to place—we scan our surroundings. About three times per second on average, we make one of these abrupt eye movements. Most of the movements are controlled outside of our conscious awareness, but as you focus on some task, you direct your eyes to the most relevant areas of your immediate environment.

If I'm a target shooter, I obviously look at the bull's-eye on the target. If I'm shooting a free throw in basketball, I look at the rim. If I'm a surgeon, I look at the organs of the patient on whom I'm operating. As we do this, however, our eyes still move around, still jump around based on this unconscious control. For instance, the eyes might jump away from the target briefly, pick up some other information, and then jump back to it. Experts, however, exhibit remarkably long fixations in the second leading up to when they perform some action—as they're about to act, their eye movements stop, sometimes for almost a second. This is the phenomenon that Vickers referred to as the quiet eye.

Actually, there's another tip here if your goal is to become an expert at some visuomotor task, a sport that requires precise hand-eye coordination. Actually, the phenomenon has recently been studied outside of sport as well, in the realm of surgeons, for instance. This tip will work for almost any endeavor, then, in which you want to control your actions precisely based on incoming visual information. In the moments leading up to when you perform some important action, pick the best place to direct your eyes and then intentionally hold them there. Vickers and her colleagues have conducted many studies that show remarkable effectiveness just based on training people to intentionally exhibit this quiet eye during their action preparation.

That's a tip for you, but I'm describing the quiet eye right now as it relates to changes in neural information processing, those changes that come with expertise. Ultimately, I'll suggest that it supports the important tip of finding someone who's already an expert to serve as a mentor or teacher.

As our eyes scan the surrounding environment, they continually pick up additional information. Becoming an expert seems to involve moving the eyes less, not more. Just as the patterns of brain activity in experts suggest less information processing, the changes in the eye scan patterns suggest that you're picking up less information as well. Becoming an expert, it seems, is about learning where the most relevant information is and where it isn't.

As you practice some endeavor, whatever it is, whatever it is you choose to become an expert at, you'll naturally gather information and develop neural circuits to process that information. Initially, this will likely be done in a very conscious fashion. If I'm learning to identify various species of birds, for instance, I'll look at things that, to me anyway, seem relevant to the task. I'll look at the color of the feathers, the sound of their song—listen to the sound of their song—and look at maybe the shape of their beak. As I practice focusing on these things over and over, it will become more and more automatic. The identification task will switch from more broad activation conscious control to focused activation unconscious control. I'll become an expert at processing those sources of information and relating them to the name of the bird species.

Cognitive scientists have often found evidence for something they call *einstellung*. This is the German word literally meaning setting or attitude, but to brain researchers it's usually defined as mechanization of thought. Imagine you have an empty five-gallon bucket, and an empty three-gallon bucket, and an infinite supply of water. How can you use these two buckets to measure exactly four gallons of water? Actually, a problem like this was made somewhat famous in the not-so-great movie called *Die Hard 3*.

Here's one of many ways to solve the problem. First, fill the five-gallon bucket. Pour three gallons from the five gallon into the three-gallon bucket. Empty that three-gallon bucket. Note that there are now two gallons left in the five-gallon bucket. Pour these two gallons into the three-gallon bucket, leaving the five-gallon bucket empty. Next, fill the five-gallon bucket up, all the way to the top. Use it to top off your three-gallon bucket—note that you will remove exactly one gallon from the five-gallon bucket to do this, leaving five minus one equals four—done.

If I gave you a long series of these problems, you would gradually become expert at this type of fluid measure task. Actually, we'd need far less than 10,000 hours for that, I think. Imagine, however, that I gave you a lot of problems that had the same basic formula for solving them. The trick in this particular solution that I've described is that you can find a way that you start with five gallons in the big bucket and pour out some portion of it to get to your goal. If the problem was to get one gallon rather than four, then you'd want to find a way to have one gallon of water in the three-gallon bucket, rather than two. It's easy to imagine a whole series of problems that are all solved in this same way.

If a researcher gives participants several dozen problems that can all be solved in basically the same way, two things happen. First, the participants get very good, quickly. They might not even be able to articulate the trick that they're using, the thing that all of those problems have in common, but their brains will discover it. Second, if you give these participants a new problem, one that can't be solved with this same technique, then they're going to be terrible at solving it. In some studies, these very experienced participants are actually worse at solving the problems than people who've had no practice at all.

When you start to learn some new skill, you bring tremendous mental flexibility with you to that endeavor. It's one of the real hallmarks of the human brain. We seem to have the ability to find relations between different sources of information as well as any other species on the planet. As we become more skilled, however, we get both faster and less flexible. At the beginning of your learning, while your cement is wet, so to speak, it's really helpful to have an instructor to nudge you in the right direction, to get you focused on sources of information that are most important, to keep distinctive biases you have in your initial performance from becoming problematic.

Let's return to my bird identification example for a moment. I asked you to imagine that I was pursuing this on my own, focusing on the color of the feathers, sound of the songs, and shape of the beaks. If I'd started working on bird identification with an expert, he or she would have noted that I've left out two really critical things that are, ironically, often most useful for identifying the birds: behavior and group interaction. The details of a bird's plumage are critical to identifying the species, but experts only use that information after they've used other information about size and shape and behavior to narrow it down to just a few possibilities.

When I'm still in the early stages of learning about how to do a task, changing the way I perform it is relatively easy. My control of the task is still operating at a very conscious level, so if I consciously choose to focus on another source of information, that's all there is to it. Once I've practiced the task for many hours—hours, weeks, months—the processing will develop to make it more efficient, very efficient, but inflexible. I'll be inflexible in terms of the information sources that I chose at the beginning. Just a little bit of instruction, a little at the beginning of a journey toward expertise, can be extremely valuable.

Musicians and athletes often describe similar stories in developing expertise in their domains as well. There are certainly fully self-taught musicians out there, but some of them develop bad habits early on in their learning. Unlearning those consciously controlled bad habits can be tremendously difficult, and we know why. Once the brain has settled into an automated, focal activation method for achieving the current best level of performance, reorganizing it can be quite difficult.

Trying new things is one of the real spices of life in my experience. Mastering something, however, is one the greatest sources of pleasure that there is. Even something very mundane can become a thing of beauty when we become expert at it. One of the truly amazing things about the human brain is its ability to become expert at almost anything. If there's something you do on a regular basis, something you enjoy, I hope you'll see that your brain can very well become an expert at that endeavor. All you have to do is work at it in a deliberate fashion, for an extended period of time, and you can become an expert at anything.

Lecture 9

Tune Up Your Brain with Meditation

In this lecture, we suggest that you spend about 20 minutes a day not thinking—or rather, engaging in the "not thinking" practice called meditation. A wealth of evidence demonstrates that if you spend time in meditation, your brain will function more efficiently and you will be less anxious, more creative, and generally healthier. The art and practice of meditation is older than cognitive neuroscience by many centuries; indeed, it is older than science itself. Historians and anthropologists believe that the earliest meditation was associated with religious practice. As you become practiced in performing a ritual, it becomes largely automatic, leaving your conscious mind to think about other concerns—or nothing at all.

Concentration Meditation and Mindful Meditation

- Some researchers consider two broad categories of meditation: concentration meditation and mindful meditation. Both types of meditation typically involve sitting quietly in a place that is relatively free of distraction.

- Concentration meditation involves focusing your mind on something as completely as possible. Many people focus on their breathing. Some focus on a particular word—a mantra—repeating it over and over in their mind. In concentration meditation, by focusing only on one thing, you stop thinking about everything else that would normally occupy your mind.

- Mindfulness meditation is, in some respects, the opposite of concentration meditation. During mindfulness meditation, you seek to be aware of yourself and your surroundings without thinking about anything in particular. This notion of not thinking is somewhat foreign to most people. Our brains naturally tend to wander from thought to related thought all the time. This flow of ideas is what psychologists refer to as our stream of consciousness.

How to Meditate

- Find a quiet place where you won't be disturbed. There should be a clock nearby so you can check when you think about 10 minutes have elapsed. Find a comfortable chair, but stay upright. Taking a nap won't do the job.

- Once you are in your chair, with the clock ready, close your eyes and simply try to put your brain in neutral. Let your thoughts wander and observe what comes up. You might find yourself drawn to think about a particular problem or task or future plan. Let yourself think about it for a few moments, but try not to get drawn into a consciously driven set of thoughts. Whenever you notice that happening, don't panic; simply decide to stop thinking about it and set your thoughts to wandering again.

- When you think about 10 minutes have passed, glance up at the clock. If you are like most people, it won't be very close to 10 minutes yet. That's okay. Just close your eyes again and continue. What you are doing is one of the simplest forms of meditation.

- Try to work up to meditating for 20 minutes at a time three or more times per week. Experiment with both concentration meditation and mindfulness meditation. If one of them feels better or easier, then go with that, but also feel free to switch back and forth depending on your mood on any given day.

Measuring the Effects of Meditation

- A wide range of research has assessed the nature of how regular meditation affects your brain. One of the most common techniques has been to look at how patterns of electrical activity change in the brain during meditation. The electroencephalograph (EEG), which involves placing electrodes on the scalp, makes it possible to record and analyze the tiny amounts of electrical activity produced by neurons in the brain. The EEG has very good temporal resolution but relatively poor spatial resolution—that is, it determines when the brain is active but can't tell where the activity is in much detail.

- To see spatial patterns in the brain more clearly, a technique that has been used to explore how your brain activity changes when you meditate is functional magnetic resonance imaging (fMRI). fMRI can record the amount of blood flow to different regions of the brain. When an area becomes more active, it uses up oxygen and fuel and creates waste products. Blood vessels in that brain region dilate to enable more blood flow to deliver more resources and carry away waste products. By looking at the circulation patterns, we can see what areas of the brain become more active.

- Both EEG and fMRI methods illustrate that the meditative brain is very active, particularly in certain areas. The particular areas that are activated seem to vary with the type of meditation that is practiced. If you engage in meditation focused on a particular word or mantra, language regions are activated. If you focus on being aware of particular parts of the body, increases in activity are seen in sensorimotor regions of the cortex.

When people engage in meditation, they report higher levels of everyday happiness.

- Several studies have found that during meditation, the amygdala and other subcortical regions associated with emotional processing become more active. Several studies have found that when people engage in meditation, they report higher levels of everyday happiness. Those who meditate also report fewer problems with regulating their own emotions.

A Practice from Prehistory

- Many researchers believe that people have historically spent a great deal of time meditating—even if they didn't call it meditation per se. We think of modern life as being much easier and more convenient, but that's a bit of a myth.

- Humans have been around for about 300,000 years, as near as modern paleoanthropologists can figure. For about the first 280,000 of those years, humans survived as hunters and gatherers. Their job was basically to harvest food that nature produced. When food was plentiful, it's estimated that people could find what they needed to feed themselves and their children surprisingly quickly.

- Studies of the few remaining modern hunter-gatherer societies suggest that the work week for ancient humans was about two and a half days per week, at about six hours per day. Since then, of course, the world has changed a great deal. We work more hours, we live longer, and our world is much more defined by technology. But our brains are basically the same as those of our prehistoric ancestors.

- Humans have engaged in idle—perhaps meditative—thinking for millennia. It seems reasonable to expect that our modern brains have adapted to use this idle time effectively and perhaps even to depend on it for regular maintenance activities.

Increases in Gray Matter

- The MRI has shown that meditation can change the anatomical structure of your brain. In one study, a team led by Britta Hölzel recruited a group of 17 people who had signed up for a meditation course. As a control, they recruited 17 others who did not participate in the course. Before the course started, all the participants visited an MRI facility, where the researchers conducted a high-resolution scan of each participant's brain anatomy. The meditation participants then took their meditation course.

- Over the eight-week course, the participants reported engaging in about 23 hours of meditation practice. After this period, the researchers found increases in the gray matter concentration in several areas of the brain. The left hippocampus showed a clear effect, as did the posterior cingulate cortex, the left temporoparietal junction, and the cerebellum.

- The brain is made up of gray matter and white matter. The white matter consists primarily of myelin, a fatty substance that coats the axon part of neurons. The white matter enhances the efficiency and speed of neuronal communication.

- The gray matter of the brain is everything else: dendrites, cell bodies, and axons. Therefore, if your brain has more gray matter, it has more neurons. According to the Hölzel study, meditation practice caused the brains of those meditating to produce more neurons and to retain more of them over time.

A Boost to Brain Neurons

- The regions enhanced by meditation, as shown in the Hölzel study, are crucial areas of the brain.
  - The hippocampus, a highly connected structure, plays a role in a wide range of functions ranging from memory to reasoning about how to navigate through the world.

- The posterior cingulate cortex is also highly connected and is considered part of the brain's default network—the area of the brain that is activated regardless of what you are doing, even when you are doing nothing at all. It is associated with emotion regulation and the control of general arousal.

- The left temporoparietal junction contains a part of the brain referred to as the Wernicke area, which is heavily involved in our ability to parse and understand both written and spoken language.

- The cerebellum, densely packed with neurons, is a highly interconnected region of the brain that plays an important role in the control of body movement. Other research has suggested that the cerebellum also participates in computations about other complex interrelated systems, such as coordinating responses to threatening stimuli.

◆ Overall, the Hölzel study and many like it suggest that engaging in meditation practice on a regular basis, over the course of even a few weeks, can boost the number of neurons in the brain. Humans typically peak in terms of the overall number of neurons in their brain around three years of age. For the rest of your life, that number steadily declines. Age-related decline in cognitive function is presumed to be related to this general shrinkage of the brain.

Enhanced Performance

◆ Studies on the Stroop effect demonstrate that meditation also seems to enhance the ability to filter out miscellaneous information. Some studies have suggested that this improvement in attentional allocation happens not only on a long-term basis but also even shortly after a period of meditation. As you spend time allowing your brain to focus on one particular thing or allowing it to focus on nothing at all, after the meditation session, you improve your ability to concentrate on certain information in particular.

- In general, meditation is associated with increases in concentration, clearer thinking, and even creativity. Focusing on nothing at all actually requires a great deal of concentration. As you get more adept at not allowing intruding thoughts to enter your mind, you may be improving your ability to specifically allocate your attention to things when you aren't meditating.

- Whether or not you adopt the practice of meditating a few times a week, there is good evidence that you should meditate for 10 minutes or so as you prepare to undertake any mentally challenging task. If you begin by meditating for a few minutes, studies of post-meditation performance suggest that your cognitive performance will be enhanced.

Questions to Consider

1. Widely varying types of meditation seem to produce similar benefits in terms of health and mental well-being. Why might this be? Could activities that we don't normally think of as meditation have meditation-like benefits? What are the characteristics of those activities?
2. What are the key differences between mindful meditation and simply thinking about things? Why do you suppose these differences matter in terms of brain activity as well as behavioral outcomes?

Suggested Readings

Davidson and Begley, *The Emotional Life of Your Brain*.

Tang, Hölzel, and Posner, "The Neuroscience of Mindfulness Meditation."

Lecture 9 Transcript

Tune Up Your Brain with Meditation

We use our brains to think about things, to solve problems, to make decisions. For most people, it's counterintuitive to sit and use your brain to do nothing. In this lecture, I'm going to recommend that you spend about 20 minutes a day doing just that. There's a wealth of evidence that if you spend time sitting with your eyes closed, focusing on your breathing or on relaxing your body, that if you do this, your brain will work better. You'll be happier, less subject to stress and anxiety, more creative, and generally healthier.

The common term for this not thinking practice is meditation. The art and practice of meditation is older than cognitive neuroscience by many centuries. Indeed, it's older than science itself. Most historians and anthropologists believe that the earliest meditation was associated with religious practice. When you spend an extended period of time engaged in a religious ritual, you are typically engaged in meditation. If it's a complex ritual, certainly the process of learning to perform it properly involves a lot of focused mental and physical activity. But the nature of most religious practices is that they're repeated many times in the same way each time. As you become well practiced in performing any ritual, it becomes automatic. Your brain can perform it largely on autopilot, leaving your conscious, attentive mind to think about other things, or nothing at all.

Meditation is one of those terms that's a single word but actually captures a broad category of very different activities. If I sit cross-legged in the lotus position chanting a series of mantras, I could describe this as meditating. If I go to church and kneel quietly, I might engage in prayerful meditation. If I'm trying to solve a hard programming design problem, I might meditate on it for a few minutes—or longer—before I start actually typing commands on the keyboard. All of these very different practices could be accurately called meditation.

Some researchers have placed the many different types of meditation into two broad categories: concentration meditation and mindful meditation. Both types of meditations typically involve sitting quietly in a place that's relatively free of distraction. Concentration meditation involves picking something and focusing your mind on that thing as completely as possible. Many concentration meditators focus on their breathing, on keeping it steady and smooth. One thing you may hear a lot in this domain is the notion that breathing is continuous, progressing smoothly from an exhalation to the next inhalation and so on, without ever completely stopping. Some concentration meditation focuses instead on a particular word, a mantra, repeating it over and over in the mind.

I started by suggesting that it's helpful to not think for 20 minutes a day. If you're engaged in concentration meditation, it doesn't sound quite right to say that you're not thinking. On the contrary, you certainly are. But by focusing your thoughts as completely as possible on that one thing, whatever it is, you stop thinking about all the other things that would normally occupy your mind.

OK, that's concentration meditation. The other category is mindfulness meditation. It is, in some respects, the opposite of concentration meditation. During mindfulness meditation, one seeks to be aware of one's self and one's surroundings, but without thinking about anything in particular. This notion of not thinking is somewhat foreign to most people. Our brains naturally tend to wander from thought to another related thought to another one all the time. This flow of ideas is what psychologists have often referred to as our stream of consciousness.

Mindfulness meditation seeks to stop that process. When you sit and don't think for a few moments, especially if you haven't practiced this a lot, your brain will naturally, eventually, start to think about something. Some thought about your plan for the day or some event in the news. Some external thought will intrude. When that happens and you become aware of it, you relax and intentionally stop thinking about it. With practice, most mindfulness meditators report that they can get better and better at this. They go for longer and longer periods in between needing to intentionally interrupt one of those thought processes.

This is an activity that most modern people rarely pursue—sitting and thinking about nothing. Most people wake up and, within a few minutes, you get up and start going about your daily activities. We talk, work, we make things, we do things. We certainly think a lot as we do all of this, but those thoughts are typically engaged with particular goals in mind. For a few minutes, maybe right after this lecture, I want to urge you to spend about 10 minutes just not thinking.

I have in mind here that you'll be in a quiet place, someplace you won't be disturbed. There should be a clock somewhere that you can glance at to check when you think about 10 minutes have elapsed. Find a comfortable chair, but stay upright—taking a nap doesn't do the job here. Once you're in your chair, with the clock ready, close your eyes and just try to put your brain in neutral. Just let your thoughts wander and watch what comes up. You might find yourself drawn to think about a particular problem or task or future plan. Let yourself think about it for a few moments, but try not to get drawn into a consciously driven set of thoughts. Whenever you notice that happening, don't panic, just decide to stop thinking about it and set your thoughts to wandering again.

When you think about 10 minutes have passed, open your eyes and glance up at that clock. If you're like most people, it won't be very close to 10 minutes yet. It will seem like a lot of time has passed, but it will have only been just a few minutes. That's OK, just close your eyes again, and continue. What you're doing is a simple form of meditation—perhaps the simplest.

My first tip of the day is that you work up to meditating in this fashion for 20 minutes at a time, and that you do so 3 or more times per week.

There's somewhat more recent research on the mindfulness meditation, but there've been no major studies that have attempted to compare it directly with concentration meditation. It's not clear that concentrating on your breathing is better than being aware of your environment and entire body, or vice versa, so I urge you to experiment with both. If one of them feels better or easier, then go with that, but also feel free to switch back and forth depending on your mood on any given day.

A really wide range of research has assessed the nature of how this type of regular meditation behavior affects your brain. One of the most common techniques has been to look at how patterns of electrical activity change in the brain during meditation. The electroencephalograph—usually referred to as an EEG—involves placing electrodes on the scalp and then connecting them to a system of amplifiers. The system makes it possible to record and analyze the tiny amounts of electrical activity produced by neurons in the brain. EEG has a very good temporal resolution—it's possible to sample that electrical activity about 1,000 times per second. But EEG has relatively poor spatial resolution. It determines when the brain is active very, very well, but it can't tell where the activity is in much detail.

To see spatial patterns in the brain more clearly, another technique that's been used to explore how your brain activity changes when you meditate is functional magnetic resonance imaging, often called fMRI. FMRI can record the amount of blood flow to different regions of the brain. When an area becomes more active, it uses up oxygen and fuel and creates waste products. Blood vessels in that brain region dilate to enable more blood to flow in to deliver more resources and carry away those waste products. By looking at the circulation patterns, we can thus see what areas of the brain become more active.

If you look at someone while he or she is meditating, it might seem like there just isn't much happening. On the outside, there isn't. But both EEG and fMRI methods shows that the meditative brain is very active, particularly in certain areas. The particular areas that are activated seem to vary with the type of meditation that's practiced. If you engage in meditation focused on a particular word or mantra, language regions are activated. If you focus on being aware of particular parts of your body, increases in activity are seen in sensorimotor regions of the cortex.

Several studies have found that, during meditation, the amygdala and other subcortical regions associated with emotional processing become more active. Several studies have found that when people engage in meditation, they report higher levels of everyday happiness. Meditators also report fewer problems with regulating their own emotions. Whatever the brain does in these emotional centers during meditation practice presumably plays a role in this. Meditation also seems to boost the human ability to selectively attend to particular information, to filter out miscellaneous information. When kids are first learning to solve word problems in math class, selective focus in one of the biggest challenges.

"Mrs. Johnson has three wicker baskets, each containing seven tomatoes and four apples. How many tomatoes does Mrs. Johnson have?" There's a lot of information in that word problem that just doesn't matter for determining the answer. The big challenge for kids in this situation is to focus on the relevant information—the number of tomatoes and baskets—and ignore the irrelevant information—the number of apples, the fact that the baskets are made of wicker, or indeed that they're baskets at all.

This is a challenge for kids, but, with more complex problems, it's a challenge for adults as well. Any problem or task is kind of like that. We need to focus on the key information and ignore irrelevant stuff. When you drive your car, you need to ignore the billboards. When you talk with your friend at a restaurant, you have to filter out the sounds of other people around you. This comes up a lot. Meditators are better at this than non-meditators. Consider the following task that's been used to test this: the Stroop task.

A series of color words are presented on a computer screen: red, blue, green, yellow, and orange. The letters of these words are printed in colors that do not match the word. For instance, the word red is printed in green letters; the word blue is printed in orange letters. Your task, if you choose to accept it, is to focus on the color of the letters, and announce those colors as quickly as possible. Go.

This task sounds pretty easy, but overcoming the visual contradiction here is hard. You can certainly see that the word is printed in a particular color—say, green—but it's very difficult to filter out those same letters spelling out the word red. This is especially true when you're trying to do all of this as quickly as you can. We just automatically want to read that word—for instance, red.

Meditators have less difficulty with this task than non-meditators. Something about that regular meditation, something about the way that it affects the brain, improves our ability to selectively focus on one particular source of information whenever we decide to do so. Many researchers believe that people have historically spent a lot of time meditating, even if they didn't call it meditation per se. We think of modern life as being much easier and more convenient than what's historically been typical, but that's a myth.

Humans have been around for about 300,000 years, as near as modern paleoanthropologists can figure. For about the first 280,000 of those years, humans survived as hunters and gatherers. Their job was basically to harvest food that nature produced naturally, sometimes without a whole lot of effort from the humans. When food was plentiful, it's estimated that people could find what they needed to sustain themselves, to feed themselves and their children, surprisingly quickly.

Studies of the few remaining modern hunter-gatherer societies—for instance the !Kung Bushmen of South Africa—suggest that the work week for ancient humans was about two-and-a-half days per week, about 6 hours a day. Other studies of the Machiguenga and the Kayapo groups in South America considered not just the specific hunting and gathering of food, but all of the work that they did in a typical week, and found an average of a little less than 5 hours a day.

Since then, most of the world has changed a lot. We work a lot more hours, of course. We live a lot longer. Our world is much more defined by our technology and efficiency. But our brains? Our brains are basically the same as those that were in the heads of those ancient humans. The processes that drive evolution function very slowly. The 20,000 years that we've spent since our hunting and gathering days is a blink of an eye in the scale of evolutionary times. Humans have engaged in idle, perhaps meditative thinking for millennia. It seems reasonable to expect that our modern brains have adapted to use this idle time effectively, perhaps even to depend on it for regular maintenance activities.

A wide range of research suggests that there are a variety of positive benefits that emerge from regularly engaging in this practice of meditation. Up to this point in the course, I've usually talked about fMRI, where the f stands for functional. With fMRI, the functional magnetic resonance imaging scanner is tuned to sense those patterns of blood flow in the brain. When a particular set of neural circuits is activated, those neurons start using up oxygen and energy supplies and producing carbon dioxide. As they do, the circulatory system dilates those blood vessels and brings more blood to those particular regions.

About six seconds after someone starts to perform some mental task, the blood flow to the regions involved in performing the task show a significant increase in blood flow. This has been a great tool for mapping what parts of the brain are activated for particular kinds of mental tasks. There's an older use of the MRI device, however. Actually, in a medical context, this is the most common use of it. Rather than looking at changes in blood flow, the MRI can be used to perform precise scans of the internal anatomy of the brain—or any other part of the body for that matter. How big is someone's hippocampus? Without the MRI, the only way to determine something like that would be to cut open the skull and take a look. No one would actually do this. With the MRI, however, such a test is quick and easy.

OK, so how does this relate to meditation? We can talk about the immediate-term effects of meditation on the brain, the way that your patterns of brain activity are altered by different types of meditation. But an even more basic question is the following: if you meditate on a regular basis for some period of weeks or months, does it change the anatomical structure of your brain? The answer here is a clear yes.

One especially good example of a study like this one comes from a team led by Britta Hölzel, working at Harvard Medical School. She and her colleagues recruited a group of 17 people who'd signed up for a meditation course. The course was intended to help with stress reduction. They recruited 17 other people who didn't participate in the course, as well. As a quick aside here, these researchers did some very good experimental design work. I know this isn't the primary focus of the course, but I just have to give credit here where credit is due. The researchers didn't just pick people off the street to serve as those controls. There were more people who wanted to take this course than there were seats available. The control participants here, the ones who didn't engage in meditation, were drawn from the people who wanted to take that course but didn't.

If the study had found differences between the participants in the meditation and control groups without this study characteristic, we'd have to wonder, are the differences from the meditation itself? Or perhaps are the differences preexisting characteristics, things that differ between people who want to take this meditation course and people who don't. In any event, the researchers thought that out in advance, so there's no need to worry about that problem.

OK. Before the course started, all of the participants—the 17 meditation students and the 17 control participants—visited an MRI facility. The researchers there conducted a high-resolution scan of each of the participant's brain anatomy. The meditation participants then took their meditation course.

The course itself was fairly intensive. There were eight two-and-a-half hour meetings, one each week. In the sixth week of the course, the students met for a longer six-and-a-half hour session. The program involved meditation that focused on that mindfulness training that we've discussed. Proponents of this type of meditation ask participants to engage in awareness of the experiences that they're having at that particular moment. As you sit quietly, relaxing with your eyes closed, you engage in a sequential scan of your own body. Often, when you're first learning this, you might listen to an audio recording of an expert guiding your thought process. The teacher might first ask you to focus on your toes: to feel them, be aware of them, relax them. Now onto your feet, next your lower legs, and so on. The body scan works through the whole body and then completes by encouraging you to be aware of your whole body at once.

When I describe this sort of thing to people, it often feels a little, well, silly. The notion that thinking about your body parts one at a time and to simply be aware of them feels very new agey. I certainly don't feel very scientific as I'm describing this. And there's more. Usually the instructor urges you to feel compassion for these body parts, to think of the parts simply as they are in a nonjudgmental way. I don't usually judge my toes—I guess I do look down on them a lot.

In any event, the research on these things hasn't typically picked the meditation practices apart into their components. For instance, are the effects of the meditation lessened if I don't encourage that non-judgmental attitude? What if I only focus on the fingers and toes, and never get to the upper parts of the limbs? What if I just focus on the whole body and not the individual parts? These types of questions I can't really answer for you, but there's good research on the effects of the practice as a whole on brain function and anatomy.

Over this 8-week intervention, the participants reported engaging in about 23 hours of total meditation practice. That's a substantial chunk of time, but it's not enormous over the span of the study. It averages out to a little less than 30 minutes per day on average. After this period, the researchers found increases in the gray matter concentration in several areas of the brain. The left hippocampus showed a clear effect. The posterior cingulate cortex, the left temporo-parietal junction, and the cerebellum also showed these effects.

I should say a word about why gray matter density is especially important as a measure of brain anatomy. The brain is made up of gray matter and white matter. The white matter consists primarily of something called myelin. It's a fatty substance that coats the axon part of neurons. The axons are the part of a neuron that sends signals—bursts of chemical-electrical signals—called action potentials. When a neuron emits one of these action potential signals, the myelin serves as an insulator for the axon conduit. The white matter thus enhances the efficiency and speed of neuronal communication.

The gray matter of the brain is everything else—the dendrites, the cell bodies, the axons themselves—and the neurons, all of them, are basically gray in color. So if your brain has more gray matter, it has more neurons. This meditation practice caused the brains of the meditators to produce more neurons and retain more of them over time. About 23 hours of meditation activity, and their brains enhanced the amount of stuff that they have to use for thought and regulation processes.

And those areas that were specifically affected are good ones to enhance. The hippocampus plays a role in a wide range of functions, ranging from memory to reasoning about how to navigate through the world. The hippocampus is a highly connected structure that seems to regulate a wide variety of processes throughout the brain. There's an entire scientific journal devoted just to the study of how the hippocampus functions. The journal is appropriately called *Hippocampus*.

The posterior cingulate cortex is another highly connected structure. It's often thought of as a part of the brain's default network, the area of the brain activated regardless of what you're doing, even when you're doing nothing at all. It's associated with emotion regulation and the control of general arousal. This is one of those central control structures that seems to be involved in regulating a large collection of brain circuits.

The left temporo-parietal junction, it's heavily involved in our ability to parse and understand language, both written and spoken language. The better this region functions, the better you're able to reason about the things that you read and hear. The cerebellum is a part of the brain located just above the spinal cord, underneath the cortex near the very back of the skull. This region is smaller than the cortex, but it contains about three-and-a-half times as many neurons. This is a densely packed, highly interconnected region of the brain that plays important roles in terms of the control of movements of the body.

We usually think of movements we make with our arms and legs as being kind of simple. If I want to lift my arm up in front of me, most people would presume that the muscles in the front of the shoulder and biceps will need to contract, and the opponent muscles on the back of the arm will need to relax. That's true, of course, but it's actually a lot more complex than that. As I swing my arm forward, the inertia pushes back on my body as a whole. If all I did was contract these muscles in my shoulder, then I would sway backward a little every time I moved my arm forward.

I don't do this, of course—none of us do. When you prepare to move your arm forward, your cerebellum performs a detailed simulation of this movement before you ever start to make it. It identifies this and compensates for it. As you lift your arm and move it forward, the first muscles to become active aren't in your biceps or your shoulder. The first muscles to contract are in your hips. Your body stiffens and generates just enough forward force to compensate for that backward push caused by the arm movement. And so the action happens, smoothly, efficiently, and kind of effortlessly, but not without some serious computation, and that computation takes place in the cerebellum. Other research has suggested that the cerebellum also participates in computations about complex interrelated systems not related to motor control as well, things like coordinating responses to threatening stimuli.

Overall, this study, and a lot of other ones like it, suggest that engaging in meditation practice on a regular basis, over the course of even a few weeks, can boost the number of neurons in the brain. Some early work wasn't as scientifically careful as this study I'm describing, but a substantial amount of recent work has made a really strong case for it. This intervention was aimed at reducing stress—and it did, by the way. Participants rated their stress levels as lower after the intervention, significantly lower than the ratings from that non-participant control group. But even if you aren't feeling a problem with stress, meditation seems to function well for brain maintenance purposes.

Humans typically peak in terms of the overall number of neurons in their brain around three years of age. For the rest of your life, that number steadily declines. Age-related decline in cognitive function is presumed to be related to this general shrinkage of the brain. If I can stave off that shrinkage with an activity that takes about a half hour a day, I think that's a pretty good activity. I strongly urge you to, at the very least, experiment with this meditation for a few weeks.

A few minutes ago, I described the Stroop task, and evidence that regular meditators have an increased ability to concentrate on selected sources of information. Some studies have suggested that this improvement in attentional allocation happens not just on a long-term basis, but especially even shortly after a period of meditation. As you spend time allowing your brain to focus on one particular thing, like a mantra, or allowing it to focus on nothing at all, you improve your ability to later focus on certain materials in particular.

It seems strange that focusing on nothing at all would help here, but perhaps the lack of focus rests the attentional system, allowing it to operate better when the Stroop task starts. Alternatively, we've discussed how focusing on nothing actually requires a lot of concentration—a lot of focus, ironically. As you get better and better at not allowing intruding thoughts to enter your mind, you may be improving your ability to specifically allocate your attention on things when you aren't meditating.

This all leads to my second tip. Whether or not you adopt this practice of meditating a few times a week, there's good evidence that you should meditate for 10 minutes or so as you prepare to undertake any mentally challenging task. In general, meditation is associated with increases in concentration, clearer thinking, even increases in creativity. A wide range of studies suggest that as you're preparing to undertake a challenging task, it can be a really good thing to take about 10 minutes and just not think about it.

If you're getting ready to start figuring out some problem or creating a piece of artwork, if you start by meditating for a few minutes, studies of post-meditation performance suggest that your cognitive performance will be better. And I don't mean to think about how you're going to begin the task; I don't mean thinking about the problem you want to solve or maybe the first few steps in creating that artwork. I mean spending several minutes not thinking about the project that you're about to undertake. Somehow not thinking about the project and the goals for a few minutes seems to enhance performance when you do. You'll lose a little time that you might otherwise have spent working on the task itself, but the time you invest prior to that will pay dividends throughout the task. Ultimately, spending that time meditating at the beginning may actually shorten the time that you need to complete the task, or improve the general quality of whatever you do produce when you're undertaking this.

I've recommended trying this for 20 minutes at a time, several times a week. If that seems like a lot to you, it's fine to start with something even simpler. Find a quiet place, close your eyes, relax your shoulders, breathe. Inhale slowly, maybe mentally count to five while you do—one, two three, four, five—and then exhale back down—four, three, two, one. Some people like to say a word instead of counting. Inhale slowly while thinking reeeeeee, and then exhale with laaaaaax. Reeeeeee laaaaaax. Repeat this a few times, maybe 10, and then open your eyes and go on with your day. This is really simple, but it is meditation. Many of the benefits that I've described will be present, at least a little, even with a minimal exercise like this.

There's good evidence in the long term that it's an extremely valuable practice to add to your daily life. A few recent studies suggest that some positive benefits begin to emerge, in terms of measures of improved concentration and lower stress, within just a few days of beginning the practice. Most researchers think of meditation as an intervention that aims to enhance brain health and brain function as well, and that's not wrong. Earlier in this lecture, I mentioned ancient humans for a reason. For most of the time that *Homo sapiens* has been around, we've naturally had a lot of down time. It seems likely that at least some of that down time was spent just sitting and thinking—that is, sitting and meditating.

It seems a reasonable inference to me that our brains are, and may always have been, built to require—or at least benefit from—a certain amount of meditation just to maintain normal function. From that perspective, this meditation practice I'm suggesting isn't about looking for a clever new way to enhance the function of your brain. From this perspective, regular meditation is a way to give your brain something that it needs to maintain regular function. Meditation might be less like a new medical treatment for some problem, and more like an essential vitamin or nutrient that we all need. Now head for a clock, and meditate. Enjoy.

Lecture 10

Take the Sleep Challenge

Let's jump right into it: You should get about eight hours of sleep a night, almost every night. A wide variety of data suggest that when we don't get eight hours of sleep per night, our cognitive performance is substantially reduced. Decision making, memory, control of physical movements, emotional regulation, memory, and even basic perception become more prone to error. Tests of intelligence, creativity, attention, and memory all show lower performance with cumulative sleep deprivation. In this lecture, we consider the consequences of lack of sleep, examine the stages of sleep and the importance of REM sleep, suggest ways to combat insomnia, and explain the relevance of circadian rhythms and blue-light wavelengths.

Four Stages of Sleep

- The most important tool in the sleep researcher's kit is the electroencephalograph (EEG), which records tiny electrical signals produced by neurons in the brain. Circuits in the brain produce variations in the amplitude of our brain waves. Some brain circuits oscillate quickly, producing high-frequency waves; other circuits cycle slowly, producing low-frequency waves. The EEG captures a sum of all the waves.

- The first thing that a sleep scientist will do with this EEG data is to apply a mathematical process called a Fourier transform. The process decomposes the signals into the underlying frequencies, revealing how much energy is present in the brain at different frequencies. The outcome of the Fourier transform is called a power function.

- When you are awake, your power function has a lot of energy in the range of 13 to 24 cycles per second. Sleep researchers refer to energy in this frequency range as beta waves. This power spectrum indicates an active, wakeful brain. As you relax and get ready to fall asleep, the energy in that beta range drops, while the energy in the alpha range of 8 to 12 cycles per second increases. (This also happens when you meditate.)

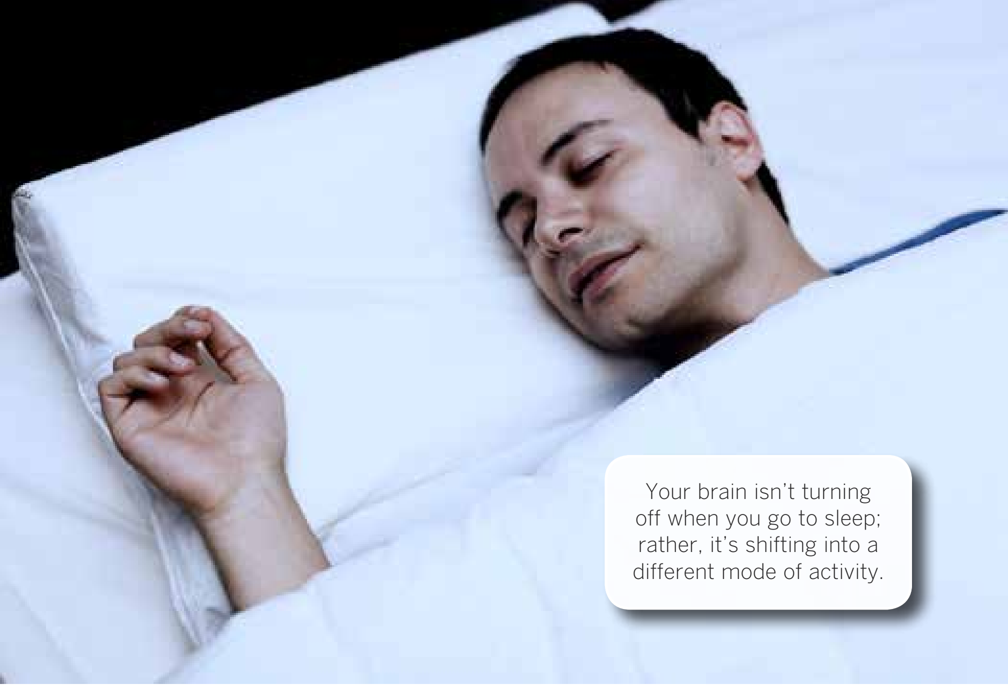
- As you drift off to sleep, the energy in the alpha range drops off and is replaced by theta waves, which are in the range of 4 to 7 cycles per second. As this happens, you lose consciousness and are lightly asleep. Sleep researchers call this stage 1 sleep. You will typically remain in this state for 10 to 30 minutes before shifting into stage 2 sleep.

- As you pass into each of the four stages of sleep, your brain continues to produce more energy in slower frequency ranges. In the deepest stage of sleep, your brain will be producing a great deal of delta wave activity, at a frequency of fewer than 4 cycles per second.

REM Sleep

- During sleep, the energy output of the brain does not change significantly. The waves of activity that it produces are slower than when you are awake, but the deeper the sleep, the higher the amplitude. Your brain isn't turning off when you go to sleep; rather, it's shifting into a different mode of activity.

- After you fall asleep, you remain in deep, delta-wave sleep for about half an hour. After this, your brain begins stepping up its rate of activity, producing fewer delta waves and more theta and beta waves. Now, you are back in stage 1 sleep. At this point, a remarkable set of changes occurs. The activity level of the brain becomes very much like that of someone who is awake. Lots of energy shows up in the alpha range. This is called REM (rapid eye movement) sleep.



- While the brain becomes very active at this point, the muscles in most of the body become deeply relaxed. The muscles that control eye movements are an exception. The eyes become very active, darting back and forth, up and down, as if rapidly scanning something. These rapid eye movements are the feature that give the REM sleep stage its name. This is also the stage at which we dream.

Significance of REM Sleep

- There is a wealth of evidence that during REM sleep, your brain does essential work that supports regular brain function.

- We tend to dream about what has happened during the recent past—indeed, most frequently about what happened the previous day. Early in the evening, those dreams will tend to be very literal; later in the evening, the dreams tend to become more abstract.

- This replay and abstraction process is critical to optimal memory, high-level creativity, and problem-solving ability. What's more, those memories seem to be consolidated during the following night of REM sleep. If you prevent someone from getting REM sleep, detailed memory for experiences and learning will suffer. Cognitive function also declines.

- Your brain needs REM sleep like it needs nutritious food. The vast majority of your REM sleep takes place in the last two sleep cycles of an eight-hour sleep session. If you reduce your sleep by a couple of hours a night, you might feel that you've still gotten most of a good night's sleep. In terms of total hours, that's correct: You've only missed out on about 25 percent of your sleep time. But in terms of REM sleep time, you may have cut your night down by 40 percent.

Power Napping

- Napping can be destructive to REM sleep. If you nap for 90 minutes, you will get a full sleep cycle in, including a brief bit of REM sleep. However, if that reduces the amount of sleep you get the following night, even by a couple of hours, you will greatly reduce the total amount of REM sleep by as much as 40 percent.

- Consider the workplace power nap, a topic that has been the subject of much scientific investigation over the past few decades. The thinking is that if people nap for 20 minutes, employers can get a lot more productive work out of them the rest of the day. That sounds better than dealing with a groggy employee performing poor (or no) work.

- The good news for power nappers is that a nap of 20 to 60 minutes (less than a full sleep cycle and without REM sleep) does boost cognitive function in many people, who demonstrate faster reaction times, better working memory, and enhanced problem-solving abilities.

- The bad news for power nappers is that essentially all this data has been collected from experiment participants who were sleep deprived.

If you are sleep deprived, a power nap will help you. If you are not sleep deprived, then you probably won't nap when you are given the opportunity—and the power nap won't help.

Combating Insomnia

- Insomnia, or trouble falling or staying asleep, is a condition that affects millions of people. A study by the Centers for Disease Control and Prevention found that 9 million Americans are regular users of prescription sleep medication. A problem is that standard sleep medications disrupt REM sleep. What's more, humans develop a tolerance to sleep medications and supplements such as melatonin.

- The best way to combat insomnia is to strengthen your unconscious association between your bedroom and sleep. Many people who report problems with insomnia also perform other activities while sitting in bed—they watch movies, work on the computer, make calls, and even eat meals.

- The unconscious systems that regulate your sleep associate all these non-sleep activities with your bed. Over time, after you change your associations with your bedroom, your unconscious mind will learn to sleep normally again. If you put a tired body into a fully dark, quiet, cool, comfortable space and make it lay very still for a while, it is very likely to fall asleep.

Circadian Rhythms

- Before you go to bed, there are a few steps that you can take to ensure an effective night of sleep. Avoid bright lights—especially lights with a blue component to them—for several hours before bedtime. Bright incandescent or fluorescent lights are bad; computer screens and LED television screens are even worse. Consider how the brain and our eyes regulate sleep.

The best way to combat insomnia is to strengthen your unconscious association between your bedroom and sleep.

- First, proper sleep relies on a 24-hour timing cycle—a circadian rhythm—maintained by the brain, particularly the part of the brain that regulates sleep function. Second, the clock in your head runs slowly. Fortunately, that clock has a natural mechanism for setting the right time every day. Third, there is a great deal of blue light in light that doesn't look blue.

- The internal clock inside your brain is a tiny region called the suprachiasmatic nucleus, which contains about 20,000 neurons. It is located in the hypothalamus, right above the optic chiasm, the place where the optic nerves from your two eyes come together. Every evening, the clock triggers a cascade of physiological events. It causes the release of melatonin, a hormone that works to lower your heart rate and body temperature and eventually to bring on sleep. There is one problem with the clock: It runs a bit slow—about one hour slow each day.

- Researchers have conducted studies in which participants lived in an environment without external time cues, sequestered in an isolated basement living area. All clocks were removed, as were other time cues. The participants in these studies were allowed to turn the lights on and off whenever they wanted. When they felt it was time to go to sleep, they could turn the lights out and do so.

- The participants slept for about eight hours a night. However, each eight hours of sleep started about 25 hours after the last one started. The human circadian rhythm clock directed the normal sleep pattern, but it waited consistently longer than 24 hours from cycle to cycle.

Blue-Light Wavelengths

- The suprachiasmatic nucleus has a reset mechanism: sunlight. In 1998, researchers discovered a type of receptor in the human retina that is critical to this process. These receptors, called melanopsin retinal ganglion cells, connect almost directly from the eye, down the optic nerve, and then to the suprachiasmatic nucleus.

- These particular receptors are most sensitive to blue-light wavelengths. Sunlight—even bright-white sunlight—contains an evenly distributed mix of many wavelengths of light, including blue. When this blue-frequency light strikes the receptors, it disrupts the suprachiasmatic nucleus function. If you look at a computer screen, it greatly reduces your brain's release of melatonin.

- On the flip side, when you wake up, first thing in the morning, you should look out a window at blue sky. Or if your daily schedule calls for you to rise before the sun, you can downregulate your melatonin production and wake up more quickly by staring at a computer screen or television. Broad-spectrum or bluish illumination, especially bright illumination, will reset your internal clock and get your brain active and on its way.

Questions to Consider

1. Studies of preindustrial sleeping behaviors have uncovered evidence of what is called second sleep. After going to bed around sunset, many people awaken around midnight, engage in singing, prayer, or other activities for about an hour, and then go back to sleep until sunrise. How does this fit with our discussion of healthful sleep habits?
2. Lack of sleep is often related to poor decision making—even about when to sleep. The theory is that if we don't sleep enough tonight, we can simply get some extra sleep tomorrow. How might mental time travel be used to improve upon this problematic decision?

Suggested Readings

Cvetkovic and Cosic, eds., *States of Consciousness*.

Stickgold and Walker, eds., *The Neuroscience of Sleep*.

Take the Sleep Challenge

There's a common experience that many people have when they take a week or more of vacation, almost any kind of vacation. Sometimes they take a trip to the beach, sometimes a mountain, sometimes nowhere at all. Wherever they go, however, they sleep late—or, anyway, sleep more. A common feature of many vacations is that the alarm clock gets turned off for many days in a row. At the end of this week of extra sleeping, many people report feeling fantastic: they feel more energetic, excited about life, creative, motivated, happy, and more. Of course, just being on vacation is a part of this, but this feeling often follows you back from vacation when you return to work and regular life. The mental clarity can be really delightful.

If you've had this experience, there's a lot of evidence that what you're actually feeling is your brain functioning the way that it's supposed to, the way your brain functions when it's had a proper amount of sleep. My first tip of this lecture is one you've heard before, from your mother or grandmother, if from no one else. You should get about eight hours of sleep a night, almost every night.

Now, there are many, many people who report that they sleep less than eight hours on most nights, less than five even. Most report that they just feel fine. Many people have a certain amount of pride in their ability to get along without wasting all of those hours doing nothing. Others may have a more fatalistic view—they may like to get more sleep, but that doesn't seem possible, at least not all the time. Either way, you can outsmart yourself by getting more sleep. A wide variety of data suggest two important things. First, when we don't get about eight hours of sleep per night, our cognitive performance is substantially reduced. Second, we don't realize it.

So let me focus my tip a little more here. I recommend that you experiment with getting eight hours of good sleep—eight hours in a row, here—every night for two weeks. This will likely entail cutting out some other activities, cutting them out of your daily schedule. You might have to work a little less. You might have to watch a little less television. The day will not get any longer for this experiment, so some shuffling of your schedule might be needed. But it's just for two weeks. If, after the two weeks, you aren't thrilled with the outcome, you can return this particular tip for a full refund.

Let's consider what sleep actually is, what your body and brain do while you're asleep. Most people think of sleep as a time when your brain and the rest of your body shut down for a few hours. But our brains remain very active when we sleep. There are certain jobs that the brain needs to do every night as part of its normal functioning. If the brain skips those tasks, the brain's level of function will decline. Decision-making, memory, control of physical actions, emotional regulation, creativity, even basic perception—all of these processes will become more prone to error.

This is true when people are prevented from sleeping at all for an extended period, but it's also true for people who get somewhat less than eight hours of sleep for several nights in a row. Tests of intelligence, creativity, focus of attention, and memory all show lower performance with this cumulative sleep deprivation. In one study conducted in the European Union, it was estimated that 10 percent of all auto accidents involve people driving while drowsy. People who report that they sleep six to seven hours per night—very common, six to seven hours per night—are twice as likely to be in a car crash as people who sleep for eight hours per night. Sleeping eight hours a night for two weeks just might save your life.

The most important tool in the sleep researcher's kit is the electroencephalograph, commonly called an EEG. It records tiny electrical signals produced by neurons in the brain. Many circuits in the brain produce variations in the amplitude of brain waves, each of which takes the shape of a sine function. The voltage cycles up and then back down and then back up. Some brain circuits oscillate quickly, producing high frequency waves. Other circuits cycle slowly, producing low frequency waves. When the EEG records the electrical activity, it captures a sum of all these waves put together. The raw data from an EEG doesn't look sinusoidal at all, because all of these different frequencies are essentially piled up on top of one another.

The first thing that a sleep scientist will do with this EEG data is to apply a mathematical process called a Fourier transform. It takes a complex mixture of different frequencies and decomposes that mixture back into the underlying sine functions. The outcome of this Fourier transform is something called a power function. We can look at that decomposition and talk about how much energy is present in the brain at different frequencies.

When you're awake—indeed, probably right now as you're watching this—your power function would have a lot of energy in the range of 13–24 cycles per second. This energy pattern is associated with normal, waking thought. Sleep researchers refer to this energy in this particular frequency as beta waves. The power spectrum of beta waves indicates an active, wakeful brain.

As you relax at the end of the day and get ready to fall asleep, the energy in that beta range drops, while the energy in the alpha range of 8–12 cycles per second increases. The beta waves become less pronounced, and the 8–12 cycle alpha waves take their place. You don't need to be asleep to make this happen, actually. If you meditate, if you just close your eyes and take a deep breath, and say "relax" as you exhale, if you relax and clear your mind, you'll shift a lot of your brain activity from beta waves to alpha waves.

OK, so you're relaxed, eyes closed, and you start to drift off to sleep. As you do, the energy in this alpha range drops off, and is replaced by theta waves in the 4–7 cycles per second range. As this happens, you lose consciousness. You are lightly asleep.

Sleep researchers call this stage 1 sleep. You and your brain will typically remain in this state for 10–30 minutes before shifting into stage 2 sleep, then 3, then 4. As you pass into each of these stages, your brain continues to produce more and more energy in slower and slower frequency ranges. In the deepest stages of sleep, your brain will be producing a great deal of delta wave activity, at a frequency of less than 4 cycles per second.

OK, so this progression into deeper and deeper sleep sounds like an engine revving down to stop, as if the brain is slowing down and not doing things. The energy output of the brain, however, doesn't drastically change. The waves of activity that it produces are slower than when you're awake, but the deeper the sleep, the higher the amplitude. In the deepest sleep, your brain waves have a much higher amplitude. There are fewer waves, but they're bigger. Just to be clear, your brain isn't turning off at all when you go to sleep; it's just shifting into a different mode of activity. There are more and more delta waves, in place of beta, alpha, or theta waves.

Your brain and body step down through four stages of deepening sleep, from awake to very deep sleep. Essentially everyone exhibits this pattern of activity as they sleep for the first hour or so. You remain in deep, delta wave sleep for about a half hour or so after. If you ever try to wake someone when they're in this fourth, deepest stage of sleep, you'll find that it's a hard thing to do. It can take several minutes, during which time the sleeper often seems confused or disoriented.

Presuming that no one does wake you up, you'll spend a half hour or so in this deep sleep. After this half hour, your brain waves begin stepping up their rate of activity, back toward the place you were at the beginning, producing fewer delta waves and more theta waves, then more beta waves. At this point, you will have stepped back up to stage 1 sleep. At the top of these steps, however, you don't continue and wake up. A really remarkable set of changes emerges. The activity level of the brain becomes very much like that of someone who is awake. Lots of energy shows up in the alpha range. This is called REM sleep.

While the brain becomes very active at this point, the muscles in most of the body become deeply relaxed. Throughout most of the day, even when you're just sitting still, your muscles maintain a certain level of tone. It's rigidity that's produced by a relatively slow but steady stream of neural impulses delivered from your brain, via your spinal cord, to your peripheral nerves. As you enter this stage of sleep, however, those signals drop off. The muscles become remarkably inactive, almost paralyzed.

The muscles that control the movements of the eyes are an exception to this. The eyes become very active, darting back and forth, up and down, as if rapidly scanning something. The eyes are still closed, of course—you're sleeping—but you can see the eyeballs moving behind the lids if you look. These rapid eye movements are the feature that gives this sleep stage its name, that's why it's R-E-M, or REM sleep. If you awaken someone when they're exhibiting these sleep characteristics, he will essentially always tell you that he was just having a dream.

Other sleep phases have particular things associated with them as well. In stage 2, people often experience hypnic jerking. Many people report a periodic experience of a momentary dream of falling. They jerk briefly awake with a bit of an adrenaline rush. In early stage 3, people can sleepwalk. By the way, it's fine to wake up someone who's sleepwalking. It's better to wake them to just avoid injuries. Usually these involve just walking into a door or stubbing a toe, but it's not unheard of for someone to leave their house and even drive a car while sleepwalking.

In stage 4 sleep, many children experience something called night terrors, in which they begin screaming out, seemingly in great fear in the middle of the night. One reassuring, even sort of amusing, consequence of the fact that stage 4 sleep is such a deep sleep is that most children who experience night terrors have no idea that they've done so. The child screams in terror. I can tell you from firsthand experience that the parents come running to the child's bedroom. The parents urgently ask "What's the matter!" And the child doesn't respond. They wake the child up. The child groggily rubs her eyes, looks around, and asks in complete earnestness, "Why is everyone in my room? I'm trying to sleep."

While all of these sleep stages have particular processes associated with them, I want to talk a bit more about this REM sleep, the dreaming sleep. There's a wealth of evidence that your brain does important work that supports regular brain function during this stage. Just one example is memory. You tend to dream about the things that have happened to you during the recent past—indeed, most frequently about things that happened during the previous day. Early in the evening, those dreams will tend to be very literal. If you went to the park with your dog and your mom, a dream early in your sleep time is likely to be about that trip to the park with your dog and your mom. Later in the evening, the dreams tend to become more abstract in nature. A dream later during the night might be about travels to distant lands taken with large animals and family members.

This replay and abstraction process is critical to optimal memory, also to high levels of creativity and problem solving. We encode things into our long-term memory as we experience them during the day, but those memories seem to be consolidated in an important way during the following night of REM sleep. If you prevent someone from getting REM sleep, even if you allow them to get a lot of non-REM sleep, detailed memory for experiences and new things that you learned during that day will tend to suffer. Cognitive function also generally declines, according to a wide range of cognitive function measures.

In a sleep lab, this REM deprivation is accomplished by letting someone sleep and identifying when they enter that REM sleep phase. As soon as they do, the researcher wakes the participant up, talks to him for a minute, and then lets him drift off to sleep again. Unfortunately for the participant, he can't just jump back into his sleep cycle right at that REM stage; he has to start again at stage 1. About 90 minutes later, when he's about to enter the REM stage again, the experimenter wakes the participant up.

If this happens all night, the participant's brain won't work so well in the morning—reaction time gets slower, short-term memory function drops, creativity is worsened, emotional regulation is reduced. Angry outbursts and mood swings are far more likely for someone who's been prevented from getting their normal REM sleep—and all of this even while getting eight hours of sleep, just without any REM sleep in the mix. Your brain needs to dream. It needs this REM sleep like it needs nutritious food.

With this in mind, I can get back to making my argument for eight hours of sleep. I described the different phases that make up a standard sleep cycle. Stage 1, then 2, 3, 4, back up, 3, 2, 1, then REM sleep. I mentioned about how long you spend in each of these phases. If you add them up, a trip through all of these stages takes about 90 minutes. If you sleep for about eight hours, you'll go through about five of these sleep cycles—down to four, up to five, and then back down for another go around. The cycles are all similar, but not exactly. Every additional sleep cycle you complete has more and more dreaming.

Your first REM cycle of the night might last only 30 seconds, maybe a minute. The second will tend to be twice as long; the third even longer. Most of your REM sleep, the vast majority of this important brain process, takes place in the last two sleep cycles of an eight-hour sleep session. If you reduce your sleep by a couple of hours a night, say you sleep six hours instead of eight, you might feel that you've still gotten most of a good night's sleep. In terms of total hours, that's sort of correct. You've only missed out on about 25 percent of your sleep time. But in terms of REM sleep time, you may have cut your night down by 40 percent. This is why eight hours per night is so important, what your brain wants and needs. Try giving it to your brain for two weeks. I'm confident that you will be delighted with the results.

This leads to my next tip for outsmarting yourself: don't take naps. Now, I'm a fan of Saturday afternoon naps, so I'm a bit pained to mention this one, but napping can be really destructive for REM sleep. If you sleep for 90 minutes, you'll get a full sleep cycle in, including a brief bit of REM sleep. But if that nap reduces the amount of sleep that you can get the following night, even by a couple of hours, you will greatly reduce the total amount of REM sleep—again, maybe by as much as 40 percent. And, as we've considered here, REM sleep is critical to normal function.

I should say a few words here about power naps. This topic has received a lot of media coverage and it's been the subject of a lot of scientific investigation over the past few decades. If you feel tired in the middle of the day, the modern workplace tends to frown on napping. Many people just push through that tired feeling. Many people reach for a cup of coffee or an energy drink.

An alternative that's been suggested by a lot of people is that we should just let people take a brief nap. Most companies would prefer to not pay their employees for sleeping on the job, but perhaps if you let people sleep for 20 minutes, you can get a lot more productive work out of them over the course of the rest of the day. That sounds a lot better than having a groggy employee walking around not doing very much good work, and perhaps even doing some bad work that'll need to be undone in the future. Google and a few other companies have gone so far as to install napping pods at various locations around their campus. If you're tired, take a nap, then get back to doing the right thing and making the world a better place.

OK, that's the idea. What about the science? The good news for power nappers is that a 20–60 minute nap—less than a full sleep cycle here, without REM sleep—does boost cognitive function. All the usual data support this: faster reaction times, better working memory, better problem-solving abilities.

Now the bad news for power nappers. First, essentially all of this data, all these studies, have been done with experiment participants who were sleep-deprived. When experimenters conduct studies of power napping, a standard procedure is to start by asking participants to reduce their nightly sleep by about an hour-and-a-half or two hours for at least one night before they participate in a power nap experiment. In some highly cited studies on this topic, participants have been prevented from sleeping for over 24 hours prior to participating. If you're sleep-deprived, a power nap will help you—this is quite clear. If you're not sleep-deprived, then you probably won't nap when you're given the opportunity, and the power nap won't help.

Take my two-week eight-hours-per-night challenge. If you decide that it's not worth it, you can always go back to the shorter sleep times that you're using now. It might be a hassle, but remember, it's just for two weeks. It doesn't have to be that you're changing your life forever. That said, I think it will.

Some people say that they don't want eight hours of sleep. Others claim that they would love those eight hours, but they have a great deal of trouble falling or staying asleep. Insomnia is a condition that affects millions of people. A study by the Centers for Disease Control found that 9 million Americans are regular users of prescription sleep medication. This is a go-to strategy that most people use when insomnia strikes. There are two big problems with this.

The big one is that standard sleep medications—Ambien, for instance—disrupt REM sleep. Most medications that function as depressants do the same thing. If you go to sleep after several alcoholic drinks, the same thing happens. REM sleep, as we've discussed, is one of the critical processes of sleep. Without REM phase sleep, sleep's just not as beneficial.

Second, with regular use, humans develop a tolerance to sleep-inducing medications. That is, even if the medication works well when you first start taking it, your body will adapt to it. Those homeostasis systems in your brain will recognize that a depressant is about to arrive, and take steps to counteract it. Eventually, unless you increase the dosage, the sleep aid will stop being very effective. And increasing the dosage is dangerous. Overdose and death are a real risk if this is done carelessly.

Unlike most sleeping pills, melatonin supplements are not depressants. Melatonin is a hormone produced by the brain as part of the process of inducing sleep. By taking melatonin orally, this process can be brought on more quickly. This can be very effective in the short term, over a few days perhaps, as you're struggling to overcome jet lag, or maybe reset the time that you fall asleep at night. But in the long term, melatonin isn't an optimal solution for insomnia. Several studies have suggested that over time people develop a tolerance to melatonin supplements, as with any other consistently taken medication. Also, possible mild side effects, such as headaches, stomach cramps, or irritability that can become more of an issue.

So how can you combat insomnia if you don't take sleeping pills? The outsmart tip here is to strengthen your unconscious association between your bedroom and sleep. Many people who report problems with insomnia also do lots of things while sitting in bed. Not just sleeping: they watch movies, they work on their computer, they make calls; in a lot of cases, even eat meals.

To the extent that you do this, the unconscious systems that regulate your sleep come to associate all of these non-sleep activities with your bed. You climb into bed, hoping to sleep. You have consciously decided that it's sleep time based on processes that are occurring in your frontal lobes, presumably. But, your sleep regulation is controlled by unconscious systems. Your unconscious control systems know that you're in bed and are ready to watch a movie, work on a computer, eat.

To fix this, stop doing all of these non-sleep activities in bed. When you go to bed, turn out the lights, and shut your eyes. Now, if you're fighting a bout of insomnia, you'll probably just have to lay there for a while. This will be especially true if you've been taking a sleeping pill but stop on that particular night. Your body will be producing extra activity to counteract the expected depressant medication, which will make it that much harder to fall asleep. If you find yourself lying there awake, the basic tip here is just to keep doing it, just relax, and wait for sleep to come to you. Be patient. Relax.

That's easy to say, but this is hard if you've been battling insomnia for a while. It can be downright frustrating, actually. You might find yourself feeling angry about being plagued with this problem, and anxious that it won't go away. Both of these are associated with increases in activation of the limbic system and the sympathetic part of the autonomic nervous system. Both will make it harder to fall asleep. I recommend meditating. Mentally focus on your breathing and try to clear your mind, try to stop thinking about falling asleep. Try to stop thinking altogether. If a thought intrudes as you do this, just gently push it aside, and continue.

When you're in the process of changing your associations with your bedroom, you may sleep even the first night you're doing so. Over time, typically a week or so, your unconscious mind will learn to sleep normally again. If you put a tired body into a fully dark, quiet, cool, comfortable space, and make it lay very still for a while, with very few exceptions, it's very likely to fall asleep.

I should say, when you do sleep—and I'm confident that you will sleep eventually—you will, by definition, lose consciousness. There are times when people fall asleep and then gently wake up without ever realizing it. It might be that, even during that first night when you try this, you'll be drifting in and out of sleep without ever knowing it. Even if it feels like it's not working, I urge you to stick with this strategy for at least a week or so. Some patience is required here, but there's really good evidence that this sleep association strategy works.

Before you go to bed, there are a few steps that you can take to ensure an effective night of sleep. A tip here is to avoid bright lights, especially lights with a blue component to them, for several hours before you try to go to bed. Bright incandescent or fluorescent lights can be bad. Computer screens, iPad screens, and modern LED television screens, they're even worse. For several hours before you plan to start sleeping, you should avoid exposing your eyes to any of them.

To fully understand this, there are three things you have to understand about how the brain and our eyes regulate our sleep. First, proper sleep relies on a 24-hour timing cycle, a circadian rhythm, maintained by your brain, particularly the part of the brain that regulates sleep function. Second, the clock in your head runs slow. Fortunately, the clock has a natural mechanism for setting the right time every day. Third, there's a lot of blue light that doesn't look blue.

OK, let's start with the human circadian rhythm and the internal clock inside your brain. The clock itself is a tiny region called the suprachiasmatic nucleus—it's about 20,000 neurons. It's located in the hypothalamus, right above the optic chiasm. The optic chiasm is the place where your optic nerves from your two eyes come together—more on the optic nerve in a minute. Every evening, the clock triggers a cascade of physiological events. It causes the release of melatonin, a hormone that works to lower your heart rate and body temperature, and eventually to bring on sleep. There's one problem with the clock—it runs slow, about one hour slow each day.

Studies have been run in which participants lived in an environment without external time cues. They were sequestered in an isolated basement living area. All clocks were removed, and care was taken to remove any other time cues as well. The participants in these studies were allowed to turn the lights on and off whenever they wanted as long as they stayed in the living area. When they felt it was time to go to sleep, they could shut the lights out and do so.

First, the participants slept for about eight hours a night. Left to our natural inclinations, the human body wants those eight hours. Second, each 8 hours of sleep started about 25 hours after the last one started. The human circadian rhythm clock directed the normal sleep pattern, but it waited consistently longer than 24 hours from cycle to cycle. If our bodies want to live on a 25-hour cycle, why don't we all do so? The suprachiasmatic nucleus has a reset mechanism: sunlight. We wake up and, sometime shortly thereafter, most people see some sunlight. As we do, it resets the clock. After a day has passed, the sun starts to set, and the light gets dimmer. The clock starts to run down and start up the sleep cycle. When the sunlight hits it the next day, boom, it starts all over again.

In 1998, researchers discovered a type of receptor in the human retina that's critical to this process. These receptors are called melanopsin retinal ganglion cells. These cells connect almost directly from the eye, down the optic nerve, and then to the suprachiasmatic nucleus. These particular receptors are most sensitive to blue light. If you shine a purely red light on your eyes, it will activate these receptors a little, especially if it's very bright. But even a small amount of blue light will cause these receptors to send a burst of activation from the eye to that internal sleep clock located above the optic chiasm.

There's one last thing about light that's important to note here. Blue light, of course, contains blue light wavelengths, but so do many other colors. Sunlight, even bright white sunlight, contains an evenly distributed mix of many wavelengths of light, including blue. So it's the blue range wavelengths that matter, but even when you're just looking at something that isn't just blue, especially in conditions of bright illumination, there's often a blue wavelength component to it. When this blue frequency light strikes the receptors, it disrupts the suprachiasmatic nucleus function. If you look at a computer screen, it greatly reduces your brain's release of melatonin. It's like you've taken the clock that was running slow already and grabbed the second hand to make it stop completely for a while.

If you must look at a screen at bedtime, there's another solution: sunglasses. There are some very pricey sunglasses on the market that specifically block blue light frequencies, but almost any orange-tinted sunglasses will work almost as well. You might feel a little silly wearing sunglasses while you watch TV before bed, but there's good evidence that they work here. You may struggle with your bedtime fashion choices, but your melatonin levels will rise more normally, and you'll drop off to sleep more quickly.

There's a flip side to this tip that you might find useful about eight hours later. Look out the window at blue sky first thing in the morning. Or, if your daily schedule calls for you to rise before the sun, you can downregulate your melatonin production, and wake up more quickly, by staring at a computer screen or television. Broad spectrum or bluish illumination, especially bright illumination, will reset that clock and get your brain active and on its way.

Eight hours of sleep per night is important to maintaining optimum brain function. If you've been getting less than that for an extended period, you've probably gotten used to the problems that come with it. If you don't believe me, try to keep an open mind and try this eight-hour a night challenge for just two weeks. Avoid computer screens in the evening. Avoid naps. Try to reserve your sleeping space just for sleeping. In two weeks, I predict you'll be glad you did.

I should note here that I realize that sleep disruptions are a part of life. There will be times when other things are more important than those eight hours per night. If you have a newborn baby, you can probably forget about this challenge for a few months. It's also not a tragedy if travel or some other adventure takes you out of your ideal sleep schedule temporarily. If you get eight hours when you can, you'll benefit greatly. And these sleep disrupting events are generally temporary. When they pass, the two-week challenge will still be there for you to try again.

Boost Insights and Creativity

Creativity may well be the most valuable product of our brain functions. Constant innovation is a hallmark of human history. Only in the last few decades have researchers studied creativity from the perspective of cognitive neuroscience, however. In this lecture, we present the findings of scientific studies that support strategies to boost creativity.

Remote Associates Test

- To develop more creative solutions, listen to happy music. One of the best studies of this effect, conducted by Gene Rowe and his colleagues, used a type of puzzle called a remote associates test. In the remote associates test, you are given three words. Your task is to come up with a fourth word that is closely associated with all three. For example, say that the three words are "cottage," "Swiss," and "cake." The related fourth word is "cheese"—creating "cottage cheese," "Swiss cheese," and "cheesecake."

- While these are simply word puzzles, a significant step in most creative processes is to consider how very different pieces of information relate to one another.

- Participants in the Rowe study were randomly assigned to one of three mood-induction conditions: positive, negative, and neutral. In the positive condition, participants listened to a jazz version of one of Bach's *Brandenburg Concertos*. Participants in the negative condition listened to Prokofiev's music score of *Alexander Nevsky*. For the neutral condition, participants read a series of facts and figures about Canada.

- After 10 minutes engaged in one of these three tasks, participants in the positive condition gave higher ratings of their positive mood level; neutral participants were in the middle; and the negative group's moods were significantly lower. Participants then engaged in the remote associates test.

- As you might guess, the performance tracked with the mood level. People who listened to the positive music answered significantly more remote associates test questions correctly. To the extent that this test taps into significant aspects of creativity, we can conclude that listening to happy music boosts creativity.

Eriksen Flanker Task

- The Eriksen flanker task was also performed by participants in the three experimental mood-induction conditions. In this test, participants watch a computer screen and respond as quickly as possible to the appearance of a letter in the middle of the screen. The task is to focus your attention on one location on the screen and to ignore flanker letters.

- Listening to happy music makes you worse at this task. Listening to sad music, however, improves performance. The researchers argue that a happy mood broadens your focus of attention and makes your brain more open to considering a wider range of diverse information.

Sudden Insight

- Mark Beeman has studied brain activation during remote associates tests using functional magnetic resonance imaging (fMRI) and the electroencephalograph (EEG). Beeman was keenly interested in the experience of sudden insight when we try to solve complex problems.

- In Beeman's studies, whenever participants had an insight experience, they would press an insight button. Beeman's analysis of the brain-imaging data revealed that a particular region in the anterior superior temporal gyrus became very active shortly before this moment of insight. This area is located at the top of the right temporal lobe.

- Three-tenths of a second before participants pushed the insight button, a burst of high-frequency activity was emitted from the anterior superior temporal gyrus. This region is associated with many tasks involved in integrating distant semantic relations or finding connections between information that is only loosely related.

Sympathetic and Parasympathetic Nervous Systems

- Research on the sympathetic and parasympathetic portions of our autonomic nervous system can help explain why happy music affects the brain regions associated with creativity. When we find ourselves in threatening, potentially dangerous situations, we activate our sympathetic nervous system. This prepares our body for a potential fight-or-flight reaction, aimed at increasing the likelihood of survival.

- When we don't sense a threat, our body activates the parasympathetic nervous system and enters into a tend-and-befriend mode of processing. Activation of the parasympathetic system is associated with complex cognition and creative problem solving.

Alternative Uses Test

- Walking is associated with boosting happiness as well as creativity. Marily Oppezzo and her colleagues explored this phenomenon with a task that has often been used to assess creativity: the alternative uses test. In this test, participants are given four minutes to come up with as many different uses as they can for a common object.

- Oppezzo's group had their participants complete the remote associates test and the alternative uses test while participating in one of several experimental conditions. Some participants sat in a chair; others stood; some walked inside or outside; and some were pushed in a wheelchair. Walking significantly boosted the creativity of the study participants.

Stimulate Your Brain with Variety

- The best creative thinkers tend to be those who engage in a wide variety of tasks. In typical studies, researchers have surveyed participants about the variety of activities they pursue. The participants then complete tasks such as the remote associates test and the alternative uses test. In general, the more varied the participants' typical activities, the higher they score on tests of creative thinking.

- If you feel stuck with a particular problem or set of challenges and want to develop more creative solutions, try something new. Doing so can stimulate your brain in novel ways.

- As your senses (and body) are stimulated with a wide variety of different inputs, the internal state of your brain's activation will tend to vary more as well. Finding a creative connection between two pieces of information will only happen if the brain circuits that encode those two pieces of information are active at the same time. If you increase the variety of ways in which your brain is stimulated, this increases the chance of sparking these unusual co-activations.

Avoid Pre-crastination

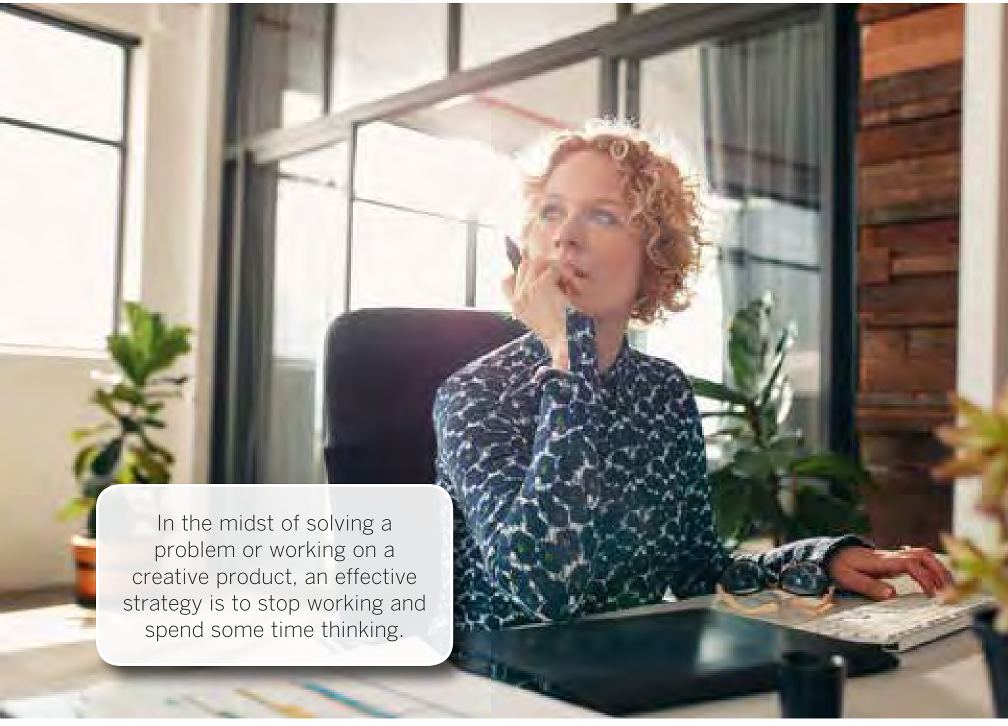
- A successful strategy associated with improved problem solving and creative work in general is to do nothing—at least not right away. Simply take some time to think about the problem or your general goals before you seriously undertake the work of addressing them.

- Counterintuitively, doing nothing for a little while is effective advice for overcoming procrastination. For the purposes of creativity, however, there is evidence that doing nothing can also help avoid the opposite problem, known as pre-crastination.

- Pre-crastination is the tendency to begin work prematurely on some critical task simply for the sake of getting it done and out of the way, even when the timing is detrimental to success. A few studies have found that procrastinators often come up with more creative solutions to problems. More thinking leads to more creativity in general.

The Incubation Effect

- Another effective strategy is to stop working and spend some time thinking in the midst of solving a problem or working on a creative project. Several studies have found evidence for the incubation effect. The general model of these studies is to give people a difficult problem to solve that will take several minutes.



In the midst of solving a problem or working on a creative product, an effective strategy is to stop working and spend some time thinking.

- In an incubation study, half the participants are randomly assigned to a control condition and are given several minutes to solve the problem. Some will solve it; some will not. The experimental group is given half as much time to work on the problem and then forced to take a break. This group is given another task to perform during that time and specifically instructed not to think about the problem during the break.

- After the break, participants in the experimental group are allowed to work on the original problem. At the end of this second work phase, both the control and experimental participants will have had the same amount of time to work directly on the problem.

- In the many studies of the incubation effect, more of the experimental participants solve the problem than control participants. During the break period, although the experimental group participants aren't explicitly working on the problem, many have argued that their brains may still be implicitly and unconsciously chipping away at the problem.

- The break period is often referred to as the time when the problem solution is incubating. Neuroscientists speculate that during the incubation period, the neuronal circuits involved in solving the problem remain active, continuing to search for associations and possible solutions.

REM Sleep

- Several studies suggest that if you include some sleep and dreaming in the incubation period, the effects are significantly enhanced. Denise Cai and her colleagues presented sleep-deprived participants with a set of remote associates test items along with challenging analogy problems. Some were answered correctly during an initial session, while others were not. The participants then took a nap or stayed awake while resting quietly for 90 minutes.

- Some participants in the nap group entered the rapid eye movement (REM) phase of sleep, which is strongly associated with dreaming.

The participants who produced REM sleep returned to the problems and performed significantly better than the quiet-rest group and even the nap participants who did not exhibit REM sleep.

- Sleep research suggests that your brain enters the REM stage of sleep several times every night. During REM sleep, the brain partially replays experiences of the previous day, consolidates them into long-term memory, and seems to find abstract relations between different sources of information. All this is helpful for creativity and problem solving.

1 Percent Inspiration, 99 Percent Perspiration

- That sudden insight that comes right before the solution to a complex problem is a magical experience—but it represents the end of the creative process, not the beginning. To be creative, you have to work at it very diligently.

- In fact, most successful creative people are extremely disciplined about when they work and even where they work. Thomas Edison famously said that genius is one percent inspiration and 99 percent perspiration.

- Most people think of creativity as unbridled thought and consider the creative process as a practice in which you simply wait for an inspired solution to come to mind. The tips outlined here will all help with creativity, but they won't work in isolation. Even if you listen to happy music, incubate your thoughts across a night of sleep and dreaming, take a walk, avoid pre-crastination, stimulate your brain with variety, or give yourself time to think before you start working, you will still need to invest substantial effort in actively working to find creative ideas and solutions.

Questions to Consider

1. Many creative thinkers have credited the use of particular drugs with boosting their creativity. How does this fit with the current understanding of the creative process? How does it contradict it?
2. Incubation research suggests that our brain unconsciously continues to work on solving problems even as we direct our attention to something else. Might it be that the mental break improves later performance even if there is no unconscious problem-solving system engaged in ongoing processing? Could an experiment answer this question? Does it matter in terms of how you use incubation to enhance your creative problem solving?

Suggested Readings

Gladwell, *Outliers*.

Kounios and Beeman, *The Eureka Factor*.

Lecture 11 Transcript

Boost Insights and Creativity

Creativity may be the most valuable thing that our brains produce. Innovations in terms of solving problems and designing products have been a repeating hallmark of human history. The creativity of artists in visual, auditory, even culinary domains provide some of the greatest pleasures that humanity has ever experienced. Creativity also shows up in our individual daily lives, not just in terms of work, but even in terms of things like maintaining relationships. If an interpersonal problem arises, finding a creative, novel solution that works can be the key to making a relationship happy, or even saving it.

Given the importance of creativity, you would think that cognitive neuroscience would have studied it a lot more. But only for the last few decades have researchers really tried to study creativity from a cognitive neuroscience perspective. The reasons cognitive neuroscience has been late to the game here have been largely pragmatic. You can't just put someone into an fMRI scanner and instruct them to be creative, starting—now!

While the work was delayed as researchers developed techniques, very creative solutions have been devised, and we've learned a tremendous amount about how the creative process works in general and how the brain implements it. Want to bring more creativity into your life, to develop more creative solutions to the challenges that face you? There are many ways to do that. One of the simplest is to listen to happy music.

For instance, if I give you a complex puzzle to solve, one that you've never seen before, you'll likely have to tap your creativity to come up with a solution. If thousands of people do the same puzzle, some will be creative enough to solve it, and some will not. The more creativity you have, the more likely you are to solve the puzzle. Studies of how listening to music influences creativity have taken this approach. One of the best studies of this effect, conducted by Gene Rowe and his collaborators, used a type of puzzle called a remote associates test. In every trial of a remote associate test, you'd be given three words. Your task is to come up with a fourth word that's closely associated with all three, a word that could form common phrases of two words with each.

OK, for instance, if I give you the words cottage, Swiss, and cake. Is there a word that fits with all three of those: cottage, Swiss, and cake? Cottage blank, Swiss blank, and blank cake. What single word could fill in that blank? The answer may have already occurred to you. If we give you enough time, you'd likely come up with cheese: cottage cheese, Swiss cheese, and cheesecake.

Let's try a couple more just to give you a feel for this remote associates test. OK, here are the next three words: glass, gun, and put. Glass, gun, and put. What word would go with glass, with gun, and with put to form familiar two word phrases? Blank glass, blank gun, and blank put. Did you get it? This one's a bit harder. The answer is shot. Shot glass, shotgun, and shot put.

One more: the three words are mower, atomic, and foreign. Mower, atomic, and foreign. Blank mower, atomic blank, and foreign blank. What could fill in that blank? This one is also hard. Most people would require longer than I'm giving you right now to figure out the answer. In the interest of time, I'll tell you the answer is power. Power mower, atomic power, and foreign power.

OK. These are just word puzzles, but they activate many of the brain processes involved in developing creative solutions to problems in general. A big step in most creative processes is to think about how different pieces of information relate to one another. Say it was the 1800s and I wanted to figure out how to make an incandescent light bulb last longer. I'd have to figure out how electricity flows through the bulb, and how that leads to both the production of light and the degradation of the filament material. I need to think about the properties of different materials, and how they change when heated—in particular, how they oxidize. Eventually, like the Belgian inventor Jobard, I might have the insight that if I could take most of the oxygen out of the light bulb, that the filament would oxidize less and last longer.

In this creative invention process, I'm using information from many different sources that are related, but only remotely so, and finding out how to draw new connections between them. That's exactly what you do with the remote associates test. You search for connections between the words that are remote, thus the name remote associates test. This may not be the whole process of creativity, but it's an essential part of it. If we can make you better at finding remote associations, we will boost your creativity at the same time.

OK, so participants in this Rowe study were randomly assigned to one of three mood induction conditions: positive, negative, and neutral. In the positive condition, participants listened to a jazzy version of the "Brandenburg Concerto." Participants in the negative condition listened to Prokofiev's "Alexander Nevsky: Russia under the Mongolian Yoke." This depressing song was rendered especially depressing by playing it at half speed. For the neutral condition, participants read a series of facts and figures about Canada. That might sound potentially negative to you, or positive—that's sort of the point. Reading facts and figures turns out to be pretty close to neutral.

And taken together, these three methods have been used to induce different moods by other researchers in the past. And they work. After 10 minutes engaged in one of these three tasks, participants in the positive condition gave higher ratings of their positive mood level; neutral participants were in the middle; and negative participants' moods were significantly lower. The participants then engaged in several tests, one of which was the remote associates task. As you might guess, the performance tracked with the mood level. People who listened to the positive music answered significantly more remote associate questions correctly. To the extent that this test taps into important aspects of creativity, we can conclude that listening to happy music significantly boosts creativity.

A concern you might have is that perhaps people were just generally more motivated in the positive condition than in the other two. Perhaps it's not their creativity, but just their overall level of engagement that changed. That's a possibility here, of course. It's worth noting that, even if it is just a motivation booster, listening to happy music will still improve performance on a creative task, so the tip of listening to happy music would still be a valid one. Moreover, the experimenters obtained other evidence as well, other evidence that it's not just motivation that's influenced here. In fact, this experiment was mostly testing for how well participants can focus visual attention on a target, and how well participants can ignore extraneous information.

A flanker task was also performed by participants in these three experimental conditions. In this flanker test, participants watch a computer screen and respond as quickly as possible to the appearance of a letter in the middle of that screen. For instance, if the letter is a K, participants press a key with their right index finger. If the letter is A, the participants press a key with their left index finger. This is an easy task, of course. It's even easier if you present more than one of the same letter. That is, participants are a little faster to respond to a K if it's presented with another K on its left and a third K on its right. However, if you flank the target K with the other target, the A in this case, then participants are slower to respond. The task is essentially to focus your attention on that one location on the screen, and to ignore the flanker letters. Listening to happy music? It makes you worse at this task. Listening to sad music, however, improves performance on this flanker measure.

The researchers argue that a happy mood broadens your focus of attention. It makes your brain more open to considering a wider range of different information. This happens in terms of your visual attention—we see this with the flanker task. It also seems to happen in terms of your general cognitive performance—we see that broadening of scope with the remote associates test.

If you want to focus your attention on one particular solution to a problem, and thus to not be distracted by other information, listening to sad music would be a good thing to do. If, on the other hand, you want to open your mind to a wide range of potentially related information, to be able to consider that in creative ways, then listening to happy music will help.

What's going on in your brain when all of this happens? Some of the best work on this comes from the lab of Mark Beeman who studied brain activation during remote associate tests. Participants in his tasks would try to solve a long series of these problems while lying in an fMRI scanner or while wearing an EEG cap.

Remember, functional magnetic resonance imaging, an fMRI, precisely assesses which areas of the brain are activated during a task. It does this based on measurements of blood flow to those regions. The electroencephalograph, the EEG, contains a large number of sensors that are placed on the scalp. These sensors pick up the tiny electrical activations made in the brain under the region of each particular sensor.

Keep in mind here that fMRI is very good in terms of spatial resolution—it can resolve changes down to a cubic millimeter of brain tissue. FMRI is not very good temporally. Changes in blood flow don't occur for several seconds after an area becomes active. EEG has the opposite characteristics. It's not so great in terms of spatial resolution. The sensors pick up the average signal produced by thousands of neurons located near the sensor. Even neurons located many millimeters away from the sensor can exert a small influence on the activity that it picks up. EEG, however, is excellent in terms of temporal resolution. It can record changes that take place within as little as a few milliseconds. Some of the best neuroimaging research involves a combination of these two techniques. Beeman's work is a great example of this.

Participants in both tasks would solve the problems while holding a button box in their hands. Beeman was very interested in that experience of insight—often, it's very sudden insight—that we all have when we're trying to solve complex problems. It seems that you don't know the solution to a problem—for instance, one of those remote associates problems—and then, seemingly from nowhere, eureka—you know it.

In Beeman's studies, whenever participants had this insight experience, they would press the insight button. Beeman's analysis of the brain imaging data revealed a particular region located in the anterior superior temporal gyrus of the right hemisphere. It became very active shortly before this moment of insight was indicated with the button press. This area is one of the outward bulges located at the very top of the right temporal lobe.

Now, the cortex is like a thin, wrinkled sheet of neurons. Some of the wrinkles bulge out; we call a bump like this a gyrus. A valley in the wrinkled surface is called a sulcus. The area that Beeman identified is a gyrus located in the top of the right temporal lobe. It seems to be critical in developing creative insights.

The EEG data confirmed this finding. Three tenths of a second before participants pushed that insight button, a burst of high frequency activity is emitted from this anterior superior temporal gyrus. The anterior superior temporal gyrus is associated with many tasks involved in integrating distant semantic relations, finding connections between information that's only loosely related, exactly the sort of thing that's needed for the remote associates test, and for creativity more generally.

Why should happy music affect this region? Most research points to the relation between the sympathetic and parasympathetic portions of the autonomic nervous system. When we find ourselves in threatening, potentially dangerous situations, we activate our sympathetic nervous system. This prepares our body for a potential fight or flight reaction, aimed at increasing the likelihood of survival. When we don't sense a threat, our body activates the parasympathetic system and enters into what is often referred to as rest and digest mode of activity. Of course, we don't just rest and digest in this mode. As we calmly consider problems, this parasympathetic system will tend to be activated. It might also be better to refer to it as a tend and befriend mode of processing.

The body diverts its resources to general maintenance activities that, while essential for long-term survival, aren't particularly useful for battling or escaping from a threat. One of those rest and digest systems is general cortical activity, the activity associated with complex cognition and creative problem solving. This sympathetic and parasympathetic system is often characterized in terms of its extreme responses. If an enormous, snarling tiger suddenly jumped in front of you, you might be terrified, and a fight or flight feeling would come over you and your brain. That said, when you're a little stressed about something, a smaller, gentler version of that same fight or flight mode is engaged. When you feel happy, more of your resources are released into your brain as a whole.

Indeed, one general piece of advice for boosting creativity that's been supported by many different studies is to be happy. If you're depressed, sad, distressed, anxious—anything but happy—your creative abilities seem to be compromised. Listening to happy music will boost your creativity while you listen to it and for at least a few minutes after, but, in general, everyday happiness will boost it on a more long-term basis. As you prepare to undertake a challenging task, one for which you want to marshal your most creative thinking, it's worth starting by doing something that makes you happy.

One task that's associated with boosting happiness as well as creativity is walking. Marily Oppezzo and her colleagues have explored this with another task that's often been used to assess creativity: the alternate uses test. In this test, participants are given four minutes to come up with as many different uses as they can for some common object. Let's try it for a minute or two here.

Think of as many uses as you can for a brick. You can use it as a doorstop, a paperweight; you can stand on it to reach up a little bit higher than you normally can. Anything else? Try to think of a few. You can use it as a weapon. You can use it to break a window. You can use a brick as an inexpensive dumbbell for weight training. Some people get really creative with this test. One participant who did this test suggested using a brick as a pretend coffin for a Barbie doll funeral.

For this test, this alternative uses task, it would be performed for several minutes with a list of several additional objects: a shoe, a paperclip, and maybe a bucket, for instance. As with the remote associates test, this isn't really the same thing as creatively inventing a new device or producing a work of art, but it taps a mental resource that is central to those real-world creative processes.

Oppezzo's group had their participants complete the remote associates test and this alternative uses test while participating in one of several experimental conditions. Some participants sat in a chair and completed the tests. Others stood up. Some went for a walk while completing the task; some walked inside, some outside. Some were pushed in a wheelchair for that trip around the inside or outside space. Note that these last two conditions are kind of clever. If a boost in creativity was found, it might not be the walking that mattered, but the stimulation of the changing surroundings that boosted the creativity. The wheelchair conditions tested for that.

The short summary of all these different conditions in this study is that all of these changes significantly boosted the creativity of the study participants. Walking helped a lot. So did going for a ride in a wheelchair, but walking boosted performance significantly more. Walking outside was best for creativity, but even walking on a treadmill was better than not walking.

Many great thinkers have been regular walkers. Charles Dickens claimed that he walked about 30 miles per day while thinking about his writing. Darwin, Aldous Huxley, Winston Churchill—a lot of great thinkers have talked and written about mental benefits of walking. Friedrich Nietzsche, the famous philosopher once wrote that, "all truly great thoughts are conceived while walking," a tradition that goes all the way back to ancient Greece, and the so-called Peripatetic school, literally the walking school, founded by the followers of Aristotle.

So the recent research provides solid evidence for this belief. If you want to be a more creative thinker, take your thoughts, and yourself, out for a stroll. While you're on that stroll, indeed even when you aren't, it's a good idea to carry a pocket notepad and a pencil. The best creative thinkers tend to be people who engage in a wide variety of tasks. The evidence here is correlational in nature. In typical studies, researchers have surveyed participants about the variety of activities that they pursue. The participants then complete tasks like the remote associates test and the alternative uses test. In general, the more varied the person's typical activities are, the more creative they tend to score on those tests of creative thinking.

There's a tip here as well: if you feel stuck with a particular problem or set of challenges and want to develop more creative solutions to it, going and trying something new can help. Doing so can stimulate your brain in novel ways. Indeed, this is probably the reason that going for a walk outside, or even being pushed in a wheelchair outside, boosts creative thinking. As your senses and body are stimulated with a wide variety of different inputs, the internal state of your brain's activation will tend to vary more as well. Finding a creative connection between two pieces of information will only happen if the brain circuits that encode those two pieces of information are active at the same time, or at least nearly the same time. If you increase the variety of ways in which your brain is stimulated, this increases the chance of these unusual co-activations taking place.

A consequence of this is that your best ideas will not necessarily occur while you're sitting at your desk or even when you're working on a particular challenge. If it's a truly fantastic insight that you have, it'll be hard to forget, but it might not always be clear that it's a great idea when you actually have it. By jotting a note down in your notebook when the idea occurs, you'll greatly increase the chances that you'll remember it, and be able to actually use it later.

Another tip that's associated with improved creative problem solving and creative work in general is, ironically, to do nothing—at least not right away. Just take some time to think about the problem or your general goals before you seriously undertake the work of addressing them. Notice that this is also good advice for dealing with procrastination. Ironically here, I'm suggesting that you do engage in a little delay in order to boost your creativity.

Doing nothing for a little while is good advice for overcoming procrastination, but for the purposes of creativity, there's good evidence that doing nothing can also help avoid the opposite problem, known as precrastination. Precrastination is the tendency to begin work on some important task for the sake of getting it done and out of the way, even when that immediate commencement of work is detrimental to overall success. Procrastination, of course, is the tendency to delay work on some important task, even when that delay is detrimental to success and even general happiness of the procrastinator.

It might be that the best way to make progress on some large and important task is to wait for more important information about it. You could leap in and start doing, but doing some more research or just some more thinking can sometimes lead to a better outcome. A few studies have found that so-called procrastinators often come up with more creative solutions to problems. They spend more time thinking about them and so perhaps they're not merely procrastinating. More thinking leads to more creativity in general.

As with many things, the optimal strategy here seems to be to seek a balance. If you want to think about a project for a while before diving into the work of it, I think it would be hard to argue that that's a bad thing. On the other hand, when you're thinking about the project, don't panic—you are working on it.

It can also be good to stop working and spend some time thinking in the midst of solving a problem or working on a creative project. Several studies have found evidence for something called the incubation effect.

The general model of these studies is to give people a problem to solve, a hard one that will take several minutes. Here's a sample problem developed by Karl Duncker that's been used in these types of studies. Participants are brought into a mostly empty room. On a table in that room, there's a candle, a box of tacks, and a book of matches. The task that the experimenters give the participants is to figure out how to attach the lit candle to the wall in such a way that it won't drip wax onto the table or floor.

How would you solve this problem? Any ideas? Somehow, the candle has to be attached to the wall and then lit. When the wax melts, none of it can drip onto the table or the floor. What would you try to do first? I'm not asking for a total solution here, just the first thing that you would try to do.

If you're like most people, you consider how a thumbtack, or perhaps several thumbtacks, might be used to attach the candle to the wall. That won't work, however—the wax is still going to drip onto the floor. Continue thinking, and I'll tell you the actual solution in a minute.

In an incubation study, half of the participants would be randomly assigned to a control condition, and would be given several minutes to solve the problem. Some would solve it, some would not. The experimental group participants would be given half as much time to work on the problem and then forced to take a break. The experimenters would give them another task to perform during that time and specifically instruct the participants to not think about the problem during the break. The filler task would be challenging to minimize further work on the problem as well. After the break, these participants are allowed to work on the original candle problem again for a few minutes. At the end of this second work phase, both the control and experimental participants will have had the same amount of time to work directly on that problem.

In many studies of this situation, more of the experimental participants solve the problem than control participants. During the break period, the experimental group participants aren't explicitly working on the problem, but many have argued that their brains may still be implicitly, unconsciously chipping away at it. The break period is often referred to as time when the problem solution is incubating. Maybe the neuronal circuits involved in solving the problem remain active, continuing to search for associations and possible ways that the problem can be solved.

Across a wide range of different types of problems—easy, hard, short, long—taking a break and getting away from the problem seems to help in finding a creative solution to it. If you're stuck trying to find a creative solution to something, the clear tip here is to work at it for a while, but then take a break.

The actual solution to that candle problem is simple once you know it. You empty the tacks out of the box, dump them onto the table. You use the tacks to stick the box to the wall. Then you put the candle onto this little shelf you've just created and light it. That's it—problem solved.

Several studies suggest that if you can include some sleep and some dreaming during that break time, the effects are significantly enhanced. If your incubation period includes a night of sleep, during which time you will dream, you'll be even more likely to solve problems like this—or whatever problems you're trying to address with your creative brain.

Denise Cai and her colleagues presented sleep-deprived participants with a set of remote associates test items, along with challenging analogy problems. Some were answered correctly during an initial session while others were not. The participants then took a nap or stayed awake while resting quietly for 90 minutes. Note that a full night of sleep is still best for maintaining optimal brain function. This was a research study to explore the effects of REM sleep on problem solving, this isn't a lifestyle recommendation.

Some participants in the nap group entered rapid eye movement phase of sleep. This rapid eye movement phase is often referred to as R.E.M, or REM sleep, and it's strongly associated with dreaming. The participants who produced REM sleep returned to the problems and performed significantly better than the quiet rest group and even the nap participants who did not exhibit that REM sleep. A variety of studies has shown that the formation of long-term memory is enhanced by REM sleep. These researchers confirmed that finding in this paradigm actually, but the differences in long-term memory couldn't account for the significant increases in creative problem solving performance. Sleeping—especially dreaming—enhances creative problem solving.

There are a variety of famous cases in which great creativity has emerged from thoughts during sleep and dreaming. Friedrich Kekulé is known for deriving the chemical structure of benzene. The ring structure of this molecule was hard to get from the data that Kekulé had available at the time. The solution to his puzzle emerged, not during an intentional work session in the lab, but during a dream state. He described the solution as just coming to him, as if out of thin air. Mary Shelley developed her ideas for *Frankenstein* after dreaming it. Salvador Dali occasionally described his great paintings as being pictures of things he saw in his dreams.

Sleep research suggests that your brain enters the REM stage of sleep several times every night. We all dream almost every time we sleep for several hours in a row. During REM sleep, the brain partially replays experiences of the previous day; it consolidates them into long-term memories, and it seems to find abstract relationships between different sources of information. All of this is helpful for creativity and problem solving. There's one problem with it, however: we often don't remember our dreams.

My last tip for boosting creativity is a tip to enhance your memory of your own dreams. Try keeping a dream journal. As during other times of the day, have a notebook on hand, next to your bed, with a pen, and a dim nightlight you can turn on in the middle of the night. Most people awake with a memory of a dream, at least sometimes. When that happens, grab the notebook and jot down some notes about the dream that you just had. Then go back to sleep.

The experience of reading those notes in the morning can be just plain fun, which itself can be kind of a boost for creativity. Remember that the moment your dream ends, it begins to rapidly fade from your memory. The notes, clearly written by you, but about something that you don't remember in detail, is a strange thing. When I've read my own notes in this situation, I occasionally get the strange feeling that someone else wrote them.

Sometimes, the notes might not even make sense. But, if you do this on a regular basis, you will tend to remember your dreams better. Sometimes, along with the entertainment of this, there are interesting insights to be had. The contents of our dreams, while occasionally bizarre, are not random. You tend to dream about the things that have been on your mind over the course of the previous day. Thinking them through at a dreamish level can lead to a novel perspective.

As we end our consideration of boosting creativity, I have to add one more suggestion. The tips presented here urge you to do things that promote that insight experience, that wonderful "Aha!" moment when a solution appears, as if from thin air. It's a magical experience in many ways, but it's the end of the creative process, not the beginning. In order to produce good creative work, you have to work, sometimes very hard.

Most successful creative people are extremely disciplined about when they work and even where they work. Thomas Edison's noted for saying that genius is about 1 percent inspiration and 99 percent perspiration. Getting away from your work, procrastinating, sleeping, going for a walk—these all lead to boosts in creativity, but they'll only be realized if you then return to focusing on your work.

Most people think of creativity as unbridled thought, of waiting for an inspired solution to simply arrive. The tips I've described here will all help with your creativity, but they won't work in isolation. If you listen to happy music, incubate your thoughts across a night of sleep, give yourself time to think before you start working, even if you do all of those things, you'll still need to invest effort in searching for creative ideas and solutions. If you invest both your inspiration and your perspiration, that's creativity.

Lecture 12

Enhance Performance with Imagery

William Arthur Ward famously said, "If you can imagine it, you can achieve it." The human imagination is an extraordinarily powerful instrument. In this lecture, we explore how the brain makes use of mental imagery and outline the process for outsmarting yourself into using mental imagery to enhance your visuomotor skills, cognitive abilities, and even social and emotional capabilities.

The Power of Imagination

- Following is an astonishing example of what the human imagination can accomplish.

- Imagine that you are standing with your legs about shoulder-width apart. Feel the pressure of the solid floor against your feet. Feel your body swaying back and forth, ever so slightly, the way that it usually does when you stand very still. In your right hand, imagine holding a heavy barbell. The texture of the metal is rough, and the barbell feels cooler than your skin where it touches your hand.

- Maintain a clear image of that in your mind. Now, imagine lifting the barbell all the way to your shoulder. When you've bent your arm as far as it will go, lower the barbell slowly until it's back at your side. Imagine relaxing your arm.

- Note that physically you have done nothing with that arm; rather, your brain did a lot of work imagining what your body was doing. While your brain gets a great deal of exercise, what is even more amazing is that your muscles get a workout as well.

The Shackell and Standing Study

- Erin Shackell and Lionel Standing designed one of the best studies demonstrating the remarkable effects of mental imagery. Their research team recruited participants and tested the strength of their hip flexor muscles. Once the participants' baseline strength had been assessed, they were randomly assigned to one of three conditions.

- The control participants left and returned two weeks later. Participants in the physical-training condition undertook a strength training program for their hip flexors. Participants in the mental-training condition were shown the hip flexor machine during the first visit, but they did not use it for the next two weeks. Instead, they imagined using it. Specifically, they imagined performing the same exercise that the physical-training participants actually performed.

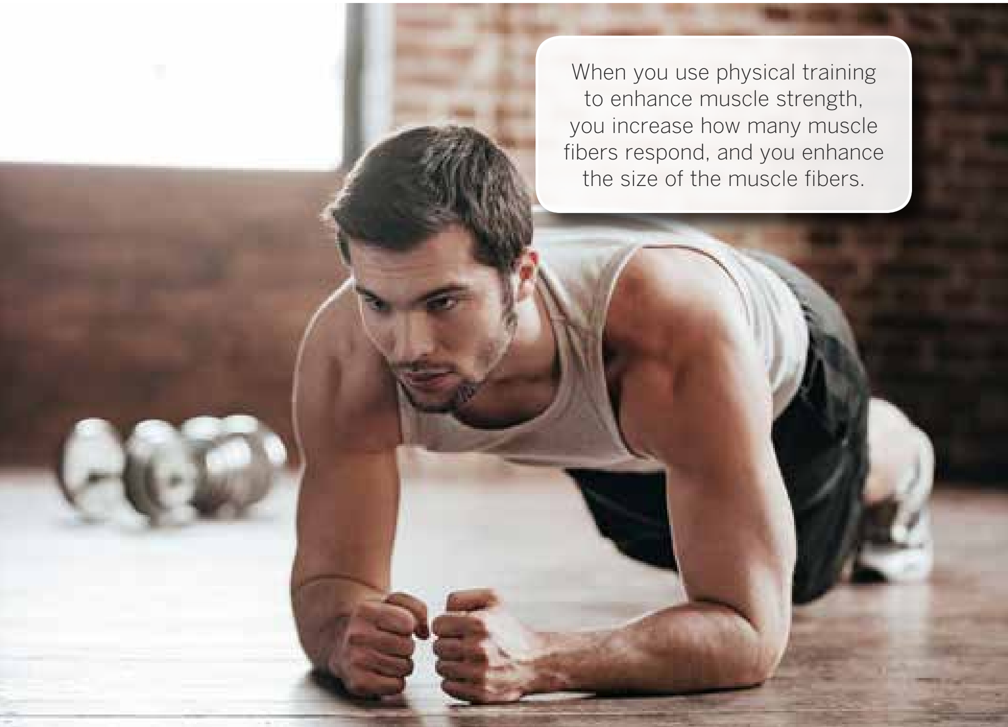
- At the end of the study, everyone returned to the gym for a repeat of the strength assessment. Participants in the physical-training group increased their performance on the strength test by 36 pounds. Participants in the control group did not change significantly. Participants in the mental-training group, without ever touching the weight machine, improved their hip flexor strength by 32 pounds—just a few pounds less than the physical-training group.

The Science behind the Study

- To understand the extraordinary results of the Shackell and Standing study, consider how your brain controls your muscles. Contraction of a muscle is caused by a continuous train of signals sent from the brain via the spinal cord to the efferent nerves embedded within the muscle tissue. As these neuronal signals arrive, muscle fibers contract.

- The overall power that a muscle produces is a function of how big the muscle fibers are and how many of the muscle fibers contract. When you use physical training to enhance muscle strength, you increase how many fibers respond, and you enhance the size of the muscle fibers. When you fatigue and damage those muscle fibers during physical training, the body responds by repairing them and making them a little bigger than they were initially. Physical training makes muscles bigger.

- Mental training, by contrast, doesn't change the size of muscle fibers very much. Imagery, however, seems to increase the strength of the signals sent to the muscles. After imagery practice, when you make an actual movement, your motor cortex will become more active than it otherwise would be. A greater number of action potentials is conveyed to the muscles, causing a greater number of muscle fibers to respond when your brain calls on them to do so. The result is that more force is generated by the muscles.



When you use physical training to enhance muscle strength, you increase how many muscle fibers respond, and you enhance the size of the muscle fibers.

Imagination and Neural Processing

- Many areas of the brain participate in mental-imagery processes. It has been known for more than a century that crucial visual processing takes place in the visual cortex in the occipital lobe, located in the back of your brain.

- There are connections from certain places on your light-sensitive retina to particular locations in the occipital lobe. If light is projected onto your eyes, a region of the visual cortex will become active.

- Stephen Kosslyn and his colleagues placed study participants in a functional magnetic resonance imaging (fMRI) scanner in complete darkness. Kosslyn then asked participants to imagine a spot of light. When they did, an area of the occipital lobe became active. When he asked them to imagine a larger spot of light, a larger area of the occipital lobe became active.

- This basic relationship between imagination and neural processing has been found across a large number of domains. When you imagine moving your arm, the part of your cortex that is activated when you actually move your arm becomes active. When you imagine hearing a sound, activation appears in the auditory cortex.

Four Key Aspects of Imagery Practice

- If you've ever watched a professional athlete—or even any expert—you've likely seen how visual imagery is used to enhance visuomotor performance. Before performing, good athletes will use their imagination to simulate the action. Such a strategy is well supported by research. Performance is essentially always better when athletes imagine the task beforehand.

- Hundreds of studies have provided evidence for the effects of imaging performance. Large-scale analyses have pulled together data from thousands of participants and identified four key aspects of imagery practice.

1. The mental rehearsal should be from a first-person perspective. When you imagine making a golf putt, you should mentally view it from the perspective of your own eyes.
2. The imagery should be multimodal. To get the most out of imagery, you want to mentally simulate the full sensory experience—including even the parts that don't seem directly relevant to performance.
3. The imagery should be precise. Our mental images of things also contain conceptual information. Indeed, for mental visual images, the identity of the object is much clearer than the sensory information itself.
4. Imagine succeeding when you perform the task. In the golf example, the ball should go in the hole. Mental images not only activate sensory and motor processing areas of the brain, but they also activate semantic processing. Semantic information is associated with labels, such as "success" and "failure."

The Science behind the Semantics

- Patterns of activity in the sensory areas of our cortex produced by actual sensory input are created in a bottom-up fashion. The activity of sensory neurons identifies low-level features of the input and builds up a mental representation of the state of the outside world.

- On the other hand, patterns of activity in the sensory areas of our cortex produced by imagined sensory input are created in a top-down fashion. Our brain starts with a high-level, rough description of the imagined world and then activates the lower-level features that are associated with it. Starting with a particular high-level, semantically labeled description of the world is a crucial part of effective mental imagery.

- Although imagined visual images are processed in the same regions of the brain as actual visual images, they aren't the same thing. When we think of those parts as separate objects, they retain that identity in the image. Integrating them together as a unit simply doesn't work.

Your mental images are images plus attached information about the identities and roles of the parts. For a successful visual-imagery practice, it's important that your mental rehearsal of the activity contains that semantic label of "successful" right from the start.

Long-Term Benefits of Mental Imagery

- In addition to research supporting an immediate advantage of using mental imagery, many studies have shown long-term benefits.

- If you find yourself suffering through an injury or experiencing physical fatigue that prevents you from practicing or exercising, here's how to improve. It's a fact that your muscles get tired faster than your brain. Even when your body isn't ready for more, the brain might be. This can be an especially good time to use mental practice as a supplement to physical practice. There is good evidence that mental imagery, used three or four times per week, can result in improvements in a wide range of different physical activities.

Therapists work on flexibility and strength of the affected limb, and over time, some function is typically recovered.

- Mental imagery may even help you to recover faster from an injury. An extreme case has been studied by Jennifer Stevens and her colleagues. They recruited patients who had suffered strokes that resulted in near-paralysis of the arm on one side of the body. The normal rehabilitation strategy for this condition takes a bottom-up strategy: Therapists work on flexibility and strength of the affected limb, and over time, some function is typically recovered.

- Stevens and her team developed a top-down strategy, in which participants engaged in mental-imagery exercises. They imagined moving the limb in ways that it could no longer move. When this practice was used in combination with standard rehabilitation techniques, participants exhibited increased recovery of motor function. Their limbs even got stronger when imagery was used.

Hebbian Learning

- Mental imagery has the immediate effect of warming up the particular brain circuits that will ultimately be responsible for controlling an action. Because mental imagery provides low-level activation to these brain regions, they are able to function more efficiently when the time comes to perform for real.

- A second, slower effect of mental-imagery practice has to do with refining patterns of neuronal connectivity. Everything you do is controlled by networks of neurons that fire in a precise, coordinated order. When you imagine performing a task, those neurons become more strongly connected to one another.

- Donald Hebb was noted for discovering that when two neurons become active at the same time, they tend to become more strongly connected to each another. Conversely, if there are two connected neurons and only one of them is active, then the connection between them tends to be weakened. This fundamental property of neurons has come to be known as Hebbian learning, and it has been implicated in nearly all experience-dependent learning that we do.

- Hebb summarized the process with a very simple phrase: “Neurons that fire together, wire together.” When you engage in mental imagery, you are giving your neural networks extra repetitions of a behavior in which they can engage in this Hebbian learning process.

Questions to Consider

1. When you practice a new activity with the goal of developing expertise, it is critical that you get feedback on your behaviors. For example, after you try to make a basketball free throw, you need to know if your actions produced a successful shot. In imagery practice, however, your brain generates the outcome. How can both real-world and imagery practice be so beneficial?
2. There is strong evidence that positive imagery helps to enhance performance and outcomes. Some people, however, engage in too much imagery: They dream big but never seem to make those dreams a reality. How can you tell when you have engaged in too much imagery practice and not enough real-world action?

Suggested Readings

Doidge, *The Brain that Changes Itself*.

Finke, *Principles of Mental Imagery*.

Enhance Performance with Imagery

Let's explore what imagination can do. Get to a safe place, have a seat, then close your eyes and imagine that you're standing with your legs about shoulder width apart. Don't actually stand, I just want you to close your eyes and imagine standing. Imagine how you're standing in detail. Feel the pressure of the solid floor against your feet. Feel your body swaying back and forth, ever so slightly, the way that it usually does when you stand still like this. In your right hand, imagine holding a heavy barbell. The barbell is very heavy, heavy enough that you have to grip it very tightly with your hand to keep it from falling. The texture of the metal is rough, and the barbell feels cooler than your skin where it touches your hand. Get a clear image of that in your mind—see and feel it.

Now, when I say go, I want you to bend your right arm and lift that heavy barbell. Imagine lifting it all the way to your shoulder. OK, go ahead and imagine that now. In your imagination, feel the strain of that lift. When you've bent your arm as far as it will go, lower the barbell slowly until it's back at your side.

OK. If you've been following along, you can open your eyes now and relax—definitely relax that arm. You've physically done nothing with that arm while I've been talking here, but your brain just did a lot of work imagining your body doing something. You just did one repeat of that barbell curl exercise, but in some studies people have been asked to imagine doing many. When you do so, your brain gets tired.

What's even more amazing, your muscles get a workout as well. One of the best studies demonstrating this focused not on the arm muscles but on the hip flexors. The hip flexors are muscles at the top of your legs, around your hips, that contract to bend each leg up, pivoting around the pelvis. This is an important muscle group. When you kick your leg forward, or even just swing your leg forward as you take a step, this is the muscle group that makes it happen. Actually, even as I'm just standing here, the hip flexors are helping to hold me upright.

Erin Shackell and Lionel Standing recruited participants and tested the strength of their hip flexor muscles using an electronic device called a sphygmomanometer. Say that three times fast. The researchers used that sphygmomanometer to record the maximum pounds of force that each participant could produce on that first day of the study. Once the participants' baseline strength had been assessed, they were randomly assigned to one of three conditions. The control participants just left and returned two weeks later. Participants in the physical training condition undertook a strength-training program for their hip flexors. Five days per week, for two weeks, these participants visited a gym and completed four sets of eight repeats of lifting a weight with a hip flexor exercise machine.

A hip flexor machine has a padded bar that you place against the front of your leg. This bar is attached via a cable and a pulley wheel to a stack of weights. As you try to lift that leg upward, you have to lift not just the weight of your leg but also the stack of weights. You can adjust how many weights are on that stack. In the experiment, the weight was gradually increased over the course of the sessions.

Participants in the mental training condition were shown the hip flexor machine during the first visit—as all of the participants were—but they did not use it for the next two weeks. Instead, they imagined using it. Specifically, they imagined performing four sets of eight reps five times per week, the same exercise that the physical training participants actually performed. Over the course of the two weeks, they were instructed to imagine using heavier and heavier weights, just as the physical training group actually did.

At the end of the study, everyone returned to the gym for a repeat of the strength assessment that they'd completed at the start of the experiment. The physical group increased their performance on the strength test by an average of 36 pounds. The control group didn't change significantly. The mental training group? Without ever touching the weight machine, their hip flexor strength improved by 32 pounds, just a few pounds less than the physical training group.

There's a very specific tip here for outsmarting yourself. If you want to train your muscles to be stronger, you can exercise them physically, or you can train them mentally. When you imagine performing a strength exercise, the muscles that you imagined using will increase in strength. This study was conducted only with the hip flexor muscles, but there's no reason to think that the biology of this particular muscle group is different in this context than any muscle group. Indeed, this study has been replicated many times with different muscle groups: the lower leg, the upper arms, even the muscles that control the wrists and fingers.

When someone has to wear a cast for several weeks due to an arm injury, they typically lose a lot of arm strength during that period. Imagining flexing and moving the arm—even when it's impossible to actually do so—results in stronger arms than those of non-imagery control group participants.

Now, I don't want to oversell this tip here. You might be thinking to yourself, "This sounds great. I never need to exercise again, ever. I'll just find a comfy chair and think about exercising." That would be a mistake. To understand why, we need to consider how your brain controls your muscles. When you contract a muscle—say, your biceps—and produce a motion of some parts of your skeleton, it's caused by a continuous train of signals sent from the brain, via the spinal cord, to the efferent nerves embedded within the muscle tissue. Any given muscle is made of thousands of tiny muscle fibers. As these neuronal signals arrive, some of those muscle fibers contract. This shortens the muscle, and the movement occurs.

If you hold the muscle at a particular level of contraction—for instance, if you hold your arm in a static position—the muscle fibers take turns contracting. Those muscle fibers that contracted when the signal first arrived will stay that way for a few moments and then relax. At the same time, other muscle fibers contract, such that the overall muscle retains a consistent length.

The overall power that a muscle produces is a function of two things: how big the muscle fibers are, and how many of the muscle fibers contract. When you use physical training to enhance muscle strength, you increase how many fibers respond, but mostly you enhance how big the muscle fibers are. When you fatigue and damage those muscle fibers during physical training, the body responds by repairing them and making them a little bigger than they were before. Physical training makes muscles bigger.

Mental training, by contrast, doesn't change the size of the muscle fibers very much. Some research suggests not at all. Imagery seems to increase the strength of the signals sent to the muscles. After imagery practice, when you make an actual movement, your motor cortex will become more active than it otherwise would have. A greater number of action potentials are conveyed to the muscles, causing a greater number of muscle fibers to respond when your brain cells call upon them to do so. The result is that more force is generated by the muscles.

So there are still many benefits to actually exercising, as opposed to merely imagining it. Your heart, lungs, circulatory system will all benefit from physical training in ways that mental training won't help. Real physical training burns a lot more calories, so your waistline may also benefit from physical training. Still, the fact that imagining something could have this type of effect on muscle strength seems amazing, at first anyway. And yet, this fits very directly into a lot that's been discovered about how the brain makes use of something that researchers refer to as mental imagery.

This leads us to a whole category of tips for outsmarting yourself in this lecture. You can use your mental imagery to enhance many aspects of your abilities—your visuomotor abilities, cognitive abilities, even social and emotional abilities. The human imagination is a powerful thing, but few of us have any idea how directly powerful imagination can be. A writer of inspirational slogans, William Arthur Ward is often quoted for saying, "If you can imagine it, you can achieve it. If you can dream it, you can become it." This sounds to most like a smarmy quote from a motivational poster, or maybe a greeting card. Ward was no cognitive neuroscientist, but there's a great deal of cognitive neuroscience research that suggests that this idea is more correct than we realize.

Many areas of the brain participate in mental imagery processes. One of the first areas where this was identified was in the visual cortex. It's been known for more than a century that important visual processing takes place in the back of your occipital lobe, located in the back of your brain. This finding wasn't based on high tech neuroimaging. When people would suffer damage to this part of the brain, they would often lose the ability to see. If you've ever suffered a blow to your head and seen stars afterward, that's because your visual cortex has been damaged. Those stars that you see are neurons in this region firing off bursts of activity, in some cases as they die. Don't worry, by the way. As long as that doesn't happen too often, your visual cortex is very robust in rewiring itself to deal with slight damage.

If I were to reach into your skull and stimulate a group of neurons in a particular location in your occipital lobe, you would see a spot of light. If I were to turn out the lights and then shine a light on the location where you'd seen that spot of light, then the same neuron section that I'd just stimulated would become active. I'm going through this to make clear that there are connections from particular places on your light-sensitive retina to particular locations in the occipital lobe. If I project a small spot of light right onto your eyes, a small region of the visual cortex will become active. If I shine a bigger spot of light onto your retina, then a bigger region of the visual cortex will become active.

OK, this occipital area is for processing visual stimuli, right? Well, yes, but it does more. Stephen Kosslyn and his collaborators had study participants lay in an fMRI scanner in complete darkness—there was no light. Not surprisingly, there was no concentration of activity in the occipital lobe. Kosslyn then asked the participants to imagine a spot of light. When they did so, areas of the occipital lobe became active. When he asked them to imagine a larger spot of light, a larger area of the occipital lobe became active.

Now, the level of activity was substantially lower than what would have been seen with actual light, but the increase in activation was highly significant. The take-home message of this study is clear. When you imagine a visual stimulus, you use your visual sensory systems to do so. When you imagine something very vividly—vividly enough that it feels like you can almost see it—that makes complete sense. The same neurons that would be active if you could see it are activated via mental imagery.

This basic relation between imagination and neural processing has been found across a large number of domains. When you imagine moving your arm, the part of your cortex that's activated when you really move your arm becomes active. When you imagine hearing something, activation appears in the auditory cortex. Within each sensory modality, imagery activity is relatively specific. For instance, if you imagine a blue stimulus it will cause more activity in cortical regions that process color information than, say, if you imagine a gray stimulus.

If you've watched professional athletes, or even any experts for that matter, you've likely seen how visual imagery can be used to enhance visuomotor performance. When long jumpers on the Olympic track and field team stand at the top of the runway, they prepare to sprint down the runway, plant their foot in just the right spot, and then launch themselves as far as possible before landing in a sand pit. As they stand at the top of that runway, almost all of them seem to do what looks like an odd little dance. They stare down the runway, they move their arms back and forth, and then they make a larger movement at the end of that little dance.

They're using their imagination to simulate the action before they perform it.

They have good reason to do so, a reason that's well supported by research: it works. If you have athletes perform with and without first imagining the task, the performance is essentially always better when preceded by the imagined condition. If you enjoy any athletic activity, this is a tip that you can use to get more out of your game. Before you hit a shot in golf, you should imagine it. Before you hit a serve in tennis, you should imagine it. Before you undertake any action that requires sensory and motor precision for success, mentally practicing it will enhance performance. There've been literally hundreds of studies that have provided evidence for this—in golf, tennis, high jumping, basketball, even musical performance. Large scale analyses have pulled together data from thousands of participants and identified aspects of imagery practice that seem to be key. I want to highlight four of them here.

First, the mental rehearsal should be from a first-person perspective. When you imagine hitting a perfect putt, it should be as you would see it from the perspective of your own eyes. Now, you can certainly imagine someone else hitting that putt, but to get the greatest benefits from pre-performance rehearsal, you should imagine seeing the performance from inside your own head.

Second, the imagery should be multimodal. When you actually perform some task, all of your senses will be on. To get the most out of imagery, you want to mentally simulate all of that, even the parts that don't seem directly relevant to performance. When I asked you to imagine lifting the barbell at the beginning of this lecture, I pointed out a lot of details that might have seemed extraneous—the feel of the floor on your feet, the texture and temperature of the barbell in your hand. I could have just said, "Imagine lifting a heavy barbell—go." You would've imagined it, but in a much less vivid fashion. The more vivid a mental image is, the more regions of the brain will be recruited for the processing, and the more likely a successful outcome of the action itself will be.

To stick with the putting for the moment, you would obviously want to imagine the ball, the putter, and the target hole, but you also want to imagine the look of the grass, the sound of the club striking the ball, the feel of the club in your hands. Note that once you begin to perform the action, you should stop imagining it. Imagining the action while performing it would certainly lead to distraction and disrupt performance.

Third, the imagery should be precise. Up until this point in the lecture, I've described mental imagery as almost exactly like real perception and action control. The same neural circuits are activated. The activation level of those neurons is lower, but, other than that, the studies I've described suggest that it's identical. Sensory and motor control areas of the brain are not the only areas affected by mental imagery, however. Our mental images of things also contain conceptual information about those images. Indeed, for mental visual images, the identity of the object is far clearer than the sensory information itself.

To illustrate this, let's create another mental image, an easy one this time. It's something you've likely seen thousands of times: an American penny. Close your eyes and imagine it now. Make it as vivid as possible in your mind. Let's make it a shiny, brand new penny. See that copper hue. Imagine what the penny would feel like if you picked it up and handled it. Take a look at the back side, maybe there's the Lincoln Memorial. OK, now flip it back over.

Do you feel confident that you can imagine that penny clearly? For all of you, the answer is likely yes. Who's on the front of the penny? Lincoln, right? Right. You can see in your mental image Lincoln's profile. You can see the hair, the nose, the collar of the shirt. If I were to ask you if you have a vivid image of this, almost everyone would say yes. OK. Which direction is he facing, to the left or to the right?

If you're like most people, your image just started changing. Sometimes Lincoln is facing left and sometimes right. The image that you were confident about just a moment ago is now called into question, at least part of it. It's likely you still feel confident about Lincoln's profile, the color of the penny, its size. But which way he's facing? Somehow that's not clear.

He's facing to the right, by the way. While we may have seen a penny countless times, and we're aware of what it looks like generally, most people never actually encode whether Lincoln is looking to the left or the right. You have now, of course. This penny imagery example demonstrates this idea that images are as detailed as we allow them to be. Your image can and will incorporate the direction of Lincoln's profile if you want it to, if having the precise setup of the penny in mind is important to you, but in order for the image to have that specificity, you have to will it into place.

If you want to use imagery to enhance performance, this is exactly what you need to do. If you just loosely imagine swinging a golf club, that's not going to help very much. It's when you imagine the specifics of that swing, or whatever you want to improve, then that detail enters the processing, and the performance improves.

Some studies have suggested that, in order to make your imagery even more precise, you can imagine parts of your future performance in slow motion. By going slowly, carefully through a critical part of that action, you can be more precise in your planning. Before you actually go ahead with the real action, however, it can be good to do at least one last run through at full speed.

OK, to enhance performance, mental imagery should be from a first-person perspective, multimodal, and precise. A fourth aspect of effective imagery is that you should imagine succeeding when you perform the task. In this golf putting example we're considering here, the ball should go in the hole. That sounds like an obvious feature of good imagery, but it connects with a much broader range of things that happen when you imagine something.

Mental images activate sensory and motor processing areas of the brain, but they also inherently activate semantic processing. Semantic information is associated with labels, things like success and failure, concepts like confidence and anxiety. When you form a mental image as part of preparing to perform some action, it's critical that these semantic labels be included as well. By understanding this aspect of imagery, you can improve your use of them in the domain of visuomotor action control. And it turns out you can use imagery to enhance things that have nothing at all to do with sports and hand-eye coordination. Let's consider the semantic aspects of mental imagery in a little more detail.

If a pattern of activity in sensory areas of our cortex is produced by actual sensory input, it's created in what's called a bottom-up fashion. The activity of sensory neurons identifies low-level features of the input and builds up a mental representation of the state of the outside world. If a pattern of activity in sensory areas of our cortex is instead produced by imagined sensory input, then it's being created in a top-down fashion. Our brain starts with a high-level, coarse description of the imagined world, and then activates lower level features that are associated with it. Starting with a particular high-level, semantically labeled description of the world is thus a critical part of good mental imagery.

Let's consider another simple example this time. Let's build a mental image from scratch from simple geometric figures. You can imagine drawing this on a piece of paper if you'd like, or you can just sort of imagine shapes forming in front of you, perhaps on a computer screen, perhaps floating in the air. OK, here we go.

First, imagine a symmetrical triangle. The base should be at the bottom. The other two lines should be identical in length and should be a little bit longer than the base. If it helps, it should be an isosceles triangle. OK, hopefully you have your triangle now. Next, I want you to add a vertical line that's the same as the height of the triangle. Place that vertical line in your image so that the top of the line touches the triangle at the center of the base. OK? Good, vivid mental image here. OK, triangle has a vertical line extending downward from it.

Let's add one more thing to your mental image: a long horizontal line, about twice as long as the vertical line. Place the horizontal line so that the bottom of the vertical line touches the center of the horizontal line. Got it? OK. You have a mental image now. Triangle, with a vertical line extending below it, and a horizontal line centered at the bottom of that line. You should have a very clear mental image of this. What is it?

Most people find it very difficult to recognize this figure in a mental image. When I show it to you in a second, you'll be able to identify it very easily, however. It's a simplified picture of a pine tree. Even when you know what it is, however, if you're like most people, your reaction is "Huh? A pine tree?" Imagined visual images are processed in the same regions of the brain as actual visual images, but they aren't the same thing. When we think of those parts as separate objects, they retain that identity in the mental image. Integrating them together as a unit just doesn't work. Your mental images are images plus attached information about the identities and roles of the parts. For the visual imagery practice that I've been discussing here, it's important that your mental rehearsal of the activity contain that semantic label of successful right from the start.

I've been describing mental imagery in this lecture in terms of preparing to perform an action. In addition to studies supporting this immediate advantage of using mental imagery, there are many studies that have shown long-term benefits from regular mental imagery practice. Even if you aren't on the golf course, for instance, you can sit quietly, close your eyes, and practice playing golf. You can do the same thing for tennis or any other sport. As you work on your game on a regular basis in this way, you'll likely see improvements.

If you find yourself suffering through an injury or just physical fatigue that prevents you from practicing some activity as much as you'd like, there's a very direct tip here for how to improve. Your muscles get tired faster than your brain. It's not at all uncommon for any athlete, professional or not, to find themselves physically too fatigued to practice well. But, even when the body isn't ready for more, the brain might be. This can be an especially good time to use mental practice as a supplement to physical practice. There's good evidence that mental imagery practice, used three or four times per week, can result in improvements in a wide range of different sporting activities.

Mental imagery practice may even help you recover from the injury itself faster. There's an extreme case that's been studied by Jennifer Stevens and her collaborators. They recruited patients who had suffered strokes that resulted in near paralysis of the arm on one side of the body. The normal rehabilitation strategy for this condition takes a very bottom-up strategy. Therapists work on flexibility and strength of the affected limb. Over time, some function is typically recovered.

Stevens and her team developed a top-down strategy in which participants engaged in mental imagery exercises. They imagined moving the limb in ways that it could no longer move—flexing, lifting, performing simple motor tasks even. When used in combination with standard rehabilitation techniques, the participants exhibited increased recovery of motor function. Their limbs even got stronger when imagery was used. That was a surprise to many rehabilitation researchers, but, given research like the mental weight training study that we considered at the start of this lecture, that seems like exactly the sort of result that we should expect.

What changes in the brain when we use imagery? How does imagery exert these effects? One effect of mental imagery is that relatively immediate effect of warming up the particular brain circuits that will ultimately be responsible for controlling an action. By providing some low-level activation to these brain regions, they're able to function more efficiently when the time comes to perform for real.

A second, slower effect of imagery practice has to do with refining patterns of neuronal connectivity. Everything you'll ever do is controlled by networks of neurons that fire in a precise, coordinated order. If you're hitting a shot in golf, you need to pull the club back in a very particular way, a specific position in space, with a very specific posture. When that's set, then you begin swinging down and forward; this changes to a follow through stage. All of these steps are controlled in a precisely timed order by a sequence of neuronal circuits.

When you imagine performing a task like this, those neurons get more strongly connected to one another. Donald Hebb was famous for discovering that when two neurons become active at the same time, they tend to become more strongly connected to one another. Conversely, if there are two connected neurons and only one of them is active, then the connection between them tends to be weakened. This fundamental property of neurons has come to be known as Hebbian learning, and it's been implicated in almost all experience-dependent learning that we do.

Hebb summarized the process with a very simple phrase: "Neurons that fire together, wire together." When you engage in mental imagery practice, you're giving your neural networks extra repetitions of a behavior in which they can engage in this Hebbian learning process.

Mental imagery isn't just useful for improving your putting, tennis, and other sports performance. All of the techniques I've described here have also been shown to be successful in terms of musical performance. If you want to enhance your ability to play some piece, say, on the piano, you need to practice, of course. If, in addition to physically practicing the piece, you also spend time mentally practicing as well, you're likely to notice improvements. This will be especially true if you engage in imagery from a first-person perspective, in a multimodal, precise, and successful fashion.

Imagery has been shown to be useful outside the domain of visuomotor action as well. If you're preparing to give a speech, it's natural to be a little nervous about that. I've been doing this professor thing for decades now and periodically I still get nervous. A simple thing you can do to overcome that fear is to vividly imagine giving the speech. As with motor performance, you want to imagine it from a first-person perspective—see the audience in your mind's eye the same way you expect to see them in real life. You should imagine things in a multimodal fashion. If you can, get a look at the room where you'll give that speech in advance so you can make your mental simulation as vivid as possible.

You should imagine the speech precisely. Think through the detail of what you'll say and how you'll say it. Finally—and this is especially important for dealing with the anxiety—imagine the speech going well. Imagine the words coming out the way you hope they will. Imagine people applauding at the end. Imagine the smiling congratulations that you'll get for a job well done.

This process of using imagery to reduce performance anxiety is very related to how many phobias are treated. If you practice staying relaxed and focused in the low-stress environment of your own mind, then you'll likely transfer that learning to the real-world environment when the time comes.

Whatever you like to do, whatever you'd like to do better, imagery provides an exciting, potentially powerful way of enhancing that performance. It's often good to think strategically about these things, about things you want to change about your behaviors. These thoughts usually take place at a very cognitive, conscious level. After you've completed those plans, it's important to imagine putting them into action. By thinking from a first-person perspective, in a multimodal and precise fashion, and by envisioning successful performance, you can build connections between that strategic thinking and the parts of your brain that actually implement your actions. If you can imagine it in the right way, you can make more rapid progress toward achieving it.

Lecture 13

Overcome Your Aging Brain

Beyond about 20 years of age, many basic aspects of human brain function decline. While currently there is no way to fully and permanently prevent this process, there are a variety of ways to slow the decline and even to compensate for the decline that does occur. The human brain seems remarkably capable of compensating for age-related changes as long as you remain active and engaged in both routine as well as novel challenging behaviors. What's more, these behaviors also have the potential to greatly enrich the quality of your life—and the function of your brain—at any age.

Age-Related Decline of Cognitive Function

- Cognitive neuroscience research suggests that an effective way to fight age-related mental decline is to take up an activity you have never done before. It is best if you find the activity very challenging—mentally and perhaps physically. Try to make it a new activity every month.

- To understand why this is a successful strategy for countering the effects of aging on the brain, consider what causes the decline of mental function. Until you are about two years of age, your brain grows in both its size and the number of neurons. During early development, the brain is programmed to overproduce neurons.

- Then, the process during childhood and early adulthood involves the planned elimination of an enormous number of these neurons. This process, often referred to as neuronal pruning, is central to improving the function of the brain as we mature.

Cognitive neuroscience research suggests that an effective way to fight age-related mental decline is to take up an activity you have never done before.

- Around 20 years of age, the human brain seems to peak in terms of many basic functions assessed by cognitive tests. This is the time when most people are fastest in reaction time and decision-making ability. Our capacity to alternate rapidly between two different tasks is best around this age. Our ability to focus our attention completely on one location in space while ignoring peripheral locations peaks as well.

- These peaks, however, refer only to specific tests of isolated cognitive faculties, such as memory, attention, and processing speed. They do not apply to complex behaviors, such as writing, problem solving, and creativity. In terms of many complex behaviors, humans usually continue to improve beyond 20 years of age.

Procedural and Implicit Memory

- While age-related decline in cognitive function is significant, it is smaller than we used to think. Florian Schmiedek and her colleagues looked in detail at cognitive function differences between younger and older adults. They recruited a large number of participants between 20 and 30 years old and another group between 65 and 80 years old. The participants performed a variety of different cognitive tests 10 times on 10 different days over the course of about two months.

- On memory tests, young adults scored around 0.25. Older adults scored around 0.15. That seems like a significant drop, but this test was aimed at the very peak of rapid encoding and memory abilities. When the task was slowed down enough, these memory differences became substantially smaller.

- It's also worth noting that some abilities decline much more slowly than others. For instance, our procedural memory—the memory for how to perform tasks—declines very slowly. What's more, our implicit memory seems barely to decline at all. Implicit memory is our encoding of information and associations that seem familiar, even if we can't explicitly remember where the knowledge comes from.

Brain Shrinkage and Neuronal Death

- A main reason that basic cognitive faculties decline beyond 20 years of age is that the brain shrinks. Neurons die off faster than they are replaced, leaving us with a smaller brain.

- The cells in your brain are organized in an extraordinarily intricate fashion. Your memories and skills are built into the patterns of connections between billions of brain cells. When new cells are added into this system, the process of integrating them into those existing circuits takes a lot of work. Those new cells have to learn to contribute to the existing computational system. As neurons die off, the brain loses some of its computational ability.

- The human brain is remarkably robust, however. When we encode a memory, it's not saved in a single place. All our memories are encoded across thousands—in some cases, millions—of neuronal cells. If a few of those cells die, the memory will still be accessible. If a few neurons involved in performing some skill are destroyed by injury, you will still be able to perform that skill. But if enough neurons die off, eventually the system is compromised, and the basic abilities measured by cognitive testing decline.

- Neurons die as a result of physical injury, disease, or circulatory issues that prevent blood from flowing to a region of the brain. The majority of neuronal death, however, is a result of simple inactivity. Neurons exhibit bursts of electrochemical activity called action potentials that cause signals to be sent to neurons nearby. If one neuron receives enough signals from excitatory neurons around it, then that neuron may be excited enough to exhibit its own action potential.

- Action potentials make up the code that our brain uses to perform computations that support our perception, cognition, and action control. Those action potentials are also a critical part of the neuronal cells' physiology. It's part of how they pull nutrients and oxygen from the bloodstream and how they expel waste products. If a neuron stops exhibiting action potentials long enough, it will starve.

Try New Activities

- The best way to reduce age-related brain shrinkage is to keep your brain active. Physical activity—even moderate exercise like walking—inspires neural activation and even the creation of new neurons in certain areas of the brain.

- One of the best ways to inspire broad-based neural activity, however, is to try new activities. As we become more experienced at some activity, our brain becomes faster and more accurate in producing the proper actions at the right times. As we become very expert at that activity, several lines of research have shown that we don't employ more of our brain to support the activity. On the contrary, we learn to use less of our brain, developing specialized circuits that rapidly, automatically mediate the task performance.

- To maintain brain health, you need to stimulate your brain. What is counterintuitive is that one of the best ways to broadly stimulate brain activity is to take on new activities—activities for which you are specifically not an expert. The more challenging the task, the more of your brain will be recruited to support it, and the less your brain will shrink.

Laugh a Lot

- There is good evidence that laughter helps keep your brain especially stimulated. A great deal of progress has been made in understanding our brain's processing of humor. One of the central mechanisms is incongruity detection and then resolution.

- As your brain identifies incongruity and then corrects its initial interpretation of the incongruity, it engages a remarkably wide range of brain areas. Language areas become more active when a stimulus is funny. The medial prefrontal cortex, posterior cingulate cortex, precuneus, superior temporal gyrus, and superior temporal sulcus show similar boosts in activation. Laughter is also associated with a substantial release of dopamine into the pleasure circuits of the brain.

- When you watch funny movies, listen to or read funny stories, or have a funny conversation with a friend, your brain lights up in terms of widely distributed activity.

Overcome Limitations

- To outsmart the aging brain, in addition to trying new activities, it's important to keep performing familiar activities. As our basic cognitive faculties slowly decline, one of the ways we maintain our performance—indeed, one of the ways we often improve our

Laughter is associated with a substantial release of dopamine into the pleasure circuits of the brain.

performance—is by developing ways to compensate for those losses.

- Timothy Salthouse and his colleagues conducted a study of how well people type as they age. Typing tests allow researchers to assess both overall performance and basic cognitive functions. A group of experienced, expert typists were recruited for the study. They visited the Salthouse lab and completed several different types of tests. The first was to type several passages as quickly and accurately as possible. Participants also completed a wide range of tests of basic cognitive, perceptual, and motor abilities related to typing.

- The researchers determined that there is almost no effect of age in the actual typing speed of experienced typists. While a 70-year-old typist is slower in terms of cognitive and motor assessments, when you present these typists with a passage of text and ask them to type it as quickly as possible, their speed is almost identical to that of younger experienced typists.

- Salthouse performed several clever experiments in which he restricted the number of characters ahead on the line of text that the typists were allowed to look. If you are looking only 10 characters ahead on the line, then if researchers block characters 15 and more ahead of where you are currently typing, it won't affect you. However, if researchers block all the characters beyond 5 ahead of where you are looking, then your performance will suffer.

- The experimenters found that older typists were maintaining their speed by looking farther ahead in the line of text than the younger typists. As their basic sensory and motor capacities declined, they discovered new strategies to overcome their limitations.

Compensate for Cognitive Loss

- In many domains, adults continue to improve in mental performance beyond 20 years of age. Imagine that you have developed the ability to perform some task at 20 years of age—for example, driving a car in busy city traffic. Your brain has organized itself to process the relevant sensory information, make strategic plans, and mediate your control of the vehicle. If your brain tries to do exactly the same thing in exactly the same way when you are 40 years old, then your performance of this task will be worse.

- However, if you learn to drive better by the time you are 40, you may be able to compensate for that basic cognitive loss. For example, you may learn more efficient routes to take at particular times of the day. You may learn to recognize earlier when pedestrians are about to walk into the street. You may learn that when your car makes a particular noise, then pressing the accelerator won't produce as much speed as it usually does.

- If the 40-year-old you is able to use these extra sources of strategic information well enough, you might not simply be as good as the 20-year-old driver, you might even be better.

Questions to Consider

1. Much research literature on overcoming the effects of aging describes an ongoing battle—with physical decline on one side and expertise increase on the other. Performance improves beyond 20 years of age because the expertise side is making gains. If this theory is correct, what does it indicate about how we should most effectively stave off the effects of age on the brain?
2. Assessments of mental decline associated with aging are overly influenced by the presence of early-stage dementia in older populations. For the great majority of the population who are not affected by dementia, the declines in mental performance are often very small. If people suspect they are declining quickly, however, what steps should they take to minimize future decline?

Suggested Readings

Cabeza, Nyberg, and Park, eds., *Cognitive Neuroscience of Aging*.

Horstman, *The "Scientific American" Healthy Aging Brain*.

Overcome Your Aging Brain

Aging—particularly certain aspects of it—can be really hard, but it's clearly better than the alternative. There is an unsettling fact to face as we start this lecture on aging. Beyond around 20 years of age, basic aspects of human brain function decline. There is currently no way to fully and permanently prevent this process, but there are a variety of ways to slow the decline—and even compensate for the decline that does occur.

One of my favorite things about tips for outsmarting your aging brain is that these strategies don't just fight the effects of aging on the brain—doing the things I suggest have the potential to greatly enrich the quality of your life—and the function of your brain—at any age.

Want to keep your brain young? Think of something that you've never done that you could do today. Ideally, it's something you want to do, maybe have always wanted to do. It should be an activity that you can perform in a single day or less. Many people would someday like to take an around the world trip. That's great, but for our purposes right now, I want you to focus on something that can happen on a smaller time scale.

The possibilities are almost limitless. Take a lesson in how to play the electric guitar. Draw a self-portrait. Find a karaoke bar and sing in front of an audience. Write a poem. Ride a roller coaster. Figure out how to knock a hole in one of your walls and put in a new door. Go to a museum that you've been driving by for years but never managed to visit. Take a sketchpad with you and draw one of the artworks that you see there. Reupholster a chair. Cook mole sauce from scratch. Anything will do here as long as it is something you have never done before.

Once you've thought of your targeted novel activity, pull out a calendar, and write it on the first day of next month. Before that month ends, do two things. First, do the activity. Once you've completed the activity, write done in big capital letters on the date that you did it. The second thing you should do that month is to come up with another activity and write it on the first date of the next month. Rinse and repeat.

I should emphasize that you don't have to do these activities well. In fact, for reasons I'll describe here, it's best if you find the activity very challenging—mentally and maybe even physically. It's OK if you eventually start repeating these activities, but, for the moment, try to make it a brand new activity every month.

Why does cognitive neuroscience research suggest that this is a good way to fight age-related mental decline? To answer that, let's consider what happens that causes that decline. As we age, our brains shrink. Your brain grows in terms of size and the number of neurons until you are around two years of age. The brain is programmed to greatly overproduce neurons during early development. One of the most important processes of brain development during childhood and even early adulthood involves the planned elimination of an enormous number of these neurons. This process, often referred to as neuronal pruning is central to improving the function of the brain as we mature.

Around 20 years of age, the human brain seems to peak in terms of many of the basic functions that are assessed by cognitive tests. This is the time when most people are fastest in terms of their reaction time, also in terms of how fast they can make simple decisions. Our ability to rapidly alternate between performing two different tasks is best around this age. Our ability to completely focus our attention on one location in space while ignoring other peripheral locations peaks as well.

If I read a list of three randomly selected words to you, and then ask you to repeat them back to me that will be easy. If I make the list longer, say five words or nine words, the task will be harder. At some point, there will be a maximum number of words that you can simultaneously hold in your short term memory. This maximum item span peaks around age 20 as well. As we age, all of these attributes slowly decline.

Let me highlight two very important things at this stage. First, I am only talking about specific tests of isolated cognitive faculties—things like memory, attention, and processing speed. I am specifically not talking about complex behaviors like writing, problem solving, engineering, inventing, creativity, and the like. In terms of many complex behaviors like these, humans usually, continue to improve beyond 20 years of age.

The opera singer Andrea Bocelli didn't even start singing seriously until he was 34. According to most experts, his greatest accomplishments occurred almost a decade later. The great Julia Child started to cook seriously when she was in her late 30s and didn't start teaching others on her famous show until she was around 50 years of age. Penicillin was invented by a guy who didn't seriously start pursuing science until his 30s. This list could go on and on. It's not that we peak in terms of our complex, real-world behavior at age 20. Isolated cognitive faculties peak at that age, but that's very different than overall performance.

How big is the decline in these basic functions? That turns out to be a complex question to answer. Many researchers have found that it's significant, but a lot smaller than we used to think.

Florian Schmiedek and his colleagues looked in detail at cognitive function differences of younger and older adults in a recent study. They recruited a large number of participants between 20 and 30 years of age and another group between 65 and 80 years of age. The participants performed a variety of different cognitive tests 10 different times, on 10 different days, over the course of about 2 months.

One of the tests was of memory. Lists of 36 words were presented, one at a time, for several seconds each. Once the list presentation had finished, the participants had to do their best to recall that list, in order. The score was calculated as the percentage of words correctly recalled, multiplied by a score from 0 to 1 that reflected how accurate the ordering of the words was. A perfect score here would be 1. If you got all of the words correct but scrambled the order, you would be around 0.5.

This is a really hard task. Even someone with a really impressive memory isn't likely to come anywhere close to a perfect 1.0 here. The young adults scored around 0.25. Older adults scored around 0.15. That seems like a big drop, but this is aimed at the very peak of our rapid encoding and memory abilities. When the task is slowed down enough, these memory differences get substantially smaller.

One of the biggest declines in cognitive processing seems to involve speed. As we get older, we need a longer period of time to do certain tasks. As long as we have that time, many of these differences grow substantially smaller, although they never quite disappear.

There's a tip here, not for eliminating the effects of aging, but for minimizing those effects. Take your time. As long as you don't hurry as long as you give your brain a little extra time, its performance will be substantially better as you age.

It's also worth noting that some abilities decline much more slowly than others. For instance, our procedural memory—the memory for how to perform tasks—declines very slowly—some studies suggest almost not at all. Our implicit memory similarly seems to barely decline at all. Implicit memory is our encoding of information and associations that seem familiar, even if we can't explicitly remember where the knowledge comes from. A tip for outsmarting your aging brain comes directly from this. Your procedural, implicit memory is your friend here. By relying on it more, you can sidestep some of the effects of aging.

For example, if you ever have trouble remembering someone's name, there's a tip that sometimes works to bring it back that's based on this implicit memory. As you look at the person's face, you might not be able to remember the name. But just guess to yourself what the first letter of the name is. Maybe I see a man and guess J. Then start thinking of names that start with J—James, Joe, Jeff, John. At some point, you may feel a spark of recognition. Now, this strategy isn't guaranteed to work, but it is often very effective. Implicit memory isn't ideal for remembering many things, but since it works so well as we age, this tip will help you get more out of it.

There's another aspect of this data that mathematical cognitive scientists have addressed recently. Among the young adult sample in this and many other studies, the odds that there are any participants in the early stages of Alzheimer's disease or other age-related dementia is essentially zero. These disorders affect a small portion of the population, most studies estimate between five and seven percent of the population over 65 years of age. The odds that there is someone in the older adult sample in the early stages of the disease is actually quite high. If one in 20 of the participants is affected, then in a sample of 100 participants, it's likely there are several around five.

Alzheimer's disease and related dementias can be devastating to the brain and physical health. As tragic as these diseases are, the brains of most older adults are thankfully not afflicted with them. If you look at the average performance of the older adult group, however, the small number of adults with dementia—perhaps early-phase, undiagnosed dementia—will tend to pull that general average down a lot. If this effect is factored out of the mean, the differences between younger and older brains grown much smaller—in some studies, the effects vanish altogether.

Imagine for a moment that you believed, for some reason, that your right arm was declining in terms of its basic function. That you believed it was getting weaker, less coordinated, and more likely to make big mistakes whenever you tried to use it. How would this belief affect your behavior?

If you're like most people, you would start using your right arm a lot less. If there was something you wanted to do and do well, you would probably use your left arm. Worse still, you might just try to do a lot fewer things out of fear that your declining right arm would cause problems. Your belief that your right arm was declining would become a self-fulfilling prophecy. Your right are would decline. The same thing can happen if you believe that your brain is declining with age, even if your brain is declining only a little and maybe not initially declining at all.

A big outsmart yourself tip for this section of the lecture is to fight against the creeping belief that your brain is declining. Modern society will give you subtle messages that it is. Old people are often portrayed on television and in movies as doddering, sedentary, sometimes generally confused. The scientific literature contains a lot of data to support this assertion, but that data is contaminated by this frequent tendency to not consider healthy versus unhealthy subgroups within the aging population.

My outsmart tip here is to presume, until proven otherwise, that your brain is declining only slowly, if at all, as you age. Not only will this tend to broaden the types of experiences you have, it's likely to minimize the age-related decline itself. If you catch yourself thinking, I can't do that sort of thing at my age. Stop, replace that thought. Maybe even say it aloud, I'm not sure if I can do that sort of thing at my age, but there's only one way to find out. And as our marketing friends at Nike would say, "Just do it."

Why do basic cognitive faculties decline slowly but they still decline—beyond 20 years of age? One of the primary reasons is that our brain shrinks. Neurons die off faster than they are replaced, leaving us with a smaller brain.

The human body is made up of trillions of cells. Those cells die all the time. In some parts of the body, they die very quickly—every cell on the inner lining of your digestive tract dies within a few days. Fortunately, those cells are replaced just as quickly as they die off. The digestive tract works just fine with these fresh, new, inexperienced cells. Cells in other parts of the body die off very slowly.

The cells in your brain are organized in an incredibly intricate fashion. The memories you possess the skills you have the language you know. All of that is built into the pattern of connections between those billions of cells in your brain. Signals are conducted through that network according to those connections to produce all of the behaviors you will ever exhibit.

When new cells are added into this system, the process of integrating them into those existing circuits takes a lot of work. Those new cells have to learn—in a sense—to contribute to the existing computational system.

The neurons die very slowly, but they are created even more slowly. As neurons die off, the brain loses some of its computational ability. Now, the human brain is remarkably robust. When we encode a memory, it's not saved in a single place maybe like it would be in the memory of a computer chip. All of our memories are encoded across thousands, in some cases millions of neuronal cells. If a few of those cells die, the memory will still be accessible. If a few neurons involved in performing some skill you know die off or are destroyed by injury, you'll still be able to perform that skill.

But if enough neurons die off and they die off all the time, eventually the system starts to be compromised. Those basic abilities measured by cognitive testing decline.

Why do neurons die? There are many things that can cause a neuron to die, including physical injury. There is a large body of evidence now demonstrating that frequent trauma to the head—even trauma that doesn't result in a trip to the hospital—results in cognitive decline even more than that associated with typical aging. Sports like boxing and American football come with this risk of premature shrinkage of the brain and the cognitive deficits associated with aging. Disease can kill neurons as well. There are particular viruses and bacteria that specifically attack brain tissue. Circulatory issues can kill brain tissue. If an artery is blocked, preventing blood from flowing to a region of the brain, the neurons in that region will quickly begin dying off.

All of these things can kill off neurons, but, as we age, it's not how most of them go. The majority of neuronal death that occurs is due to simple inactivity. Neurons exhibit bursts of electrochemical activity called action potentials. These cause signals to be sent to neurons nearby. If one neuron receives enough signals from the excitatory neurons around it, then that neuron may be excited enough to exhibit its own action potential.

Action potentials are the code that our brain uses to perform computations that support our perception, cognition, and action control. But those action potentials are also a critical part of the neuronal cells' physiology. It's part of how they pull nutrients and oxygen from the blood stream and how they expel waste products. If a neuron stops exhibiting action potentials long enough, it will starve.

How can you reduce age-related brain shrinkage? Keep your brain active. Physical activity—even moderate exercise like walking—inspires neural activation and even the creation of new neurons in certain areas of the brain—for instance, the hippocampus.

One of the best ways to inspire broad-based neural activity, however, is to try new things.

As we become more experienced at some activity—playing a particular sport, for instance—our brain becomes faster and more accurate in producing the proper actions at the right moments in time. As we become very expert at that activity, several lines of research have shown that we don't employ more of our brain to support the activity. On the contrary, we learn to use less and less of our brain, developing specialized circuits that rapidly, automatically mediate the task performance.

To maintain brain health, you need to stimulate your brain. No big news there. What's counterintuitive is that one of the best ways to broadly stimulate brain activity is to do new activities—activities for which you are specifically not an expert. The more challenging the task is, the more of your brain will be recruited to support it. And the less it will shrink.

If any of your novel activities involve laughing, there is good evidence that it will help keep your brain especially stimulated.

Let's try a joke here. When my mother was 65 years old, she started walking five miles a day to help her mind and body stay young. Now she's 93, and we have no idea where she is.

That's an old Ellen DeGeneres joke. There is still no complete scientific theory of what makes something funny. I can't type a joke into a computer and get a number back, indicating how funny it will be. But a lot of progress has been made in understanding our brain's processing of humor. One of the central pieces of that puzzle is incongruity detection and then resolution.

When I read the first line of that Ellen joke, I said my mother was 65 and started walking five miles a day. I never stated that she walked a loop starting and ending near her house, but you likely inferred that to be so. When I said she was doing it to keep her mind and body young, it reinforced that inference. When I said we have no idea where she is it caused you to have to rethink that whole sentence. Maybe she walked five miles a day, then stopped for a while, and then continued from where she left off.

As your brain identifies the incongruity, and then corrects its initial interpretation of it, it engages a remarkably wide range of areas of the brain. Language areas become more active when a stimulus is funny as compared to when it is not. The medial prefrontal cortex, posterior cingulate cortex, and precuneus, superior temporal gyrus, and superior temporal sulcus all show similar boosts in activation when presented with material that people rate as funny. Laughter is also associated with a substantial release of dopamine into the pleasure circuits of the brain. When you watch funny movies, listen to or read funny stories, or have a funny conversation with a friend, your brain just lights up in terms of widely distributed activity.

Here I've recommended doing one completely new activity per month. My thinking there is that your life is probably already full and exciting, even before you add this new activity into the mix. That said, you shouldn't feel limited to one new thing per month. If you've done your new thing for the month of July, and you think of something you really want to do on July 25th, by all means, go do it. My suggestion here is a minimum of one completely new activity per month. There is no maximum.

There's another tip to outsmart the aging brain that might seem contradictory to that first one, but give me a few minutes to explain. It's not. In addition to trying lots of new things, it's important to keep doing familiar activities that are important to you.

There's a story about a 90-year-old man who could put his legs up, over, and behind his head. This is a challenging physical contortion task for anyone. Most young men can't do it. Somehow, this very old man could. People would often ask him, "What's your secret? How is it that you can still do this at your age?" The man's reply was always the same. "When I was a young man, I stretched and practiced and figured out how to make my body do this. Then I just did it again, every day up until today."

The story illustrates an important point that is central to fighting the effects of aging on the brain. As our basic cognitive faculties slowly decline, one of the ways we maintain our performance—indeed one of the ways we often improve our performance—is by developing ways to compensate for those losses.

Timothy Salthouse and his colleagues conducted a study of how well people type as they age. Now, typing probably is not near the top of your list in terms of aging concerns. Memory, creativity, and insight? Sure. Typing? Well, I guess it would be good to type well when I'm older, but maybe I could do something else, say, use dictation software. The reason Salthouse studied typing and the reason I'm highlighting typing here is that typing can be carefully assessed in terms of both overall performance and in terms of basic level functions that contribute to it.

A group of experienced, expert typists were recruited for the study. They visited the Salthouse lab and completed several different types of tests. The first was to type several passages as quickly and accurately as possible. The computer used for the task coded that speed and accuracy. The participants also completed a wide range of tests of basic cognitive, perceptual, and motor abilities that are related to typing.

For instance, participants would tap a key as fast as possible to provide a measure of their raw finger speed. They would respond to a series of individual characters on the screen by pressing a key as fast as possible. In typing, of course, that's what you do—you see a letter, and then you press the key that corresponds to that letter. The presumption here is that this choice reaction time should be very related to overall typing speed.

For novice typists, this was true. The faster you can recognize characters and press the right button, the faster you can type. If you compare a group of young adult novice typists to a group of older adult novice typists, you see the typical age effect. Older adults are slower at the choice reaction and button press tasks, and they are slower typists.

With experienced typists, however, the younger versus older comparison produces an interesting pattern of results. The maximum key press speed of older experienced typists is slower than for younger experienced typists. Also, the older experienced typists are slower in the single character choice reaction time task. There is a roughly linear function that relates both of these performance functions to age. The older we get, the slower we get. Well, no.

If you look at the actual typing speed of these experienced typists, there is almost no effect of age at all! A 70-year-old typist is slower in terms of all of the cognitive and motor assessments when compared with 20 and 30-year-old experienced typists. But then, when you present these typists with a passage of text and ask them to type it as quickly as possible, their speed is almost identical. How could this be?

Salthouse performed several clever experiments in which he restricted the number of characters ahead on the line of text that the typists were allowed to look. If you are only looking 10 characters ahead on the line, then if I block characters 15 and more ahead of where you are currently typing, it won't affect you. If I block all the characters beyond five ahead of where you are looking, however, then your performance will suffer. There is information you want to be using, but I've restricted your access to it.

These experimenters found that older typists were maintaining their speed by looking farther ahead in the line of text than the younger typists. As their basic sensory and motor capacities declined, they discovered new strategies to overcome those limitations.

This process doesn't just work with typing. We can develop strategies to compensate for loss of brain function in almost any activity. If our brain doesn't allocate attention as fast as it used to, we can just slow down a bit and give it the time that it needs. If our brain doesn't automatically remember names as well as it used to, then we can focus our attention on encoding the name a bit better when we meet people to compensate. If our brain grows fatigued more quickly than it used to, then we can rest more. Remember, the decline in brain function is typically small, so even simple strategic tweaks are all that will usually be needed.

I mentioned that in many domains, adults continue to improve in terms of mental performance beyond 20 years of age when the brain seems to peak in terms of basic cognitive performance. Imagine that you have developed the ability to do some task at 20 years of age for instance driving a car in busy city traffic. Your brain has organized itself at that point to process the relevant sensory information, to make strategic plans, and mediate your control of the vehicle. If your brain tries to do exactly the same thing in exactly the same way when you are 40, then your performance of this task will be worse.

But, if you learn to drive better by the time you are 40, you may be able to compensate for that basic cognitive loss. For instance, you may learn better routes to take at particular times of the day. You may learn to recognize better when pedestrians are about to walk into the street. You may learn that when your car makes a particular noise that pressing the accelerator won't produce as much speed as it usually does. If the 40-year-old you is able to use these extra sources of strategic information well enough, you might not just be as good as the 20-year-old driver. You might even be better.

We often describe certain tasks as like riding a bike. Once you learn how to ride a two-wheeled bike well, even if you don't ride a bike for many years, you will still be able to hop onto a two-wheeler and just go. This isn't just a cliche, by the way. For many visual-motor control tasks, like riding a bike, once we've mastered the task, the memory seems remarkably durable.

If you're having trouble remembering an old phone number that you used to dial a lot, on a regular basis, you can often get it back by actually pressing the number keys on a phone. You might not be able to explicitly recall the number, but your fingers, having grown used to dialing that number, will still have it in procedural memory. For your fingers, dialing the number is like riding a bike here.

Our memory for many procedural tasks works this way. Remember this is one of those cognitive faculties that does not seem to decline much with age, so you will be happy to know that this like riding a bike property will continue to apply into your later years.

For many complex activities, however, as we age, the bike seems to change. Your brain and body change over time. In order to maintain your level of performance, you will have to find clever, strategic ways to improve. If there is some ability that you would like to maintain as you age, you can absolutely do so. You just need to make sure that you work at it on a regular basis to maintain it. The really good news is that, if you manage to strategically improve faster than your brain declines, you will continue to get improvements, perhaps for many, many years.

Running long distances is something that has been a source of pleasure for me since I was nine years old. For a 170 pound runner, about 400 pounds of pressure are applied to the foot. This travels from your feet, up through your knees and hips. That happens with every single step, every time you land. And every mile requires you to run approximately 1,500 steps. It used to be that people presumed that this repetitive, massive pounding wore out your legs. Everyone is born, it was presumed, with a certain number of steps in them. Once you've run those steps, your knees are worn out, time to stop running.

More recent studies have found that the cartilage in your knees can repair the damage suffered during a typical run for many, many years, almost regardless of how much you run. Indeed, a lack of active use of the legs seems to be more involved in the decline of the knees than active running. The relationship between miles run and knee cartilage health, it turns out, is almost non-existent. There's an expression that has become increasingly common in research on running and aging. People don't stop running because they get old. They get old because they stop running.

This doesn't just apply to runners' knees. It applies to the brain as well. The human brain seems remarkably capable of compensating for age-related changes, as long as people remain active and engaged in both routine as well as novel challenging behaviors.

Lecture 14

Grow Your Brain Out of Depression

Depression is sometimes called the common cold of mental illness. Many people have suffered some level of depression at some point in their lives. In a survey by the National Institutes of Health in the United States, nearly 16 million adults reported at least one major depressive episode in 2014, slightly less than 7 percent of the adult population. If milder symptoms or shorter durations of depression are included, those numbers go even higher. Another reason that depression is considered the common cold of mental illness is that mild depressed feelings often go away on their own. In this lecture, we'll explore some of the causes of depression and the actions you can take to help depression diminish more quickly.

Effects of Exercise

- A wide range of research suggests that physical activity can help effectively battle depression. Studies of the effects of exercise on depression date back to at least 1981. A large study published in the *Archives of Internal Medicine* in 1999 involved 156 participants who reported symptoms of major depression. The participants were randomly assigned to three different experimental groups: a medication group, an exercise group, and a group receiving both medication and exercise.

- After 16 weeks, about 65 percent of participants reported that their symptoms had been reduced to the extent that they no longer fit a diagnosis of major depression. The medication group reached this state faster than the exercise-alone group, but by 16 weeks, there were no significant differences between the groups. Exercise seems to work a little more slowly than medication, but the overall effects seem to be about the same.

- A follow-up study was conducted, in which 133 of the participants were recruited six months after the end of the original study. It was found that for the people who continued with the exercise program, the rate of depression was significantly lower. While exercise seems to work more slowly than medication over the first few weeks, the lasting effects of exercise seem to be substantially greater.

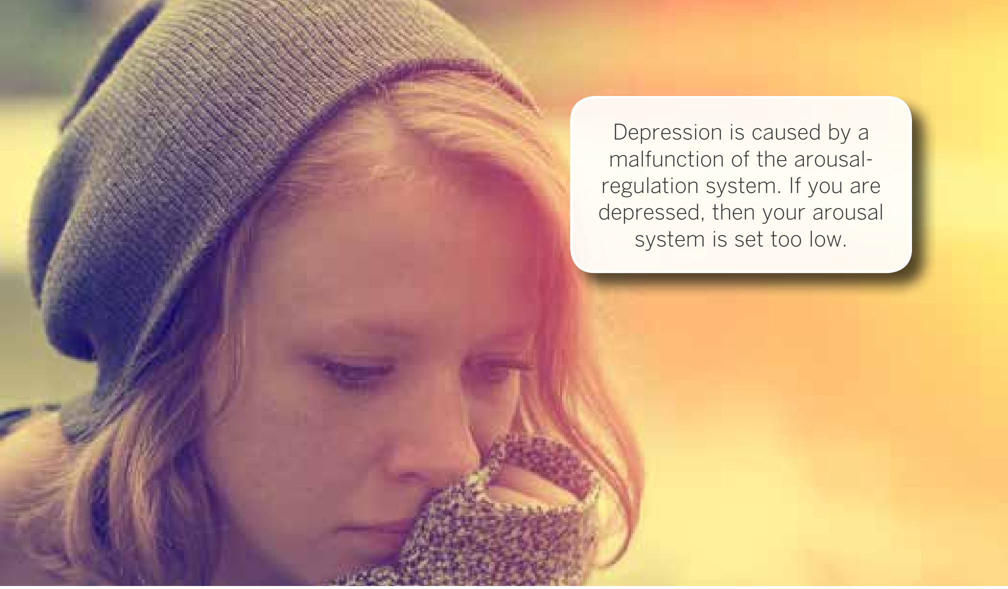
Homeostasis

- To understand how exercise helps to boost mood and reverse the effects of depression, consider what causes depression. One of the central organizing principles of the human brain—in fact, for the human body in general—is homeostasis. Your brain also regulates your level of general arousal. If you are ever overly excited by surrounding stimuli, your brain will down-regulate the responses to new stimuli. On the other hand, if you are immersed in a sedate environment, then your brain will up-regulate its responsiveness.

- According to most theories, depression is caused by a malfunction of the arousal-regulation system. If you are depressed, then your arousal system is set too low. When you are in a high-stimulation environment, the brain down-regulates its responsiveness too much. In a low-stimulation environment, the system doesn't up-regulate enough. One theory for how this might be implemented in the brain is through the production of different neurotransmitters.

Neuronal Communication Process

- Periodically, a neuron produces an action potential near the cell body. The voltage spikes from −70 millivolts to around +40 millivolts and then back down again. This pulse propagates down the length of the



axon portion of the neuron until it reaches its terminals. Within these terminals are storage sites called synaptic vesicles. Every time an action potential reaches one of these axon terminals, some of these vesicles burst open, releasing the neurotransmitter stored within them.

- The neurotransmitter is released into the synapse, a microscopic gap between one neuron and the next. The neurotransmitter diffuses across the gap and adheres to receptor sites on a neighboring neuron called the post-synaptic neuron. As the neurotransmitter adheres to the surface of that postsynaptic neuron, it influences the likelihood that it will produce an action potential of its own.

- Different neurons contain different types of neurotransmitters. Some are excitatory—that is, the more excitatory neurotransmitter released into the synapse, the more likely is the chance of a postsynaptic neuron action potential. Some neurotransmitters are inhibitory—that is, the more inhibitory neurotransmitter released into the synapse, the less likely is the chance of a postsynaptic action potential.

- Reuptake is the final step in the neuronal communication process. Our brains invest a great deal of energy to produce neurotransmitters. Rather than use them once and then discard them, neurons recycle the neurotransmitter. After the neurotransmitter is released from the synaptic vesicles, it gets absorbed back into the synaptic vesicles. If the action potentials of a neuron slow down enough—or stop entirely—the amount of neurotransmitter in the synapse itself will quickly drop down close to zero.

Serotonin in the Synapse

- One neurotransmitter that has been implicated in theories of depression is serotonin. People who suffer from major depressive disorder have substantially fewer serotonin receptors in their midbrain than do nondepressed control participants.

- The midbrain is a region that contains the hypothalamus and the limbic system, the region of the brain associated with emotion and mood regulation. It seems that part of the process that leads to depression involves a reduction in the sensitivity of these regions to serotonin.

- When serotonin is released into the synapse, it greatly magnifies the effect of any action potential. It effectively strengthens the connections between midbrain neurons and reduces the symptoms associated with depression. The best evidence for the serotonin theory of depression is the proven effectiveness of a variety of serotonin-specific medications, a family of drugs that function as selective serotonin reuptake inhibitors (SSRIs).

Function of Endorphins

- Exercise can have the same effect as SSRIs on the midbrain because during physical activity, our brains produce extra neurotransmitters, such as endorphins.

- Endorphins are neurotransmitters associated with the regulation of pain perception. When your body is physically damaged, your brain computes a perception of pain. If you are running or biking, for example, the consistent stress placed on the muscles results in damage and a pain perception associated with it. This exercise-induced damage is a positive outcome, however. As you recover from that damage, your muscles repair themselves and, in addition, make themselves stronger than they were before the exercise.

- The homeostasis concept applies here as well. If you feel a consistent amount of pain, your brain takes steps to reduce it. Endorphins are released that inhibit the brain's response to that discomfort. When you exercise and you fatigue and damage your muscles, your brain starts to produce endorphins to counteract the painful effects. When you stop exercising, eventually, the endorphin production drops again—but not immediately. For a while, those endorphins continue to be produced and influence the brain. The endorphins not only dull the physical pain of exercise but also inhibit the mental and emotional symptoms of depression.

- In fact, a variety of other neurotransmitter systems are also activated by exercise. Norepinephrine, for instance, is produced much more during physical activity than during periods of rest. This neurotransmitter increases general arousal for the sake of physical activity. Like the endorphins, norepinephrine production continues for a while even after you stop exercising.

Neurogenesis

- A new theory suggests a completely different pathway by which both exercise and SSRIs might impact depression symptoms. It may be that the key to reducing depression is to make more neurons.

- In the 1980s and 1990s, several teams of researchers found evidence for adult neurogenesis—the creation of new neurons. The original work was done with songbirds, which typically learn new songs every spring. As the birds undergo this seasonal learning process, their brains substantially change size to support this new learning. The new cells are created, recruited into learning circuits, and then used like older cells. In humans, it seems that new neurons are produced in at least two parts of the human brain where rapid learning takes place.

- The first area is called the striatum, a subcortical part of the brain that is central to implementing our responses to positive and negative reinforcements. This is the part of the brain where continual learning and restructuring takes place.

- The other region where rapid neurogenesis seems to take place in humans is the hippocampus, the part of the brain critical to many significant cognitive functions. Our mental map of the surrounding environment seems to be implemented here, including our sense of where we are on that mental map. Our ability to form new long-term memories is implemented in the hippocampus as well. In addition, the hippocampus is involved in many aspects of information processing.

- Neurogenesis is much rarer in people who suffer from depression symptoms. Several studies have found that people who suffer from major depression for several months actually have measurably smaller hippocampus regions.

Role of Inflammation

- A strategy to fight off depression is to take aspirin. A number of large-scale studies found that people who suffer from inflammation-related illness are more likely also to suffer from depression. Most of those studies have been correlational.

- Several recent studies have more directly explored the hypothesis that depression may result as an inflammatory disorder of the body as a whole. Some studies have targeted populations that did not exhibit depression symptoms—some of whom were prescribed anti-inflammatory medications for reasons unrelated to depression and some of whom were not. The people who took the anti-inflammatory drugs exhibited lower rates of depression after taking the medications.

- Taking aspirin, ibuprofen, or other anti-inflammatory drugs is worth a try if you find yourself struggling through an extended period of negative mood.

Benefits of Fermented Foods

- To boost your mood when you are feeling low, try adding fermented foods to your diet. Fermentation is used in the production of many foods. In general, it involves exposing foods to a family of bacteria called lactobacilli. These helpful, friendly bacteria eat the starches

To boost your mood when you are feeling low, try adding fermented foods to your diet. Common examples of fermented foods are kimchi, sauerkraut, and yogurt, and sugars in food and convert them into lactic acid—a sour-tasting substance. Common examples of fermented foods are kimchi, sauerkraut, yogurt, sourdough bread, tempeh, and miso.

- There is a growing body of evidence that the incidence of depression is lower in people who regularly consume fermented foods, although the exact mechanism for this is still a mystery. Similar to the results of taking anti-inflammatory medication, however, the data on fermented foods seem to suggest that the effects are much larger for some people than others.

Questions to Consider

1. Depression is associated with emotion centers of the brain, such as the limbic system. How might the creation of new neurons in learning regions such as the hippocampus lead to improvements in emotional well-being?
2. If so many people suffer from depression, what is the origin of its social stigma?

Suggested Readings

Eriksson et al., "Neurogenesis in the Adult Human Hippocampus."

Korb, *The Upward Spiral*.

Lecture 14 Transcript

Grow Your Brain Out of Depression

Depression is often referred to as the common cold of mental illness. It's described that way, because, like a cold, almost everyone catches a bit of depression from time to time. A large-sample, national survey sponsored by the National Institutes of Health in the United States suggested that almost 16 million adults reported at least one major depressive episode in 2014. That's a little less than 7 percent of the total adult population.

In this case, the term major depressive episode is defined as a period of at least two weeks during which a person experiences continued depressed mood or loss of interest in pleasure, along with at least four other related symptoms, for instance, problems with sleeping, problems with eating, reduced energy, reduced ability to concentrate, and substantially reduced self-image.

These criteria are established in the diagnostic and statistical manual of mental disorders every few years by the American psychiatric association. The DSM is currently in its fifth major revision, and so is called the DSM-5.

I've described the clinical definition of major depression. If you include milder definitions of depression, for instance, milder symptoms or shorter durations of those symptoms, then those numbers of people affected go even higher. Depression is like the common cold of mental illness, but it's not always just a mild source of annoyance. Full blown depression can be completely debilitating.

The vast majority of those millions of depressed people identified in those large-scale surveys reported that they had not sought treatment and that they didn't intend to. Most people just suffer with their depression—even major depression. Given the scale of the problem, this is somewhat tragic because depression is a very treatable disease

There are many very capable professionals who can administer a combination of talk-based therapy and medications. Serious depression is a serious thing and can lead to major life problems and even suicide. This lecture isn't aimed at replacing the medical therapies that are sometimes needed to treat depression. If you've had depression that has significantly affected your ability to work, play, and enjoy life for an extended period of time—more than a month—then I urge you to consider seeking treatment.

The vast majority of people, however, who experience depression, never seek treatment. They suffer, do their best to move on with their lives, and, eventually, the depression subsides. Another reason that depression is referred to as being like the common cold is that—like a cold—it often does go away on its own. Our brain possesses a variety of self-regulatory processes that compensate for that depressed feeling even if you don't try to do anything to address it.

In this lecture, I want to talk about some of the causes of depression and some of the things you can do to make that mental cold go away faster. With a cold, you drink lots of fluids, get plenty of rest, maybe eat some chicken soup and the cold subsides. There are similar things you can do to address that mild depressed feeling that we all get some time.

The first thing that a variety of studies supports is to do your best to make yourself more active. This can be a challenging thing to do. One of the primary—indeed, maybe one of the most defining symptoms of depression is a sharply reduced feeling of motivation. When you feel depressed, you feel an aversion to doing things like exercise. A wide range of research, however, suggests that physical activity is one of the best things you can do to battle that depressed feeling.

Studies of how exercise affects depression date back to at least 1981. One large study published in the *Archives of Internal Medicine* involved 156 participants who reported symptoms of major depression. They were randomly assigned to three different experimental groups. There was a medication group—they were prescribed a typically used depression medication—Zoloft. There was an exercise group that participated in a daily program of moderate aerobic exercise. A third group did both of these things.

After 16 weeks, about 65 percent of the participants reported that their symptoms had been reduced to the extent that they no longer fit a diagnosis of major depression. The medication groups reached this state faster than the exercise alone group, but by 16 weeks, there were no significant differences between those two different groups. Exercise seems to work a little more slowly than medication, but the overall effects seem to be about the same.

A follow-up study was conducted, in which 133 of those participants were recruited six months after the end of the original study. It was found that, for the people who continued with the exercise program, the rate of depression was significantly lower. The exercise thus seems to work more slowly at the onset than medication over the first few weeks, but the lasting effects of exercise seem to be substantially greater.

How much exercise do you need to do to get these effects? Several studies have found effects like this with even small amounts of activity. One experiment found that walking about 35 minutes per day, five days a week was enough. Another found that 60 minutes of walking three times per week was enough. Overall, this is 175–180 minutes per week. In one study, fast walking for 15 minutes a day five times a week produced significant benefits. That's only 75 minutes per week.

You don't need to become an Olympic professional level athlete to boost your mood. Just a moderate amount of activity, on a regular basis, for an extended period of time, seems to produce clear benefits. If you're depressed, it might be the last thing that you want to do, but, if you take your medicine and increase your level of activity, the benefits can be substantial and long-lasting.

Why does exercise work? Why does it boost your mood? Why does exercise reverse the effects of depression? Any answer to this how type of question has to start with a theory about what causes depression to begin with. One of the central organizing principles of the human brain—the human body in general, actually—is the concept of homeostasis. Your body maintains a very consistent set of internal conditions. The concentration of salt in your bloodstream stays within a few parts per million of the optimal concentration all the time—even if you drink a big glass of water or eat a big bag of salty potato chips. Your body temperature stays right around 98.6 degrees Fahrenheit—even a few degrees higher or lower than that, and it will disrupt many of the thousands of chemical reactions that have to take place to support normal function of the body and the brain as well.

Another thing that your body regulates is your level of general arousal. When something interesting enters your surroundings—an interesting person, some opportunity, even an interesting idea—it tends to spur you to action. You are watching this video, so you are likely someone who likes to seek out new and interesting experiences—things like learning.

It would be a bad thing, however, to respond too much to new stimuli. If you were suddenly very excited every time something new came along, you would have trouble focusing; you'd have trouble concentrating on any one thing. You would probably be tired a lot as well. We only have so much physical and mental energy to expend in any given day.

Your brain takes these things into account. If you are ever too excited by your surroundings for too long, it will down-regulate those responses to new stimuli. This is pretty intuitive, I think. If you are surrounded by a particularly exciting environment, if you were in Times Square or an amusement park with lots of thrilling roller coasters, you will, at least in the short to medium term, become a little jaded to novelty.

On the other hand, if you are immersed in a somewhat sedate environment—the waiting room at the DMV or a very quiet and uneventful Sunday afternoon—then your brain will up-regulate its responsiveness. Something that might not ordinarily seem very interesting at all will suddenly take on an air of fascination.

Most theories of depression—and there are a lot of them, actually—start with the notion that depression is caused by a malfunction of this arousal regulation system. If someone is depressed, then it's as if their arousal system thermostat is set too low. When you are in a highly stimulating environment, the brain down-regulates its responsiveness too much. In a low stimulation environment, the system doesn't up-regulate enough.

One theory for how this might be implemented in the brain is via the production of different neurotransmitters. Serotonin is a particular chemical, produced in the brain that enables neurons to communicate with one another.

The basic components of neuronal activities have been called the action potential. Neuronal cells all possess a resting electrical potential of about negative 70 millivolts. If I were to place a tiny electrode inside a neuron and another one just outside that same neuron, there would be a voltage difference—like a very weak battery. That voltage difference is very consistently around negative 70 millivolts for every neuron in your entire body

Periodically, a neuron produces an action potential. Starting near the part of the neuron called the cell body. The voltage spikes from this negative 70 millivolts, to around positive 40 millivolts, and then back down again to negative 70 millivolts.

This pulse of electrical activity propagates down the length of the axon portion of the neuron until it reaches its terminals, the ends. Within these terminals are storage sites referred to as synaptic vesicles. Every time an action potential reaches one of these axon terminals, some of these vesicles burst open, and they release the neurotransmitter that's stored within them.

The neurotransmitter is released into something called the synapse; this is a microscopic gap between one neuron and the next. The neurotransmitter diffuses across that gap and adheres to receptor sites on a neighboring neuron. I call this—the second neuron—the post-synaptic neuron. As the neurotransmitter adheres to the surface of that postsynaptic neuron, it influences the likelihood that it will produce an action potential of its own.

Different neurons contain different types of neurotransmitters. Some are excitatory—that is, the more of the neurotransmitter is released, the more likely a postsynaptic neuron action potential is. Some neurotransmitters are inhibitory. That is, the more of this inhibitory neurotransmitter that's released into the synapse, the less likely a postsynaptic action potential is.

There is one last step in this neuronal communication process that's worth considering here—reuptake. Our brains invest a lot of energy in producing those neurotransmitters. Rather than using them once and then discarding them, neurons recycle the neurotransmitter. After the neurotransmitter is released from those synaptic vesicles, it gets sucked back up into the synaptic vesicles; if the action potentials of a neuron slow down enough or stop entirely the amount of neurotransmitter in the synapse itself will quickly drop down close to zero.

One particular neurotransmitter that's been implicated in theories of depression is called serotonin. The brains of people suffering from depression tend to have relatively low levels of serotonin.

This is based in part on some clever neuroimaging technology. Rather than focusing a scanner on blood flow or the anatomical structure of a brain region, a positron emission tomography scanner—it's usually referred to as a PET scanner—can be tuned to concentrations of various neurotransmitters—neurotransmitter receptors, actually—in different parts of the brain. People who suffer from major depressive disorder have substantially fewer serotonin receptors in their midbrain than do non-depressed control participants.

The midbrain is a region that contains the hypothalamus and the limbic system, that's a part of the brain associated with emotion and mood regulation, so this makes a lot of sense. It seems that the part of the process that leads to depression involves a reduction in the sensitivity of these regions to serotonin.

This neuroimaging work is really fascinating, actually, on its own, but the best evidence for the serotonin theory of depression is the effectiveness of a variety of serotonin-specific drugs. You've probably heard of Zoloft and Prozac. These are the two most famous members of a whole family of drugs that function as selective serotonin reuptake inhibitors—commonly these are called SSRIs.

I described that reuptake process a minute ago—the neurotransmitter is released into the synapse and then reabsorbed into the presynaptic neuron's vesicles for storage and later release. These drugs interfere with that reuptake process. So the serotonin is released into the synapse, where it has its normal effect. But instead of being stopped a few moments later by the reuptake process, the serotonin is left right there in the synapse. Over time, this greatly magnifies the effect of any action potential. It effectively strengthens the connections between those midbrain neurons. And so the theory goes, reduces the symptoms associated with depression.

That all makes sense, but why would exercise have the same effect? Why should exercise result in the same effects on the midbrain as a SSRI drug? Researchers have found evidence for several different answers to these questions. One possibility is that, during physical activity, our brains produce extra neurotransmitters, for instance, endorphins.

Endorphins are neurotransmitters associated with the regulation of pain perception. When your body is physically damaged, our brain computes a perception of pain. If you are running or biking, the consistent, repetitive stress placed on the muscles results in damage and a pain perception associated with it. Just to be clear, this exercise-induced damage, in this case, is a good thing. Exercise stresses and damages those muscles. But as you recover from that damage, your muscles repair themselves and, in addition, make themselves a little stronger than they were before the exercise.

The homeostasis concept I've been discussing here applies as well. If you feel a consistent amount of pain, your brain takes steps to reduce it. Endorphins are released, which inhibit the brain's response to that discomfort.

Imagine you are exercising. You are out for a 30-minute jog or walk. As you repeatedly stride forward, you fatigue—and damage—your muscles. Your brain starts to produce endorphins to counteract the painful effects of this. Thirty minutes later, you stop. What happens to those endorphins? Eventually, the endorphin production drops again, but not immediately. For a while—many minutes in some cases—those endorphins continue to be produced and continue to influence the brain. Many people report a feeling of great pleasure when this is happening. Colloquially, this is sometimes referred to as the runner's high.

A painful stimulus plus endorphins equals homeostasis; you're at that normal state. When you stop exercising, the painful stimulus is gone. Nothing plus endorphins equals pleasure. It's almost as if, for a few minutes, you have taken a mild dose of morphine. The endorphins don't seem to merely dull the physical pain of exercise, but to also dull the mental and emotional pain of depression.

In fact, a variety of other neurotransmitter systems are also activated by exercise. Norepinephrine, for instance, is produced much more during physical activity than during periods of rest. This norepinephrine neurotransmitter is the one that increases general arousal for the sake of physical activity, actually. For instance, it's involved in increasing activity in the heart and lungs when you start moving around. It also plays a large role in regulating general respiration, heart rate, sweating, lots of things.

And, like the endorphins, even after you stop exercising, the production of norepinephrine continues for a while. As it increases your level of physical activation, it will reduce the effects of depression.

So, exercise boosts the production of certain mood-elevating neurotransmitters. This makes total sense. There is a relatively newer theory. However, that suggests a wholly different pathway by which both exercise and those SSRIs might impact depression symptoms. It may be that the key to reducing depression is to make more neurons.

The conventional wisdom for many decades in neuroscience was that the brain produced neurons only early in development. By later childhood certainly by the onset of puberty it was believed that your brain had produced all of the neurons that it ever would. It's long been understood that the brain continues to alter the patterns of connections between existing neurons—that it does this throughout our lives—new synapses appear and disappear all the time—and the strengths of those existing connections are altered by our experiences. But in terms of the production of completely new neurons? That was presumed not to happen in the human brain.

If a peripheral neuron is destroyed—for instance, if someone suffers a bad injury to a finger—it will often heal itself. But in the central nervous system, the part up here in the skull, neurons seem not to regenerate after they are destroyed. This is, to a large extent, true, but several teams of researchers in the 1980s and 1990s found evidence for adult neurogenesis—the creation of new neurons. The results were first found not in humans, actually, but in songbirds and later rats.

The basic technique for doing this is really quite ingenious. A mildly radioactive label is injected into the bloodstream of the animal; that is a label that's designed to adhere to the animal's DNA. In later microscopic imaging of the brain tissue, the labeled DNA can then be seen. When the body makes a new cell—any cells now, not just brain cells—it does so via a process called mitosis. The cell makes a copy of its own DNA, along with other critical internal components of the cell, and then divides—splitting in two to create a copy of itself. After a cell has undergone this mitosis, the labeled DNA look different in very predictable ways. Essentially you can see where the brain has been making new cells during the time between the labeling injections and when the imaging takes place.

Amazingly, the brains of many animals seem to make new neurons on a pretty regular basis. The original work, like I said, was done with songbirds—birds like canaries—who typically learn new songs every spring. As they undergo this seasonal learning process, their brains change in size substantially to support this new learning. The new cells are created, recruited into learning circuits, and then used just like older cells are.

In humans, it seems that new neurons are actually not produced in most brain regions. They might be, but, if they are, the neurogenesis is very slow and perhaps rare. There is now good evidence, however, that a neuron creation process takes place in at least two parts of the human brain; parts where rapid learning seems to take place.

The first is called the striatum; this is a subcortical part of the brain that's central to implementing your responses to positive and negative reinforcements. You might recall our discussion of the nucleus accumbens in the lecture on fighting procrastination. This is the part of the brain where you get that shot of pleasure when you complete something. That nucleus accumbens is one subpart of this larger striatum region. Just like songbirds, this is a part of the brain where continual learning and restructuring takes place. In retrospect, it's sensible that this would be a place where we would see neurogenesis taking place.

The other region where rapid neurogenesis seems to take place in humans is in the hippocampus. This is a part of the brain that's critical for many important cognitive functions. There is an entire scientific journal devoted to publishing results of studies of the hippocampus. It's title? *Hippocampus*.

Our internal mental map of the surrounding environment seems to be implemented here in this part of the brain—including our sense of where we are on that mental map. Our ability to form new long-term memories is implemented in the hippocampus as well. People who suffer damage to the hippocampus can often remember many things that took place in their earlier life, but, after suffering the hippocampus injury, they lack the ability to remember new names, new places, new events—this is a condition called anterograde amnesia.

The hippocampus is involved in many aspects of the information processing that our brains perform. There's an old neuroscience joke, that if you ever find yourself taking an exam on cognitive neuroanatomy, and you are presented with a question about any cognitive function—call it function x—and the question reads function x is associated with brain region—blank. If you are faced with this question, you don't have to think very hard. Just write in hippocampus, and you will be correct.

A particular region of the hippocampus seems to hang on to a stock of undifferentiated neuronal cells—essentially stem cells. When it uses some of them, the stock is replenished. Throughout our lives, these stem cells are converted into functioning neurons and incorporated into the regular function of the hippocampus. The precise details of how this takes place is still a bit of a mystery.

What we do know is that the neurogenesis takes place. Something else we know is that it doesn't take place nearly as much in people who suffer from depression symptoms. Several studies have found that people who suffer from major depression for several months actually have measurable smaller hippocampus regions. If the hippocampus reduces the rate at which it produces new neurons for an extended period, it will begin to shrink. This directly fits this notion that depression is related to a low rate of neuronal production in the hippocampus and other areas of the brain associated with learning and arousal.

We also know that patients who take anti-depressive medications don't typically experience an immediate recovery—their mood doesn't immediately improve when they start to take a SSRI drug. Usually, the positive impact of the medication doesn't kick in for several weeks. This is a bit surprising if depression is all about the neurotransmitters. The effects of those on serotonin and other neurotransmitters really shouldn't take many weeks; it should take place over the course of maybe hours, certainly days at the most.

Interestingly, it also takes a few weeks for the brain to start producing new neurons more rapidly again. The neurogenesis and depressive symptom seem to follow about the same timeline. Again, it seems that depression might be very much about neuron production.

All of this sounds like the story might be winding down. Depression is strongly associated with reduction in neurogenesis. Increase neurogenesis—maybe with drugs maybe with exercise—and depression goes away. Well, those things seem to be true, but the relation between depressed mood and the brain and the rest of the body is more complex. Let's jump right into our next tip for improving your mood and staving off the symptoms of mild depression—take aspirin.

There have been a variety of large-scale studies now that have found that people who suffer from inflammation-related illness are more likely to also suffer from depression. Most of those studies have been correlational. For instance, a Danish group looked at the medical records of patients and found that people with high levels of general inflammation tend to exhibit depression symptoms.

It could be the inflammation causes the depression in a direct sort of way—that's certainly the story I'm hinting at here. But it could also be that the connection is only indirect. Perhaps if you are suffering from the pain and discomfort of inflammation you are more likely to feel negative about the world around you and life in general.

There have been several recent studies, however, that have more directly explored this hypothesis that depression—certainly some depression—may result as an inflammatory disorder of the body as a whole. Some studies have targeted populations who did not exhibit depression symptoms, some of whom were prescribed anti-inflammatory medications for reasons unrelated to depression, and some of whom were not. The people who took the anti-inflammatory drugs exhibited lower rates of depression after taking these medications.

Now, that's still not completely airtight from a scientific perspective. It's not a large-scale, clinical trial with a double-blind, random assignment to an aspirin or nonaspirin group. But the evidence from this study and a wide variety of other studies like it provide fairly convincing evidence. It seems that, certainly for some people, depressed mood might result from general inflammation in the body as a whole.

Now, aspirin and ibuprofen might seem like innocuous, everyday types of supplements. I want to take just a moment here to emphasize that they are real medicine. They're commonly used medications that are available without a prescription—but they are still serious drugs. You should watch out for potential side effects of these medications and always use them according to the precautions listed on the label. It's also a good idea to consult your physician whenever you begin a new program of taking medications for anything.

With those precautions in mind, however, this taking of aspirin, ibuprofen, or other anti-inflammatory drugs is worth a try if you find yourself struggling through an extended period of negative mood. I think this is a really good case where you should consider being your own scientist. You can do a brief case study of how aspirin or ibuprofen affect the mood of a particular patient—you.

I'm a big fan of the A B A B design for a situation like this. Start by collecting some baseline data on your own mood. Our memory for how we've been feeling over an extended time is actually not so good, so you'll want to collect this data every day. That is, if I ask you how you've been feeling over the past week, your response will be affected—too strongly affected—by how you feel right now, at this very moment. If you are feeling particularly happy today, you will tend to remember times over the past week when you've also felt happy. Conversely, if you are feeling a bit sad right now, you will tend to remember times when you've felt similar over the past week.

To fight against this tendency, it's good to have a notebook or spreadsheet where you note your mood on a regular basis. I recommend writing down a rating of your general mood three times a day, once when you wake up, once around midday, and then once around bed time. On a scale from 1-10, where 1 is very unhappy, and 10 is blissful, how have you been feeling over the past few hours?

After you've collected some of this baseline data—this is your A condition—start taking a little aspirin every day. It should be a small dose, say about 100 mg—that's about half of one standard capsule—per day. If it's aspirin, it's a good idea to take it when you are also eating something to reduce stomach discomfort associated with it. Indeed, if you start to feel any bad side effects from this medication treatment, you should stop, wait until you completely recover, and then try your study again with a smaller dose.

Take the medication and continue collecting data. After a week, take a look at your average happiness ratings across the two weeks. If the aspirin worked, then you should obviously see higher ratings. Now, this might be because of the aspirin, but maybe you are just generally getting happier, and you're just getting over that common cold of depression. That is, maybe it was just a coincidence. To check for that, don't take the aspirin in week three and continue to collect data. Take the aspirin and continue to collect data in week four. If your mood tends to go up and down when you are taking and not taking the aspirin, then you might be someone whose mood is driven by general inflammation.

Even if researchers in this area had conducted and published one of these ideal large-scale studies with random assignment and other important scientific design features—and it's likely that someday soon such a study will have been done—you should probably still follow this self-study method if you decide to explore how anti-inflammatory drugs affect your mood.

There have been several other studies that have demonstrated a wide range of inflammatory response among different people. People are often very similar to one another—but each person is also a bit different. For one person, a bit of aspirin might have a large positive effect. For another person, the aspirin might have no effect at all—or even a negative effect. There is only one way to find out what works for you: try it, collect data, and take a look at the effects systematically.

As I finish this lecture, I want to give you one more tip for fighting depression that is in this same category. To boost your mood when you are feeling low, try adding fermented foods to your diet.

To be clear, I'm not talking about alcoholic beverages here. Fermentation is used in the production of many foods. In general, it involves exposing foods to a family of bacteria called lactobacilli. These helpful, friendly bacteria eat the starches and sugars in food and convert them into lactic acids—a sour-tasting substance. Kimchi and sauerkraut are common examples. Yogurt is fermented. So are sourdough bread, tempeh, and miso—the central ingredient in miso soup. You can find a wide range of fermented foods at a typical grocery store. A quick search online will give you a wide range of options. Some of which—hopefully many of which—you are likely to actually enjoy.

There is a growing body of evidence that the incidence of depression is lower in people who regularly consume fermented foods. The exact mechanisms for this are still a bit of a mystery, but a growing body of data suggest that the effect is real. As with the aspirin, however, that data seems to suggest that the effects are much larger for some people than for others. Will they work for you? You will have to be the scientist to answer that question.

If you feel mild depression on a regular basis, I hope you will consider trying these techniques to help get your mood regulation systems back in order. There are many reasons to regularly exercise and eat delicious fermented foods. Even if we don't know exactly why they have a positive effect on mood, those potential benefits are there. And if drinking a delicious yogurt smoothie turns out to be good for my brain too, so be it.

If your depression becomes severe or persists for more than a few weeks, I have an even greater hope that you will seek out professional treatment. Too many people suffer with depression—in some cases for years, or decades—depression that could be very effectively treated.

We know a lot about what happens in the brain when depression strikes, and a lot about how to correct it. There is no shame in needing that help. Remember those statistics from the beginning of the lecture about how common depression is. We all feel bad from time to time. And unlike the common cold, taking steps to combat depression can do a lot to shorten how long it lasts.

Lecture 15

Hack Your Brain to Unlearn Fear

According to cognitive neuroscience, we can learn to conquer even our most debilitating fears or phobias. Fear responses are learned; in most cases, fears are not innate. A phobia is an extreme or irrational fear or aversion. We know a great deal about how the brain implements learning and association of a situation with emotion. In this lecture, we will consider how the cognitive systems function and describe ways in which you can unlearn your fears and manage phobias.

Functional Fear of Heights

- Fear isn't necessarily a negative emotion. For example, most people have at least some fear of heights. Consider, however, the consequences of falling from a great height. Actually, a functional fear of heights is built directly into the human visual system. Dennis Proffitt and his colleagues have documented a fascinating depth-perception illusion that they discovered while standing on a balcony in the psychology building at the University of Virginia.

- This particular balcony is about 20 feet above the ground and extends for much of the length of the building. In the experiment, person A stood on the ground below the balcony. Person B stood on the balcony directly above person A. Person C stood on the balcony off to the right side of person B. The job of person B was to ask person C to move gradually farther away until the distance between person B and person C matched the distance between person B and person A on the ground.

- When person B felt that the vertical distance matched the horizontal distance, the experimenters measured the two distances and compared them. Virtually every participant dramatically overestimated the distance to the ground. When the experimenters repeated the process from the ground looking up, however, the effect went away.

- When you look down from a height, your visual system seems to know that vertical distances require great caution. Whatever the distance actually is, your automatic, unconscious visual system takes that value and multiplies it before passing the information on to your conscious perceptual system.

Short-Term and Long-Term Memory

- Emotional states are part of our system of memory encoding and processing. If you experience a neutral stimulus and then experience an extreme emotion such as terror, you will come to associate that stimulus with that particular emotion.

When you look down from a height, your visual system seems to know that vertical distances require great caution.

- Human memory is often described in terms of two separate brain systems: short-term memory and long-term memory. When you perceive something in the environment, you first store it in your short-term memory. If you want to remember something for a long time, you have to transfer it from your short-term memory into your long-term memory. To recall the information, you summon it from your long-term memory back into your short-term memory. Short-term memory is often called working memory.

- When you create a long-term memory, you encode the specific information as well as the context in which the information was learned, including a number of extra yet related details. When you encode a long-term memory for some new piece of information, you capture much of the context in which that information was delivered.

- In addition to the external context—for example, the place and time of day—you also encode the context of your internal state. Most relevant to our discussion of fears here, your internal emotional state is a part of that context.

Fight-or-Flight Reaction

- The human nervous system possesses fundamental mechanisms for regulating arousal. When your brain detects a threat, it shifts its resources to activating the muscles and augmenting sensory processing. Your heart rate and breathing become faster as blood is pumped to the muscles to oxygenate them. Blood vessels in the digestive system contract so that the oxygen and fuel there can be diverted elsewhere. When people experience fear, they tend to open their eyes widely. When you do this, you can see a little better, especially in the periphery. Your body is prepared for a fight-or-flight situation.

- Fear of flying may be common because of excess carbon dioxide in the plane while people are boarding. Often, pilots shut down the

air conditioning while the plane is being serviced and inspected between flights. It typically stays off until everyone is on the plane, but people keep breathing, taking in oxygen and exhaling carbon dioxide. One of the best ways to induce a fight-or-flight arousal response is to have someone breathe air that is rich in carbon dioxide. Our body's deep-seated survival instincts take over and an association is formed.

- For strong phobias, you don't necessarily have to have especially bad experiences to maintain or even strengthen them. If you have a substantial fear of flying, then if you simply think about flying, you will start to feel nervous. As you remember a time when a flight got very bumpy as you landed, your sympathetic nervous system will ramp up its activity. Even though nothing new has happened, the memory of flying will become even more strongly associated with the fear.

Systematic Desensitization

- Because phobias and fears, in general, are learned, we can break that learning cycle. Successful methods to manage fears and phobias involve recalling memories of fear-inducing situations and then weakening the associations between those memories and the fear.

- One of the oldest techniques is called systematic desensitization. You start by calming your mind and body and willfully place yourself in a state of complete relaxation. Sit still, do nothing, focus on your breathing, and concentrate on relaxing all your muscles one at a time.

- Once you are fully relaxed for 10 minutes or so, you then think about the source of your fear. This memory will cause you to become tense as the anxiety and fight-or-flight response kick in. Relax and wait for these to pass, and then repeat the process. Eventually, you will be able to think about that fear-inducing experience without feeling the paralyzing anxiety associated with it.

- If you can fly and stay relaxed a few times, you will have mastered your phobia. One way of accomplishing the desensitization process is to create new memories—that is, to overwrite the old ones—in which the external cues are associated with relaxation rather than fear. Decades of research support systematic desensitization for treating fears.

Reconsolidation of Memory

- Recent research has produced a fascinating new way of thinking about desensitization and suggests a way to accelerate the process. This new research also has the potential to provide a much better understanding of how memory and fear actually function. The key here is to interfere with reconsolidation of a memory.

- This new research starts with an innovative view of short-term and long-term memory. In the traditional view of memory, we perceive the world around us and pull that information into our short-term memory. Some of that information gets consolidated into our long-term memories. Later, when we want to remember something, we pull that long-term memory back into our short-term, working memory. In the traditional model, what is moved to the working memory is a copy of the long-term memory, not the long-term memory itself. Recent research suggests that this is incorrect.

- According to the new theory, remembering is like checking a memory out of a library. After you pull a memory into working memory and use it, you need to re-make that long-term memory again. The initial transfer of information from short-term to long-term memory is called memory consolidation. The transfer from short-term memory back to the long-term memory library again is called reconsolidation. If you don't reconsolidate a memory—if you don't re-make it after recalling it—then the memory gets lost. In fact, the very process of remembering something might result in its being forgotten.

- There is clear evidence that when a memory is recalled from long-term memory back into working memory, then it is placed in a state of flux, a state in which it can be changed or even erased.

Propranolol

- Recent studies have used the drug propranolol to rapidly reduce or even eliminate phobias. Propranolol is a beta-blocker medication, often used to treat high blood pressure, irregular heartbeat, migraine headaches, and a variety of other ailments. Beta-blockers block the receptor sites for adrenaline and norepinephrine—substances associated with stress-based arousal. When your fight-or-flight system is activated, it does so on the basis of these neurotransmitters. If a beta-blocker is in your system, the neurotransmitters are released, but the ability of the neurotransmitters to affect neurons on the receiving side of a synapse is reduced. Propranolol is also used to treat many anxiety-related disorders.

- In a study recently published by Merel Kindt and her colleagues at the University of Amsterdam, participants were recruited who had particular phobias—for example, arachnophobia, or fear of spiders. Others were recruited who suffered from anxiety associated with some past experience—for example, painful memories of being mugged and assaulted at gunpoint.

- Kindt was very directly inspired by studies of memory consolidation and reconsolidation. She didn't aim to eliminate the memory but to change its emotional associations.

- In her studies, participants experienced the fear-inducing stimulus. Once the fear state and the memories associated with it had been activated as fully as possible, some participants took a dose of propranolol. In the days and even months after this experience, these patients reported a dramatic drop in their fear. It was as if the propranolol, by blocking the participants' ability to fully experience the fear, also blocked the tendency to reconsolidate that fear into long-term memory.

Talk Therapy

- Another strategy that doesn't involve propranolol may have the same result of managing fears and phobias: talking to someone. There is a wealth of evidence from clinical psychology that talk therapy produces a reduction in anxiety associated with fear.

- There are many different types of talk therapy: Freudian psychoanalysis, psychodynamic therapy, behavior therapy, cognitive therapy, humanistic therapy, integrative holistic therapy. As different as they all are, they all seem to work (although not all the time and not with every person).

- It might be that the benefits of talk therapy have been based on the reconsolidation mechanism all along. As you sit in a therapist's office and have a conversation, you are relaxed. As you discuss your fear, you recall what has troubled you. As you reconsolidate those memories, over and over, while being in a relatively safe, calm environment, you will tend to weaken the associations between those memories and fear. As you do, you will gradually diminish the effects of the fear on your life.

Questions to Consider

1. Some recent evidence demonstrates that recalling fear-inducing events while under the influence of beta-blocker medications—which reduce the brain's fear response—can quickly reduce phobias. Many substances have similar relaxing effects: alcoholic beverages, a cup of tea, and even comfort foods like macaroni and cheese. Would recalling negative events while consuming these substances produce the same results?
2. Flooding is a method for treating fears in which the feared stimulus is continually presented to someone until the phobia subsides. If the process is interrupted before the phobia subsides, however, the intense and unpleasant experience of long-term exposure can increase the fear. When might flooding be an effective method to use, and when not? What steps should people take if they use this method to rapidly treat a phobia?

Suggested Readings

Knaus, *The Cognitive Behavioral Workbook for Anxiety*.

Soeter, "An Abrupt Transformation of Phobic Behavior after a Post-Retrieval Amnesic Agent."

Hack Your Brain to Unlearn Fear

When I was about 6 years old, my parents took me to the Philadelphia Zoo. It was a great day. We had a lot of fun. I have a bunch of really very pleasant memories of that trip. About half way through the day, we visited the petting zoo. There were a couple of sheep, a goat, some rabbits, various other animals, and a llama.

When I was 6, I had a lot of brownish, blond hair. This particular llama apparently thought it looked like straw or something else worth trying to eat. It lowered its head, placed its considerable mouth around the top of my head, and tried to take a bite. My memory gets a bit blurry at that point. I presume I screamed and I think I cried a lot. If you've ever spent time with a llama, you'll know that they don't have any sharp teeth. And the llama jaw is just not built for crushing anything firmer than a wad of dry hay. I was never in any danger, and I wasn't really physically injured in any way. There were no scrapes, no blood, nothing.

When I was 20 years old, I remember visiting that zoo again with some friends. It wasn't nearly as fascinating as it was when I was younger. I was viewing it from my older perspective, but it was still fun. When we walked by the petting zoo, I glanced over and saw a llama. In all likelihood, it was a different llama. It had been 14 years since the initial incident. But it sure looked like the same llama.

I knew, certainly, by age 20, that llamas are not an aggressive or man-eating species. My rational mind told me that I was in no danger from this creature. But the fight or flight response that rushed through my body was intense. My heart pounded. I began sweating and breathing heavily. The hair on my arms stood straight up. I was gripped by fear. All of this for a kindly llama that lived in the petting zoo.

Irrational, unwanted fear reactions like this are relatively common. A library of scientific terms has been invented to describe them. Arachnophobia—the fear of spiders; acrophobia—the fear of heights; aerophobia—the fear of flying; glossophobia—the fear of public speaking. These are all relatively common, but there are a lot of unusual, less common fears. Trypophobia—the fear of holes; monophobia—the fear of being alone; ornithophobia—the fear of birds; alektorophobia—the fear of chickens.

As far as I can tell, there's no scientific term for llama-phobia—there's no Greek word for llama, actually. But if you have an obscure phobia, we can still coin something; in Greek, there is an expression for small camel—that's as close as you can get to llama—mikri kamila. I am a recovering mikri- kamilaphobic.

A phobia is an extreme or irrational fear of or aversion to something. Where do phobias come from? How and why does the brain develop these stimulus-specific irrational fears? What does cognitive neuroscience tell us about how we can fix phobias?

I should note that fear, in and of itself, isn't necessarily a bad thing. Most people have at least some fear of heights, but there's a reason for that. When you're up high, there is a danger of falling and getting injured—maybe even dying. It's totally sensible to be extra careful and a little worried when you are up high. Indeed, it makes sense to totally avoid hanging out at a dangerous height unless you have to; unless you have some very good reason for being there. Fear doesn't just grip you when you are up high; the fear of the heights will keep many people from going there in the first place.

Actually, a functional fear of heights is built right into the human visual system. Dennis Proffitt and his collaborators have documented a fascinating depth perception illusion. They discovered this while they were standing on a balcony in the psychology building at the university of Virginia.

This particular balcony is about 20 feet above the ground and extends for much of the length of the building. Proffitt asked one experimenter to go down to the ground and stand below the balcony. The study participant stood directly above that experimenter, where she could look down and see the first experimenter. A second experimenter stood on the balcony on the right side of the student participant. The job of the participant on the balcony was to ask the second experimenter to move gradually farther away until the distance between the participant and the balcony-experimenter matched the distance between the participant and the ground experimenter.

When the participant felt that the vertical distance matched this horizontal distance, the experimenters would measure those two distances and compare them. For virtually every participant, they dramatically overestimated the distance to the ground. When they repeated the process from the ground, that is now the participant is on the ground looking up at the balcony experimenter, the effect went away.

When you look down from a height, your visual system seems to know that vertical distances are something that require great caution. Whatever the distance actually is, your automatic, unconscious visual system takes that value and multiplies it before passing the information on to your conscious perceptual system.

This overestimation of vertical distances is greater for people who report that they have a fear of heights, but even those who say they don't really have that fear still show a strong effect here. Your unconscious visual system is afraid of heights.

This is a fear—and a sensible, functional one—it doesn't really rise to the level of a phobia, however. In order to be a phobia, something has to be irrational before we would call it that. While fear of some things can be very functional and important, many people report having fear responses to things that aren't inherently sensible.

For instance, elevators, on the whole, are almost perfectly safe, but some people fear them so intensely that they will insist on walking dozens of flights of stairs to avoid anxiety about falling or being trapped inside. Traveling in a commercial jet is eminently safe. The odds of being injured during a drive to the airport are small, but even those small odds are substantially greater than the odds of being injured during the flight itself. Regardless of this fact, essentially no one fears driving down a highway, while many people experience substantial fear of flying. Giving a speech or toast in front of a large group is another common fear. Many people suffer from at least some general social anxiety, experiencing fear when meeting people or even, in some cases, pondering meeting them. There are dozens of miscellaneous fears that people describe—you know that there is no real danger associated with them, but your body and mind respond as if there is.

Even if it doesn't prevent you from doing the things you want to do, irrational fear is still distracting and annoying. It can sap the joy right out of a situation. It would be nice if it could go away. It can.

Where do these fears come from? Fear responses are learned. In almost every case where someone has a fear, it isn't that he or she was born with that fear. At some point in the person's life, they had an experience—an unpleasant experience in a particular situation—that led to the later fear response when that situation is encountered or even remembered in the future. We know a lot about how the brain implements learning and association of something with emotion. As we consider how those systems function together, I'll describe a few ways that you can unlearn a fear.

If we want to talk about learning, I need to talk briefly about some characteristics of human memory. Human memory is often described in terms of two separate brain systems—short-term memory and long-term memory. When we perceive something in the environment around us, we first store it in our short-term memory. If I tell you a phone number, you can hold that number in your short-term memory. You can keep it there, but only if you continually refresh it by repeating it over and over to yourself. If I distract you from that repeating task, the number will quickly fade from this temporary memory storage and be gone forever.

If you want to remember something for a long time, you have to transfer it from your short-term memory into your long-term memory. If you study that number I told you long enough to memorize it—to remember it at a later time—that's exactly what you've done. Once the information is in your long-term memory, it will stay there for a long time, maybe for good.

OK, now you want to recall the number at some later date. You do this by recalling the information, from your long-term memory, back to your short-term memory. For this reason, short-term memory is often called working memory.

Now, when you make a long-term memory, you encode the number, but a lot of other things seem to go along with it. The brain doesn't just encode the number; it encodes the context in which the information was learned, the context in which that long-term memory was formed.

In fact, when you remember individual pieces of information—when you commit them to your long-term memory—those details often come to mind along with a lot of extra, related information. When I remember learning this information about memory—that stuff I'm telling you now—a lot of other things come to mind. I remember my professor—Allen Schneider. I remember what he looked like and how he sounded. I remember the classroom and the drab color of the auditorium seat. When we encode a long-term memory for some new piece of information—whether we want to or not—we capture much of the context in which that information was delivered.

In addition to the external context of the room, the people, the time of day maybe, we also encode the context of our internal state at the time of an event. Most relevant to our discussion of fears here, our internal emotional state is a part of that context. If I were terrified about being in that intro psychology lecture hall for some reason, where I learned about memory, then my memories of Intro Psychology would be tinged with fear. In order to recall information about short- and long-term memory, I would have to pull out some of the related information—not just about the professor's face and the look of the room, but that remembered experience of terror.

So emotional state is part of our memory encoding and processing. From that perspective, phobias are a somewhat predictable result. If you experience some neutral stimulus—maybe a llama—and then experience a particular emotion—maybe terror—you will come to associate that stimulus with that particular emotion.

The human nervous system possesses some very fundamental mechanisms for regulating arousal. When your brain detects a threat, it shifts its resources to activating muscles and augmenting sensory processing. Your heart rate and breathing become faster as blood is pumped to the muscles to oxygenate them. Blood vessels in the digestive system contract so that the oxygen and fuel there can be diverted elsewhere. The body can worry about digestion later after the threat has passed, so that gets shut down. When people experience fear, they tend to open their eyes wide. They don't think about doing it, those muscles in the face just contract and open the eyelids all the way. When you do this, you can see just a little bit better, especially in the periphery; this is a functional change. Your body is prepared by all these things for a fight or flight situation.

If you fear public speaking, it is very likely that you have, at some point, stood in front of a group of people and said something. When you did, everyone looked at you. As you walked to the right or left, all of those eyes followed you. Every move and sound you made was placed under very direct scrutiny, and you, understandably, felt maybe a bit uncomfortable. What happened next, however, was the bad part. Because you felt a little uncomfortable, you probably didn't speak very well. The distraction of those staring eyes dominated your thoughts enough that those ordinarily automatic processes of translating an idea into a grammatically correct sentence didn't function as they should.

This probably made you feel more uncomfortable, which produced greater interference with those verbal processes, which made you more uncomfortable, and so on. The vicious downward spiral had been set. Worse still, in the future, when a situation arose in which you were confronted with even the idea of speaking in front of a group again, all of those fight-or-flight associations came roaring back into your nervous system.

I could tell a similar story for any fear. The fear of flying typically starts with the mild discomforts of being confined to a relatively small space, not having direct control over your travel, and the loud noises and shaking associated with air turbulence. For some people, this unpleasant experience is worse than for others. Eventually, just thinking about flying will cause the fear response, further strengthening this association.

I have a pet theory that flying phobias are so common because of excess carbon dioxide in the plane while it's boarding. Often pilots shut down the air conditioning while the plane is being serviced and inspected in between flights. That air conditioning typically stays off until everyone is on the plane, ready to go; but people keep breathing, they keep taking in oxygen and exhaling carbon dioxide. One of the best ways to induce one of these fight or flight arousal responses is to have someone breathe air that's rich in carbon dioxide. Our body's deep seated survival instincts seem to take over, and an association is formed.

For strong phobias, you don't necessarily even have to have especially bad experiences to maintain or even strengthen them. So, for instance, if you have a substantial fear of flying, then if you just think about flying, you will start to feel nervous. As you remember that time the flight got really bumpy as you landed at JFK airport, your sympathetic nervous system will ramp up its activity. Even though nothing new has happened—other than the experience maybe of thinking about flying—the memory of flying will become even more strongly associated with the fear.

OK, phobias and fears, in general, are learned. We know how that works. How do we break that cycle? There are several different methods that have been developed that are extremely effective. All of them have something in common, however. They all involve recalling memories of fear-inducing situations and then weakening the associations between those memories and the fear itself.

One of the oldest techniques is called systematic desensitization. There are many different versions. Here is just one example. You start by relaxing—calming yourself, willfully placing yourself into a state of as complete a relaxation as possible. Not everyone is very good at this, by the way. It sounds easy—sit still, do nothing, focus on your breathing, focus on relaxing all of your muscles one at a time. But if you're tense, especially if you are plagued by fears, this can be a challenge all by itself. Regardless, with practice, almost everyone can get good at calming their mind and body.

Once you are fully relaxed for 10 minutes or so, you then think about the source of your fear—you remember a time when you were in an elevator or on a plane or speaking in front of an audience. This memory will cause you to become a bit tense as the anxiety, fight or flight response kicks in. You then relax and wait for it to pass. You then repeat this process. Then you repeat again, and you repeat it again. Eventually—and this phase of the process can take some time, in some cases many sessions of practicing this—you'll be able to think about that fear-inducing experience without feeling the anxiety—-at least not the paralyzing anxiety we associate with fear.

One way that you might make this a little easier on yourself is to try it sometimes when you are already relaxed and happy. Maybe even when you are with a friend or two. Just take a break from the conversation, close your eyes, and imagine the thing that you fear. If you do this enough, you'll build that association between the thing and happy emotions. In so doing, you will weaken the association that it has with fear.

I don't know of any study that has specifically addressed it, but I'm confident that alcoholic beverages might be especially useful here. There are many problems associated with excessive alcohol use, but it is undeniable that, in moderation, alcohol can help to induce a state of relaxation. If you have a drink or two before you start your desensitization work, you might have to exert a lot less willpower in order to maintain your relaxation as you focus on imagining something that has typically caused you to feel anything but.

The process is then repeated while systematically moving closer and closer to the feared experience. Let's consider the fear of flying. Once you've mastered relaxing while just thinking about flying, how about looking at a picture of the inside of an airplane? Once you can look at photos while maintaining that relaxation state, think about flying and still relax, it might be time to take the next step and go to the airport and relax. Eventually, the process ends with actually getting onto an airplane while remaining calm and relaxed. Some treatments involve using virtual reality to simulate one of these experiences before you try it in real life.

If you can fly and stay relaxed a few times, the phobia will have ended—or at least been mastered. One way of describing this desensitization process is to create new memories—to overwrite the old ones to some extent—in which the external cues are associated with relaxation rather than fear. It works, there is no question about that, this definitely works. Decades of research support this methodology for treating fears of everything from flying to snakes to general agoraphobia—a fear of leaving your house at all.

Some more recent work has produced a fascinating new way to think about desensitization. It suggests a way that the process might be greatly accelerated. It also has the potential to provide a much better understanding of how memory and fear actually function. This is very new research I'm about to describe. It could be that in a decade or so we'll think about these results very differently, but there are a few reasons to suspect that it's correct. The key new word for the technique here is to interfere with reconsolidation of a memory. Let me start with the memory theory part and then explain how it has led to a radical new treatment for phobias.

This new view of phobias starts with a new view of short- and long-term memory. As in the traditional view, the idea remains that we perceive the world around us and pull that information into our short-term memory. Some of that information gets consolidated into our long-term memories. Later, when we want to remember something, we pull that long-term memory back into our short-term, working memory so that we can think about it again.

Now here's what's different. The basic, older model presumes that what is moved to the working memory is a copy of the long-term memory, not the long-term memory itself. This recent research suggests that that's not correct.

The theory considers remembering something, recalling something, as being akin to checking the memory out of a library. You pull the memory into working memory and use it. When you're done, you need to remake that long-term memory again. The initial transfer of information from short-term to long-term memory is called consolidation. This transfer from short-term memory back to the long-term memory library again is referred to as reconsolidation. If you don't reconsolidate a memory—if you don't remake it after recalling it then the memory gets lost. The very process of remembering something might result in something being forgotten.

The bulk of evidence for this reconsolidation phenomenon comes from studies conducted with rats. At the start of one of these experiments, rats learn an association between two stimuli—for instance, a beep and a mild electric shock. Rats don't like electric shock, of course, so when they know that one is coming, they exhibit several characteristic behaviors. One of the easiest to study is derived from the fact that rats stop drinking water when they anticipate shock. A rat in one of these studies would have a water bottle available. Whenever the rat is thirsty, it licks the end of the nozzle, and some water comes out. All of the rats in this study are thirsty when they start, so they all tend to exhibit a high rate of licking of the water bottle.

If, while they are licking the bottle, a beep sound is played, followed two seconds later by a brief shock, the rats quickly learn this association. When the beep is played, the rats stop drinking. After a few dozen trials, they will do this even if the shock doesn't occur after the beep a few times. The rats have learned something. They have learned to fear the beep.

OK. The rats have learned the association—beep predicts shock. If I wait 24 hours and test them again, the rats will still exhibit this reduction in drinking when I play the beep sound. The association is clearly stored in the rat's long-term memory.

There are particular proteins that are produced by neurons when a new memory is being formed. If the synthesis of these proteins is blocked, then the brain can't change its structure—it can't form new memories. Anisomycin is a drug that produces just such an effect. If I were to inject a rat with anisomycin before the experiment, I described, the association between beep and shock would be greatly weakened if not altogether absent.

The rats I'm describing here, though, have already learned this association. If I inject anisomycin, it won't have any immediate effect. The rats already have the association encoded into their long-term memory. They won't be able to form new associations, but the old ones will remain completely intact and still influence their behaviors just like it did before.

The key experimental group in one of these studies are rats who are both exposed to the beep and injected with anisomycin. For these rats, the beep signals a coming shock—they check that memory out of their long-term memory library. But the anisomycin blocks the rats' ability to remake the memory—to check it back into their long-term memory library—to reconsolidate it. For these rats, somewhat amazingly, the association between beep and shock seems to vanish. If I later play the beep, they'll tend to keep drinking as if the beep had never been paired with shock in the first place. They seem to have unlearned the association.

Now, the way I've described this process of checking out memories and then checking them back in is a little oversimplified, but there is clear evidence that, when a memory is recalled from long-term memory back into working memory, that it's placed in a state of flux, a state in which it can be changed—even erased. The process sounds a bit like science fiction. In fact, there are several books and movies that have built on this idea that one could be inspired to think about some memory and then a drug or other technology could be used to erase it. Check out Philip K. Dick's story "Paycheck" or the movie *Eternal Sunshine of the Spotless Mind* for two of my favorite examples of the complexities that might ensue if such a technology really were available.

It might sound like science fiction, but there have been some recent studies with humans that have used a rather mundane drug—propranolol—to rapidly reduce or even eliminate phobias. Propranolol is a beta blocker medication, and it's often used to treat high blood pressure, irregular heartbeat, migraine headaches, and a variety of other ailments. Beta-blockers, such as propranolol, block the receptor sites for adrenaline and norepinephrine—these are drugs associated with stress-based arousal. When your fight or flight system is activated, it does so on the basis of these neurotransmitters. If a beta blocker is in your system, the neurotransmitters are still released, but the ability of the neurotransmitters to affect neurons on the receiving side of a synapse is reduced. Thus the effects of adrenaline and norepinephrine on your system are reduced. For this reason, propranolol is also used to treat many anxiety-related disorders.

I've known a few people who periodically use a beta blocker when they have to give a research presentation under high-stress circumstances. They often describe themselves as still feeling terrified as they walked across the stage and begin their presentation. But, even as they feel frightened, their voice remains completely calm. As they hold a laser pointer and aim it at the projection screen, their hands don't shake; they stay completely still. The adrenaline is still flowing, for sure, but many of its effects are blocked by the aptly named beta blocker.

OK—what does this have to do with treating phobias? In a fascinating study recently published by Merel Kindt and her colleagues, they were at the University of Amsterdam for this, participants were recruited who had particular phobias—for instance, arachnophobia—a fear of spiders. Others were recruited who suffered from anxiety associated with some past experience—in some instances painful memories of being mugged or assaulted at gunpoint.

Dr. Kindt was very directly inspired by those rat studies of memory reconsolidation and disruption of that reconsolidation. She wanted to try this technique with humans. Anisomycin, however, is pretty bad for your health—especially in the doses needed to generate the memory disruption effects that she sought. Kindt settled for trying something much gentler. She didn't aim to eliminate the memory, but rather to change its emotional associations.

In these studies, participants experienced the fear-inducing stimulus—just like the rats experienced the beep. The arachnophobia patients handled a large tarantula in a jar. The painful memory group answered questions about their painful memory and verbally described it in great detail. Once the fear state and the memories associated with it had been activated as fully as possible, some of the participants took a dose of propranolol. Somewhat amazingly, in the days and a few cases months after this experience, many patients reported a dramatic drop in their fear. It was as if the propranolol, by blocking the participants' ability to fully experience the fear, also blocked the tendency to reconsolidate that fear into long-term memory.

Now, I am not urging you to go get your hands on some propranolol and experiment. Absolutely not. Propranolol is a prescription medication that should only be used under the supervision of a doctor. And this is very experimental medicine at this point. We are still at least several years from treatments like this being certified as safe and approved for general use. A large number of follow-up studies are being conducted, however. It might be that this, or something like this, will become a standard part of the toolbox of therapists who focus on treating phobias.

There's another tip here that doesn't involve propranolol that might accomplish the same thing—talking to people about your fears. In many situations, the person that you talk to about a phobia or fear is a therapist, but it doesn't have to be. There is a wealth of evidence from the clinical psychology world that talk therapy produces a reduction in anxiety associated with fear. Just talking about it. Why should that work?

There are many different types of talk therapy—Freudian psychoanalysis, psychodynamic therapies, behavior therapy, cognitive therapy, integrative holistic therapy. As different as they all are, they all seem to work—not all the time, not with every person—but there is evidence to suggest effectiveness for all of these different approaches.

It might be that, at least in terms of phobias, the benefit of talk therapy has been based on this reconsolidation mechanism all along. As you sit in a therapist's office and have a conversation, you are—more or less—relaxed. As you discuss your fear, you will recall the things that have troubled you. As you reconsolidate those memories, over and over, while being in a relatively safe, calm environment, you will tend to weaken the associations between those memories and fear. As you do, you'll gradually weaken the effects of the fear on your life.

My own fear of llamas has passed, I'm happy to report. As soon as my friends on that trip when I was 20 realized that I was terrified of this harmless llama—or rather as soon as they stopped laughing about it—they insisted that I immediately go over and pet him.

Rather than take the slow, systematic desensitization route to curing my own particular phobia, the collective peer pressure of my friends compelled me to make use of a much older treatment method for phobias—flooding, that is, continual exposure until the phobia subsides.

In my case, for the first few minutes that I was with the llama, my terror remained. I touched the llama, but very gingerly at first. Slowly, over the course of several minutes, I did calm down. Nothing bad happened. This llama did not attack. I formed new associations with the sights, sounds, and extreme smells of the llama. Those new associations, thankfully, greatly weakened the pre-existing fear association. I don't love llamas. To be honest, they still make me a bit uneasy, but the strong fear is gone, it stayed gone.

This flooding method is a risky approach since if it goes badly, then actually the phobia may become even stronger. Still, if you have one or more people supporting you, this can work for your fears too, if you want to take a faster but much less pleasant route to defeating them.

Eliminating all fear would be a very bad thing. But fear can limit the things that we try, the goals we set, the life we live.

FDR famously said, "The only thing we have to fear is fear itself." According to cognitive neuroscience, even our most debilitating fear or phobia is something we can learn to conquer.

Lecture 16

Use Your Body to Alter Your Mind

To a great extent, the brain controls the body. The act of waving your right arm, for example, is caused by a particular pattern of neural activity in a certain place in your brain—specifically, the motor cortex in your left frontal lobe. In this lecture, however, we challenge the assumption that the brain fully controls the body. A great deal of research suggests that your thought processes don't stop when they leave the confines of the skull. In fact, your body influences the state of your brain as well.

Facial Feedback Hypothesis

- If you are unhappy and want to feel happier, smile. In the 1970s, James Laird conducted studies in which he asked participants to contract certain muscles in their faces while they watched cartoons. He found that if the participants were making exaggerated smile expressions, then they were more likely to report that the cartoons were more humorous than if they did not make the smile expressions.

- This basic effect has been replicated many times. If you adopt a smile posture for a few minutes, you will generally report feeling more positive afterward. If you make a frown, then you will begin feeling bad.

- Researchers refer to this as the facial feedback hypothesis. Most people readily accept the notion that your emotional feelings influence the way you act: If you are happy, you are more likely to smile. The facial feedback hypothesis suggest that information flows in the other direction as well. If the emotional centers of your brain detect that you're smiling—presumably based on signals coming from the muscles and the brain areas that control them—then they encode that as evidence that you must be happy.

- What's more, smiling doesn't just make you feel happier; it also seems to reduce your responses to pain or stress. Tara Kraft and Sarah Pressman published a study in which participants completed a series of challenging, stress-inducing tasks that increased the heart rate. Once participants finished the task, they would probably take a deep breath and relax as their heart rate returned to normal. When participants held a chopstick in their teeth, forcing a smile posture, the response of their heart to the stress was diminished. What's more, the time it took the heart to return to baseline levels was also reduced.

- Similar studies suggest that smiling enhances the function of the immune system and even boosts the brain's release of serotonin and endorphins. Serotonin is associated with feelings of satiation. Therefore, smiling can help "stress eaters" in a very direct way, reducing the cravings associated with that stress.

Use of Botox

- If the facial feedback hypothesis is correct, then the use of Botox can affect emotional calculations. It has become routine for medical professionals to inject botulinum toxin into the skin of patients with the goal of producing smoother, less-wrinkled skin. Botulinum toxin paralyzes some muscles on the face.

- In one study, participants who had received facial Botox injections were placed in a functional magnetic resonance imaging (fMRI) scanner. This type of scanner senses the patterns of blood flow in the brain and can determine when different parts of the brain become especially active or inactive. If you look at pictures of faces and mimic those expressions, the emotion-processing centers of the brain will

light up. Botox patients, however, produce significantly less activity in those emotional centers than do typical participants.

- What's more, it seems that how you process the emotional states of the people around you is also affected by what you do—and don't do—with your face. In a related study, experimenters asked people to read short text passages and judge their emotional content. Participants who had received general Botox treatments that reduced their ability to make emotion-laden facial expressions were slower at this task than were standard control participants.

- This evidence supports the facial feedback hypothesis. The very nature of your emotional reasoning is based on what you do with your body—specifically, with your face.

Embodied Cognition

- Much of modern science considers the brain a stand-alone instrument for information processing, much like a monarch of the body that makes unilateral calculations and hands down orders. Many cognitive neuroscientists have adopted an alternative approach, however, centered around the concept of embodied cognition.

- The basic idea behind embodied cognition is that many of the impressive feats that we credit to our cerebrum are actually accomplished by a complex interaction between the brain and the rest of the body. Certainly, in emotional processing, that seems to be the case. What you do with your body—and your face in particular—plays a significant role in how you feel.

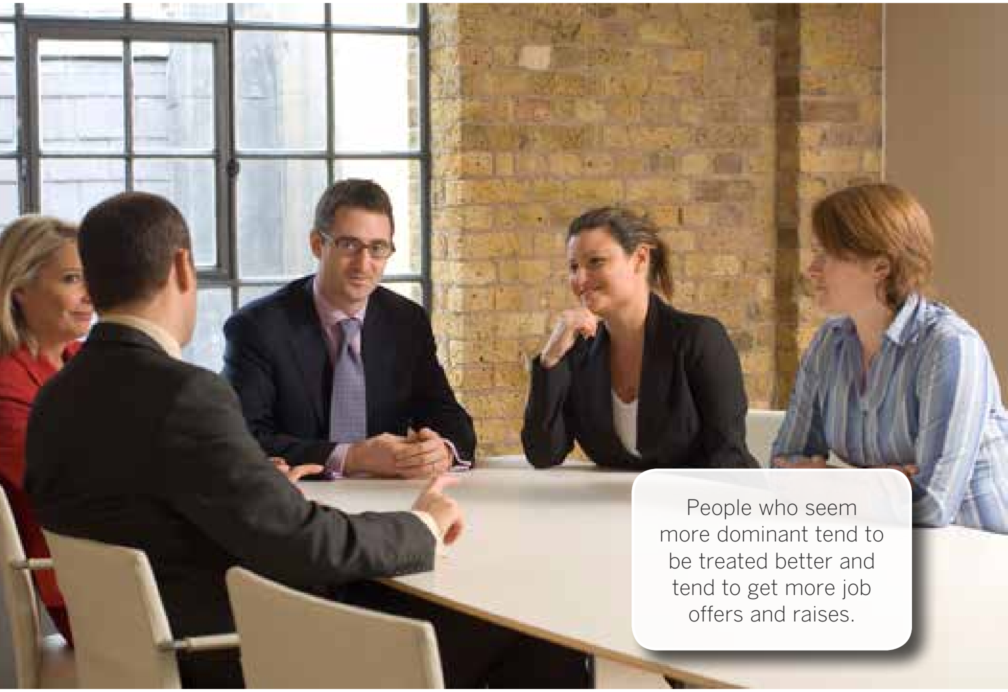
- Consider what happens when your adopt the power pose Amy Cuddy and her colleagues refer to as Wonder Woman. Stand with your shoulders back. Your legs are spaced apart, your neck is extended, and your head is facing forward. As you stand like this, even for about two minutes, your body changes the way your brain is functioning. There are some unconsciously controlled systems in your brain that are ramping up in activity, while others are being suppressed. In just a few minutes, your personality actually changes; you become more confident and more assertive.

- What's more, if you are faced with a stressful situation 30 minutes after you have stood like this for two minutes, your body will react to the stress differently than if you had not stood like this.

Dominant Postures

- When we are faced with a stressful stimulus, such as a confrontation with a colleague or superior, we face two very different options. One strategy is to engage in the conflict. The other strategy is to back down—to agree simply to end the argument. Even before a confrontation like this takes place, you can people posturing in preparation for it. The senior or dominant member of the group will tend to adopt a spread-out posture, the back straight.

- Less-dominant people in the group will do the opposite; they will cross their legs and arms and hunch their shoulders. They will seem to do everything they can to make themselves smaller and to consume less of the space in the room.
- For many reasons, people who seem more dominant tend to be treated better. They tend to get more job offers and raises; they tend to receive a larger share of contested resources; and they even seem to get better grades. If you can do something to make yourself more assertive and dominant, the outcomes are likely to be positive for you.



People who seem more dominant tend to be treated better and tend to get more job offers and raises.

Hormonal Changes

- As with our emotional systems, it seems that our bodies play a significant role in mediating how we respond to others. In fact, our bodies seem to dictate to our brain how dominant we are.

- In several classic studies performed by Cuddy's research group and since replicated by several others, participants were randomly assigned to three experimental groups. One group spent several minutes standing in a power pose. A second experimental group adopted a nondominant pose: shoulders hunched, legs and arms crossed, head down. A third experimental group did neither.

- After spending several minutes in one of these three pose conditions, participants were then placed in a stressful situation. Those in the power-pose condition performed better than the nondominant posers.

- A second effect, however, was even more striking. After completing the stressful task, the participants provided a saliva sample. The experimenters found that the power posers had lower concentrations of cortisol, a stress-related hormone. Power posers also had greater concentrations of testosterone, a hormone strongly associated with confident, dominant performance.

The Two-String Problem

- For centuries, researchers have been interested in how humans creatively solve problems. A classic research method called the two-string problem can help us understand the insights that enable us to solve problems.

- In this research, study participants enter a large room. In the middle of the room, two strings hang down from the ceiling. Initially, they are about four feet apart. On the floor nearby are a book of matches, a pair of pliers, and a few pieces of cotton. The task that the experimenter gives the participant is to touch the ends of the two strings together.

- This test is easy when the strings are only four feet apart. However, then the experimenter moves the strings farther apart, to five, six, and seven feet.

- Most participants quickly realize that they can extend their reach using the pliers on the floor. But this won't work when the strings are farther apart. The solution, which most participants eventually discover, is that if you tie one of the strings to the pliers, it can act as a weight at the bottom of a pendulum. The participants then set one of the strings swinging, grasp the other string, and then grab the second string as it swings back to them.

Keep Moving

- The process of problem solving is clearly enhanced if participants are allowed to keep moving around as they try to solve the problem. If participants are instructed to sit down and think, it will take longer to solve the problem, and they are more likely to give up without actually solving it.

- Alternatively, if an experimenter instructs the participants to remain standing and to move around while thinking, they often begin to do something really interesting. They will often swing an arm from side to side like a pendulum. Moving the body doesn't merely get the blood flowing, it seems to contribute directly to finding a solution.

- A recent study suggests that even sitting in a chair reduces our thinking effectiveness. If you ask people to perform mathematical computations or come up with as many creative uses as possible for a brick, they will perform faster if they are standing than if they are sitting. If they are lying down, the performance gets much worse.

- Your brain is a significant part of your body—but it is only a part. Our cognition clearly seems to extend to the body as a whole. Even complex concepts can have connections to physical actions.

Questions to Consider

1. Amy Cuddy and her team have focused on the use of the Wonder Woman pose to boost assertiveness and reduce stress reactivity. What other body postures might work to promote positive changes in mental state? Is there a happy posture? A creative posture? A smart posture?
2. Engaging in physical actions that are consistent with some mental state seems to change your brain. How might professional actors and con artists make use of these tendencies? Might professional actors suffer—or benefit—from performing certain roles?

Suggested Readings

Csikszentmihalyi, *Flow and the Psychology of Discovery and Invention*.

Spivey, *The Continuity of Mind*.

Lecture 16 Transcript

Use Your Body to Alter Your Mind

Most people think of the brain as controlling the body. And that's certainly true to a great extent. If I wave my right arm around, it's because of a particular pattern of neural activity in a particular place in my brain—specifically the motor cortex over in my left frontal lobe. If I twitch my right hand, it's because of a very specific set of neurons located there. If I were to insert an electrical stimulator into that motor cortex in just the right spot and give it a jolt, I could make that same twitch happen.

In this lecture, I want to challenge this assumption that the brain fully controls the body. There is a lot of work now that suggests that our thought processes don't stop when they leave the confines of the skull. Your brain certainly controls the rest of your body; no one can really dispute that. But your body influences, even controls, the state of your brain as well.

This leads me to my first tip for this lecture. To feel more happy, smile. This can feel strange the first few times that you do it. The situation I'm imagining here is that you specifically do not feel like smiling. You would employ this tip specifically when you are feeling unhappy. And when we are unhappy, it's rare for us to smile.

What I'm suggesting with this tip is that when you are in that situation, choose to smile anyway. Force your face into a smile posture. Fake it. There is good evidence that doing this will cause you to feel more happy, for your brain to be transformed into a more happy state of activity by that smile posture.

In the 1970s, James Laird conducted some studies in which he asked participants to contract certain muscles on their faces while they watched cartoon movies. He found that if they were making exaggerated smile expressions, then they would report that the movies were more humorous as compared with people who did not make those expressions.

My favorite study on this phenomenon was conducted by a researcher named Fritz Strack. He was a bit skeptical of this earlier Laird study because perhaps the participants were able to recognize the facial expressions that they were making. Maybe the participants realized they were doing something related to happiness, and thus were primed to think happy thoughts. Strack came up with an elegantly simple and clever way to get around this. He asked participants to hold a pencil in their mouths while looking at amusing cartoons.

This will be a lot clearer if you try this at home while I describe it. Pause the lecture if you need to and go get a pencil or pen. Ideally, it should be a clean pencil or pen, because you will be putting it in your mouth.

OK. What I want you to do now is hold the pencil between your teeth. It's important while you do so that the pencil not touch your lips. It should just be touching your teeth. OK. Now hold it there for a few seconds. If there is a mirror nearby, take a look at yourself. You are smiling. Well, you aren't quite smiling, but you put your face into a posture that's similar to the one you use when you do smile.

OK. Relax for a few seconds now. This time, I want you to hold the pencil between your lips. It's critical that the pencil only touches your lips. It can't touch your teeth at all. When you have it, take a look in the mirror. You are frowning.

In the experiments that Strack and his colleagues ran, participants were randomly assigned to the teeth only or lips-only condition. The experimenters had a cover story for why they asked the participants to do this strange task, by the way. They said they were interested in how different types of controllers that might be used by people who lost the use of their hands might affect their mental processing. Various controllers, they said, would engage the mouths in different ways.

This doesn't sound completely nuts. I think if I had been a participant in this study, I might have thought it wasn't the best-conceived piece of research in history. But the key here is that people didn't know that this was at all about how holding the pencil might make a participant happier or sadder in general.

At the end of the procedure, Strack and his colleagues took the important step of asking people what they thought of the experiments—what they thought they were about. When people were specifically asked if they thought that the pencil might have changed their overall mood, essentially everyone said no. That is, the cover story worked. Participants didn't know what the experiment was about as they were participating in it.

Participants who made the smile posture reported feeling more amused and positive than the participants who adopted that frown posture. I should mention there was a control group of participants who didn't hold a pencil in their mouths at all. They fell in the middle of these two groups.

Note that this control group is an important part of the experimental design. Maybe holding a pencil in your teeth is unpleasant and holding it between your lips is really unpleasant. That would produce the differences between those groups without actually making anyone feel happy. But with no pencil, with the control group, we can rule that out.

This basic effect has been replicated many times. That replication word is an important one in cognitive neuroscience, by the way. No matter how compelling any single experiment is even any single paper summarizing a whole set of experiments if only one lab has ever produced a particular result, you should be tentative in the conclusions that you draw from it. Maybe one particular group of participants drove that effect maybe there are subtle things about how one group of experimenters coded the data.

In any event, this pencils study is one that has been replicated many times now—more than a dozen different times, actually. If you adopt a smile posture for a few minutes—if you smile—you will generally report feeling more positive after you do so. If you make a frown—if you adopt a facial posture that we associated with feeling bad, then in short order, you will begin feeling bad.

Researchers refer to this as the facial feedback hypothesis. Most people readily accept the notion that our emotional feelings influence the way we act, if I'm feeling happy, I'm more likely to smile. If I am scared, I'm more likely to open my eyes wide and open my mouth.

The facial feedback hypothesis suggests that information flows in the other direction as well. If the emotional centers of my brain detect that I'm smiling—presumably based on signals coming from the muscles and the brain areas that control them—then they encode that as evidence that I must be happy. If my brain detects that I'm acting happy—then it presumes maybe I am happy. If my brain detects that I'm acting scared—then, perhaps, I am scared.

And smiling doesn't just make you feel happier. It seems to reduce your responses to pain or stress. Tara Kraft and Sarah Pressman published a study in which participants completed a series of challenging, stress-inducing tasks. The tasks weren't super-stressful—one, for instance, involved following a moving target with your non-dominant hand, but not while directly looking at it, while looking at it in a mirror. Keeping track of that mirror reversal of left and right and moving things with your non-dominant hand, this is challenging enough to induce some stress. If you performed this task, your heart rate would increase slightly. Once you finished the task, you'd probably take a deep breath and relax as your heart rate returned to normal.

If participants held a chopstick in their teeth, forcing that smile posture, the response of their heart to the stress was reduced; the time that it took the heart to return to baseline levels was also reduced.

When you find yourself in a stressful situation, when you are feeling that stress building, maybe when some people or some situation is really starting to get to you—when you feel your blood pressure starting to rise—you should smile. Making a smile—even a fake smile—will reduce that feeling of stress and might even be good for your heart health.

Similar studies have suggested that smiling boosts immune system function and that it even boosts the brain's release of serotonin and endorphins. Remember that serotonin is associated with feelings of satisfaction—satiation. I know a lot of people who describe themselves as stress eaters. They are very good at maintaining a good, healthy diet most of the time, but when a stressful situation hits, they head for the snacks. Smiling—even fake smiling—will help with that in a very direct way. It will reduce the cravings associated with that stress. The tip is clear here. If you want to elevate your mood, smile. Other studies have suggested, by the way, that this effect is not limited to facial expression. If you make angry sounds, your anger will be increased. If you talk happy, it has a similar effect to making a smiling expression.

If this facial feedback hypothesis is correct, and there is a lot of evidence now that it is, then there is something that plastic surgeons do every day that affects the emotional calculations of many of their patients—Botox injections. It's become a very routine procedure for medical professionals to inject botulinum toxin into the skin of patients, with the goal of producing smoother, less wrinkled skin. The botulinum toxin—Botox—achieves this by paralyzing the muscles that squeeze and stretch the face. If I want to reduce the wrinkles on my forehead, I could have someone paralyze those muscles here so that I am no longer able to squeeze the skin into a wrinkled configuration.

Many people receive Botox injections to reduce frown lines—wrinkles that often appear beyond the edges of the mouth associated with the downward movements we make with our mouths. Once a patient has these injections, they partially lose the ability to frown. If you survey those people a few weeks later, they ironically don't tend to rate themselves as looking more attractive, but they do report feeling happier—or at least less sad. If the face loses its ability to make sad expressions, it seems that our tendency to feel sad feelings may be reduced.

This particular Botox study fits the story, but there are some things about it, if you think about it, that are less than compelling. Maybe people just feel better in general once they've received a treatment aimed at improving their appearance. Maybe that's what produced the observed reduction in sadness and/or the increase in happiness. Other studies, however, suggest that that's not the case.

In one of my favorite studies on this topic, participants who had received facial Botox injections were placed in a functional magnetic resonance imaging scanner—an fMRI. This type of scanner senses the pattern of blood flow in the brain, and can thus determine when different parts of the brain become especially active or inactive. If you look at pictures of faces and mimic those expressions, the emotion processing centers of the brain will light up. That's been well established in the past. If you compare Botox patients, however, they produce significantly less activity in those emotional centers than do typical participants.

This result is different than the others I've been describing in some important ways. Up until now, I've just been talking about how your own facial expressions affect your own mood. Here, it seems that how you process the emotional states of the people around you is also affected by what you do—and don't do—with your face.

In a related study, experimenters asked people to read short text passages and judge their emotional content. Is this text conveying a sad feeling from the writer, an angry feeling from the writer, things like that? Participants who'd received general Botox treatments—those treatments that reduced their ability to make emotion-laden facial expressions—were slower at this task than standard control participants.

In a sense, this is the best type of evidence for that facial feedback hypothesis. Remember, the claim here is that the very nature of your emotional reasoning—the emotion processing that takes place in your brain—is based on things that you do with your body, specifically with your face. Here, people aren't explicitly making or perceiving facial expressions at all. They are reading words and judging the emotional content.

I thought that I might put a tip here—that research on the cognitive neuroscience of emotions indicates that you should avoid Botox injections—or anything else that might affect the ability of your face to express emotions. But there is a mixed bag of results here. Indeed, if one feels they are too emotional or too strongly influenced by the emotions of others, then Botox might be a possible treatment, something to reduce that effect. In particular, remember that one study suggested that reducing your ability to frown had positive effects on the emotional state.

On balance, I think my mini-tip here is just to be aware that your face is important for lots of reasons that don't just have to do with your personal appearance.

When you feel an emotion, when you express emotion, when you process the emotional states of others around you, there is a lot of information processing that takes place. Certainly, some of that computation takes place in the emotion centers of your brain. But some important parts of it take place in the muscles of your face.

There's a really fascinating set of ideas here about the relationship between our brains and the rest of our bodies. Much of modern science has often thought of the brain as a standalone, information processing device—like the king of the body that makes unilateral calculations and hands down orders to be carried out. Many cognitive neuroscientists have adopted an alternative approach, centered around the notion of something called embodied cognition.

The basic idea is that many of the impressive feats that we credit to our cerebrum up here are actually accomplished by a complex interaction between the brain and the rest of the body. Certainly in terms of emotional processing that seems to be the case. What you do with your body—and your face in particular—plays an important role in how you feel.

For this next part, I will need you to stand up. There are some things I want you to think about, but you will need your embodied cognition to do so. The first thing I want you to do is to adopt what Amy Cuddy and her colleagues refer to as a power pose. This first one here is called the Wonder Woman. Stand with your shoulders back and spread apart. Don't let them shift forward and get hunched. This is the opposite of that. My legs are spaced apart—not close together or crossed. My neck is extended, and my head is facing forward—not turned to the side and pulled downward.

As you stand like this, and you should do this because you'll definitely get more out this part of the lecture if you're standing and actually doing it. As you stand like this, even for about two minutes, your body changes the way your brain is functioning. There are some unconsciously controlled systems in your brain that are ramping up in activity, while others are being suppressed. In just a few minutes, your personality actually changes. As you stand here, you are becoming more confident, more assertive.

If you are faced with a stressful situation in the 30 minutes or so after you've stood like this for two minutes, your body will react to it differently than if you had not stood like this.

When you think of confident people, this type of posture comes to mind. Among nonhuman primates—and even humans—we have a notion of a dominant or alpha personality. When an alpha male baboon is faced with a stressful situation—like a challenge from a rival troop or the appearance of some predator—that baboon's nervous system springs into action.

Mammals, including humans, possess a large and important autonomic nervous system. This extensive network of neurons connects all of our internal organs and is responsible for regulating our general state of arousal. You've likely heard of a fight or flight response; you are faced with a threatening, fear-inducing stimulus. Your body produces a rush of adrenaline, increased heart rate and breathing; you become prepared to fight for your life or quickly escape the danger—the flight part of the response. All of those shifts in arousal are associated with the sympathetic nervous system—that's one half of your autonomic nervous system.

The other half of the autonomic nervous system is the parasympathetic system, and it is associated with the opposite of fight or flight. When you are relaxed, engaged in standard types of behaviors, this parasympathetic system is active. Often a boost in the activity of the parasympathetic system is referred to as the rest and digest mode—in contrast, to fight or flight.

When this alpha male baboon I'm describing faces off against the threat, his whole body shifts into this fight or flight mode, and an aggressive response will often result. In some cases, this might be a physical, violent response. In many cases, it's just a show of aggression, enough to scare off a rival for instance. So, the fight or flight response is activated, and then it is given an outlet.

Consider, however, a baboon that falls much lower in the social hierarchy. Maybe the baboon is smaller, weaker, and a far less dominant member of the troop hierarchy. When faced with a threat, this baboon will still have a strong sympathetic nervous system response. The fight or flight response will be activated, but this smaller baboon is much more likely to engage in the flight action—to cower and avoid the conflict.

Now, this flight response is adaptive, in that not fleeing might result in injury or even death, but it's detrimental to the long-term health of the baboon. The sympathetic response system produces a wide range of stress-related hormones—among them something called cortisol. And cortisol is associated with many negative health outcomes.

This same thing is true with humans. When we are faced with a stressful stimulus—say a confrontational disagreement with a colleague—there are at least two very different strategies. You might engage in the conflict—probably with words rather than teeth and claws that the baboon would use, of course. Alternatively, you might seek to escape—to at least tacitly agree with the confrontational person, to let them have their way so that you can end the confrontation.

Even before a confrontation like this takes place, you can see baboons or humans posturing in preparation for it. And in this case, I literally mean posturing. If someone is a more senior or dominant member of a group, they will tend to adopt a more spread out posture. When they sit among the group, their arms and legs will often spread into the adjacent spaces around them. Their backs will tend to be more straight.

People in the group who are less dominant will tend to do the opposite; they will cross their legs and their arms; their shoulders will tend to be hunched. They will seem to do everything they can to make themselves smaller—to consume less of the space in the room around them.

Simply by watching pairs of people interact, you can often readily see who is the more dominant of the two. When the two have a conflict, you can readily predict who will be the winner of any argument.

For many reasons, people who seem more dominant tend to get treated better. They tend to get more job offers and raises; they tend to receive a larger share of contested resources; they even seem to get better grades in college classes. If we can do something to make you more assertive and dominant, the outcomes are likely to be very good for you.

One other piece of this puzzle is the notion that we, like members of that baboon troop we've imagined, tend to get into the habit of responding in one way or another—either in an assertive or diminutive fashion. If you've gotten used to shrinking from stress, you are likely to continue to do so.

As with the emotional system, it seems that our bodies play a significant role in mediating how we respond. Certainly, if our brain decides to be dominant and assertive, it can dictate to our bodies to behave accordingly. Interestingly—and you can probably see this coming already—our bodies seem to dictate to our brain how dominant we are.

In several classic studies performed by Cuddy's research group, and since replicated by several others, participants were randomly assigned to three experimental groups.

One group spent several minutes standing in what she refers to as a power pose. The Wonder Woman was one option. Another involves leaning forward, across a table—imagine a boss telling his underlings what to do.

Actually, if you are still standing in that Wonder Woman, you should switch to this one now. Spread your legs apart again, take up as much space as you can. Lean forward into the table, put your weight on your hands, occupy as much of the space of the table as you can. Be as big as possible. OK, so that's one experimental group.

A second experimental group spent several minutes adopting a non-dominant pose. Shoulder hunching, leg crossing, arm crossing, head ducking—that was the second experiment. A third experimental group did neither of these things.

After they had spent several minutes in one of these three pose conditions, the participants were then placed in a stressful situation. In one set of the studies, the participants participated in a simulated job interview. The person conducting that interview was instructed to respond with a very flat and un-encouraging effect throughout. The interviewer also sought to be as critical as possible about the participants' qualifications.

The power pose manipulation had two very striking effects. The first, in a sense, is the most important. Participants in the power pose condition performed better. The interviewers weren't told which experimental condition any given participant was in—what poses they had been practicing for instance—but they tended to evaluate those power posers more highly. The non-dominant posers were rated significantly lower.

Related work has found that power posers are also more confident in general. They are more comfortable with taking risks and tend to predict better outcomes from those risks.

A second effect, however, was even more striking. After completing the stressful task, the participants would provide a saliva sample; they would spit in a cup. The experimenters found that the power posers had lower concentrations of cortisol—that stress-related, really problematic hormone. Power posers also had greater concentrations of testosterone in their bodies. Testosterone is a hormone strongly associated with confident, dominant performance. Just standing in a strong, confident pose changed the confidence level and the assertiveness of people; it also altered the very nature of the body's stress response.

The tip is really clear here. When you prepare to engage in some high-stress task—maybe a job interview, maybe a speech where you want people to be impressed, maybe even a tennis game—you should spend a few minutes standing in a power pose. There is evidence that it will improve your attitude and performance, and that you'll respond better to stressful situations. You will tend to remain engaged with the challenge rather than shrinking from it.

Again it seems that your brain is taking cues from your body. I imagine some stress computation system looking out at your body from inside your skull. Wow, he's acting really confident. I guess I must be confident. Let's engage the rest of the subsystems to match it. The thought process undoubtedly goes through the cerebrum here, but critical information processing takes place outside the skull, resulting in our embodied cognition.

There are many ways that the function of the human brain seems to be influenced by the state of the rest of the body. There is one more that I'd like to highlight here, having to do with how we use our bodies when we're engaged in creative problem solving.

Researchers have been interested in understanding how humans solve problems for centuries. It's one of those things that we, as a species, really excel at. We're better at figuring things out than any other species on the planet. And in some very specific contexts, like the game of chess, we have even learned to devise artificial intelligence systems that take that problem solving even further. How do we solve problems?

The way we solve problems is not like a computer. There's a classic research method, called the two string problem, that has been used to better understand what leads to the insights that enable us to solve problems.

In this research, study participants enter a large room that is mostly empty. In the middle of the room, two strings hang down from the ceiling. Initially, those two strings are about four feet apart. On the floor nearby are a book of matches, a pair of pliers, and a few pieces of cotton. The task that the experimenter gives the participant is, take the two strings and touch the ends of them together.

Initially, when the strings are only four feet apart, this is really easy. One just grabs the ends and touches them together. But the experimenter then moves the ceiling attachment positions for those two strings further apart. Five feet. Then six. Then seven. Note, that the participants aren't allowed to climb up to the ceiling to move these anchors. That would be cheating here. The task is to bring the two ends of the strings together without bringing out the ladder and doing it.

Initially, the participant grabs one string, then walks over until she can reach the second, then pulls the two together. But when the strings are hung far enough apart, this is no longer possible. The participants stretch an arm out as far as possible, but still can't quite reach that other string.

What would you do? Any ideas? Most participants quickly realize that they can use those that are on the floor to extend their reach a little bit. That might buy them one extra solution, say they're holding the string, now they can grab it with the pliers and pull it in. But then the experimenter comes in and moves the strings further apart again. Even with the pliers now, the participant still can't reach all the way over. What would you do next? Remember here the equipment you have to work with is a book of matches, that pair of pliers, a few pieces of cotton, and otherwise, the room is empty.

This is an interesting problem. It's easy to describe and somewhat challenging to solve, but still easy enough that a lot of people will eventually solve it. The problem has provided a good test bed for exploring what sorts of manipulations might hinder problem-solving, and conversely what sorts of things we can do to enhance it.

In the context of the lecture, one of the key things you can do to improve problem solving is to allow the person to keep moving around as they try to solve it. When the participant gets stuck—and most do at this point for at least several minutes—if they are instructed to sit down and think about it, it will be harder to solve this problem. It will take longer, and they are actually a lot more likely to give up without actually coming up with a solution.

Alternatively, if an experimenter instructs the participant to remain standing, in fact, tells them to move around while they're thinking, the participants often start to do something really interesting. They will often swing an arm from side to side like a pendulum. Moving the body doesn't merely get the blood flowing here, it seems to contribute directly to finding a solution.

Any guess what the solution is yet? If you haven't figured it out, I urge you to stand up and do this yourself. Imagine the two strings hanging from your ceiling; you've got your stuff in the room, stand there and swing your arm from side to side.

Did you get it? If you want to pause and think about it, now would be a good time. Keep moving around while you do. There is good evidence that it will help.

Ok, here's the solution that most participants do eventually discover. If you tie one of the strings to the pliers, then the pliers can act as a weight at the bottom of a pendulum. The participants often have this insight.

They set one of the strings swinging back and forth; they hold the other string and wait for the pliers to swing towards them and then they grab it. Now they can put those two strings together; problem solved.

The tip here is clear. If you want to solve problems as well as possible, let your body keep moving; let it keep doing its part of the thinking process as much as you can.

There's a recent study that suggests even sitting in a chair, something we all do a lot, reduces our thinking effectiveness. If I ask someone to perform mathematical computations, even simple math problems, or maybe come up with as many creative uses as possible for a brick, they'll perform these tasks faster if they are standing up as compared to sitting down. Actually, if they lie down on the floor, the performance gets much worse.

I don't think it's a coincidence that mathematicians traditionally work on hard problems while they're standing at a large board. The enormous increase of interest in office desks that enable standing instead of sitting is also relevant here as well.

Your brain is a part of your body, and important part to be sure, but it's only a part of it. Our cognition clearly seems to extend to the body as a whole. Even complex concepts that we understand often seem to have connections to physical actions.

I urge you to try the suggestions that I've described in this lecture. Sometimes when you wish you felt happier than you are, smile and see if that helps. When you want to feel more assertive, when you are about to face a challenging social situation, stand like Wonder Woman for a few minutes and see how you feel afterward. When you are stuck trying to figure something out, try standing, and try moving around maybe move around a lot. I predict that you'll not only find a solution, you'll also be giving your brain a better workout.

Lecture 17

Suppress—Don't Repress—Anger

While extreme anger can create numerous problems, mild anger can be a valuable source of energy and motivation. In this lecture, we explore how we can outsmart anger and turn it into positive, productive action. Some of humankind's greatest accomplishments began when someone became outraged over the world as it is, rather than as it could—or should—be.

Mirror Neurons

- The next time someone is being mean to you, try an experiment. Be nice—be unexpectedly, shockingly nice—and see what happens. Research suggests that when you take this kind of action, you will partially take control of the emotional centers of the aggressor's brain and turn off his or her ability to be unkind.

- The reasons for the effectiveness of this technique begin with the brain's mirror neuron system. When you perform a movement of your body, you activate particular neural circuits in your motor cortex. What's more, even when you simply watch someone else making that same motor movement, the same region of your brain will become active.

- Mirror neurons were first discovered by a research team led by Giacomo Rizzolatti. The researchers described them as mirror neurons because the neural system was, in essence, mirroring the activities of another individual, as if the observer were performing the actions.

- Humans learn a great deal through imitation. If you've ever taught a child how to tie shoelaces, you likely didn't simply describe it verbally. If you watch someone perform a dance a few times, even if you've never tried it yourself, you will likely be able to approximate it the first time you try. While you were watching the dance being performed, your brain was interpreting the dance by simulating your own performance the entire time.

- There is substantial evidence for the motor theory of speech perception as well. When you listen to someone speaking, particular regions of your brain parse the sentences and derive meaning from them. An important step in that process is that your brain activates the regions that would be involved in producing the same sounds. In fact, there is evidence that simply listening to speech produces low levels of activation in your own vocal tract.

A Counterintuitive Strategy: Be Nice

- Recent research suggests that the mirroring tendency isn't limited to motor activities. If someone behaves aggressively toward you, your brain's default response is aggression in return. When you observe the aggressive behavior, your brain will already be mirroring it—priming an in-kind response.

- As your brain mentally simulates performing those actions, it will tend to activate the associated systems. Regions of the amygdala associated with the sympathetic nervous system will become active—inspiring a fight-or-flight mode. Situations in the past that have made you angry are associated with this information, and the circuits that encode this information in the frontal lobes will become active as well.

- Conversely, if someone is very warm and friendly to you, your brain will mirror that. The parasympathetic nervous system will become active. Your brain will prepare itself to say words and perform actions that are typically linked with friendliness. Because of your mirroring brain's pattern of activation, from a neural perspective, a friendly response will be easier.

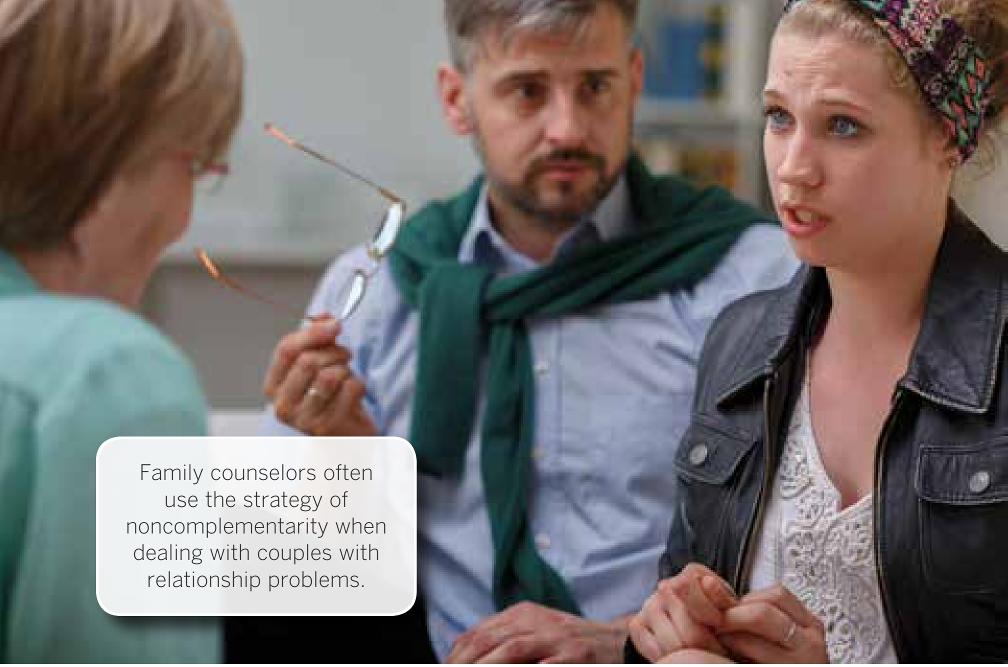
- This brings us back to the counterintuitive strategy of being nice to someone who is mean to you. When someone behaves aggressively toward you, you will have a natural tendency to respond in kind. Your brain will mirror the behavior you see and prepare to respond to malice with malice. Your behavior, of course, will tend to be mirrored by the other person's brain, and the malice will build between the two of you. If you can short circuit this cycle, mean can change to nice.

Shift to a Noncomplementarity Mode

- Researchers refer to our tendency to imitate one another as complementarity. Our behaviors tend to match the tone and content of the person with whom we are interacting. Fundamentally, the human brain is wired to interpret and respond to the actions of others.

- It can be incredibly difficult to resist the unconscious complementarity reflex. When someone expresses anger at you, your brain is adept at finding connections to words and actions that are related to anger because anger is so firmly activated in your brain. But if you can respond to aggression with kind behaviors, you can often defuse a negative interaction. Researchers refer to this shift away from complementarity as noncomplementarity.

- Family counselors often use the strategy of noncomplementarity when dealing with couples with relationship problems. If two people continually argue aggressively with each other over an extended period of time, the aggression response will be stimulated even before the first word is spoken. The brain gets into a defensive posture even before any actual attack. Once two people are stuck in this mode of processing, it can be very difficult to find a way to live happily. If one person periodically expresses something genuinely positive and demonstrates real kindness to the other person, however, the vicious cycle can broken.



Family counselors often use the strategy of noncomplementarity when dealing with couples with relationship problems.

Misdirected Anger

- While extreme anger and rage can be very destructive, mild anger has the capacity to produce actions that result in positive outcomes. For example, if someone is harming you or someone you love, it is quite reasonable to get angry. What's more, you shouldn't short circuit that process. If you are angry and it spurs you to positive, meaningful action, go with it.

- The problem with anger, however, is that it has an unfortunate tendency to get misdirected. Imagine that you have had a bad morning and experienced a highly unpleasant interaction with a colleague. Although you felt angry, it wasn't appropriate to express it at the time; therefore, the anger gets repressed. Then, imagine when you get home later that day, you find that the dog has chewed up one of your socks. Your reaction at this point may be much greater than is proportionally appropriate—certainly much more than the poor dog deserves.

- When humans get angry, we feel as if we direct our anger at a particular something; however, the anger doesn't seem to remember that particular something very well. If another situation or individual taps into our established reservoir of anger, it can all come rushing out at the same time.

Suppression, Not Repression

- When you feel anger, a variety of research suggests that you should suppress it, but you should not repress it.

- The theory behind some anger-management therapies is that anger is like a poison created by your brain. If you express that anger, then you let that poison out. Screaming, letting off steam, venting grievances, and not bottling up anger are all expressions that focus on the concept of catharsis. According to the theory, by engaging in certain actions, it may be possible to reduce or eliminate anger.

- As compelling as these concepts are, recent evidence suggests that catharsis is a myth. In fact, particularly at certain phases during the process of becoming angry, expressing anger will result in more, not less, overall anger.

- Consider this research by Brad Bushman and his colleagues. They began their study by recruiting participants and making them angry. Half the participants were randomly assigned to a catharsis condition and were allowed two minutes to vent their frustration by hitting a punching bag. The other participants simply waited for those two minutes.

- In the testing phase of the experiments, the participants played a game against an opponent in another room. At various points during the game, the participants were given the opportunity to punish their opponent with loud blasts of noise. The hypothesis here was that if catharsis works, then attacking the punching bag should reduce the amount of anger left in the brains of the participants. This lower level of anger should result in shorter, quieter bursts of noxious sound being directed at the opponents.

- Exactly the opposite result was obtained, however. Using the punching bag did not reduce anger; it significantly increased it.

Consciously Redirect Anger

- Repression is a highly problematic approach to anger management. If you repress some feeling of anger, you pretend that the anger doesn't exist. Many of the worst outcomes associated with misdirected anger come from the repression process.

- An alternative to repression is suppression of the anger. Suppression of an angry feeling involves resisting the urge to scream, yell, and fully express the anger in the most obvious way. In that sense, it is similar to repression. But if you are suppressing the anger, you can still express the anger—but without the overt, aggressive aspects usually associated with that expression.

- Say that you are really angry. You might feel like yelling to express this anger. But you know, based on four decades of research on catharsis, that yelling will not make you less angry; on the contrary, it will make you more angry. The tip when you are in this situation is to verbally convey the same information about being angry but to do so in the most monotone, boring voice possible.

- You are suppressing the bad aspects of the anger—the parts that will inspire an aggressive response on the part of the other person. Better still, you are making it clear what the anger is about. By keeping the discussion calm, both parties can use their full complement of frontal-lobe brain tissue to resolve the problem.

- Suppressing anger isn't about pushing away the anger, it is about consciously redirecting the anger response away from the activities—like shouting and cursing—that are often the most instinctual.

You might feel like yelling to express anger. Yelling will not make you less angry; on the contrary, it will make you more angry.

Count to 10

- Evolutionary biologists describe the systems that mediate our angry emotions and behaviors as very ancient and very fast. As our ancestors competed with others for limited resources, being able to generate a strong aggressive response quickly was a competitive advantage associated with survival. Anger is fast. Thinking—and calmly responding—is slow.

- There's a time-honored anger-management strategy worth mentioning here that is strongly supported by research on the brain. If you feel a surge of anger and want to get it under control, slowly count to 10. Simply waiting for the slower cortical systems to catch up with the faster subcortical systems that mediate anger can greatly reduce irrational anger behaviors.

Questions to Consider

1. Catharsis of anger seems to work for some people if they go for a very long run. It's difficult to be angry when you're on the verge of exhaustion. Is this claim inconsistent with the evidence that catharsis is actually a myth?
2. The strategy of expressing anger in a monotone voice can be a very effective way to convey your concerns without ramping up your anger. It can also sound a little humorous and feel incongruous. If you crack a smile while conveying your anger, when is that likely to help the situation? When is it likely to make the situation worse?

Suggested Readings

LeDoux, *The Emotional Brain.*

Sander et al., "Emotion and Attention Interactions in Social Cognition."

Suppress—Don't Repress—Anger

The emotion of anger has a long reputation as something bad and uncontrolled. But, as with other aspects of our brains, it's not only possible to outsmart anger, we can even turn anger into something positive and quite helpful.

Here's a tip. The next time someone is being mean to you, try an experiment. Be nice to them and see what happens. There are many ways you might choose to be nice, but the key here is to be unexpectedly nice—to be almost shockingly unexpected. Sincerely compliment the mean person's appearance. Give the mean person a gift. Smile warmly, look the mean person in the eyes and ask him or her to go to lunch with you, your treat.

A lot of recent research suggests that when you say or do something nice like this, you will partially take control of the emotional centers of the aggressor's brain and turn off his or her ability to be mean to you—at least to some extent.

The reasons for the effectiveness of this technique begin with the brain's mirror neuron system. These neural circuits were first discovered in the motor cortex of monkeys, but a variety of work has demonstrated that they are present and perhaps more complex in humans. When you perform a movement of your body, you activate particular neural circuits within your motor cortex.

If you make a particular movement with your right hand—flexing your fingers sequentially, for instance—the action is coordinated by neural circuits located in a particular region of the left frontal lobe. Recall that the human brain has this crossover organization throughout the nervous system, with the left side of the body controlled by the right side of the brain and vice versa.

If you watch me making that same motor movement, that sequential flexing of the fingers—when you do, that same region of your brain will become active. Note that this brain region is active even when you, yourself, aren't moving while you watch me. You are just perceiving and thinking about my hand movements. The activations in that motor cortex will be of a lower magnitude than they would be if you were performing the movement yourself, but the same region is activated and in a very similar fashion.

These neurons were first discovered by a research team led by Giacomo Rizzolatti. They described them as mirror neurons because the neural system was, in essence, mirroring the activities of another individual. As if the observer were performing the actions him or herself.

Our brains seem to engage in this mirroring as part of the process of understanding the actions of others—in determining if and how to respond. What is that guy doing? And why? Well if I were engaged in that action, what would I be thinking?

Humans also do a lot of important learning by imitation. If you've ever taught a child how to tie shoelaces, you likely didn't describe it verbally. I'm not even sure how you would do that. You demonstrated probably slowly and repeatedly how to tie shoelaces. The learner watched you carefully, the child's brain mirrored that activity and then, eventually, tried to reproduce the observed, mirrored actions. If you watch someone perform a particular dance a few times, even if you've never tried it yourself, you will likely be able to approximate it the very first time you try. While you were watching the dance performed, your brain was interpreting that dance by simulating your own performance, doing that the whole time.

There are a few interesting things that these mirror neuron systems cause in our everyday behaviors. The next time you are having a face to face conversation with someone, there's a fun experiment that you can try. You can make your conversation partner do things that he or she would not otherwise do.

As you are engaged in the conversation, cross your arms—left over right. Over the course of the next 30 seconds, the probability that your friend will cross his or her arms will be greatly increased. If it doesn't work the first time, uncross your arms for about 30 seconds and then repeat the process. Maybe, this time, crossing your right arm over the left.

The possible movements you can try here are almost limitless. Try leaning back against your chair and put your arms behind your head. Stroke your chin. Touch your earlobe. Tap your fingers together.

Now, your conversation partner isn't a marionette here. Not every action you perform will be immediately mimicked. But, as you engage in these behaviors, your friend's motor cortex is being activated. It will be mirroring your actions with a low level of coordinated activation. As your friend continues talking, the likelihood of these actions being imitated is greatly increased.

Even if you don't feel like manipulating the actions of your friends, you can often just see this mirroring behavior if you watch two people having an intense conversation. As they pay close attention to one another, they will tend to make many of the same gestures and movements. This mirroring is an important part of how we relate to one another. If nothing else, it conveys that we're paying close attention.

The human brain doesn't just exhibit this mirror pattern in terms of visually guided arm and hand actions. There is substantial evidence for the motor theory of speech perception. When you listen to someone speaking—as you are listening to me right now—there are particular regions of your brain that parse the sentences and derive meaning from them. One of the important steps in that process is for your brain to activate the regions that would be involved in producing those same sounds that you recently heard from the speaker.

There is evidence that just listening to speech produces low levels of activation in your own vocal tract—in the particular muscles that you would use to produce the same sounds. Again, understanding what someone else is doing is accomplished by simulating, at a neural level, what you yourself would do to produce those same behaviors.

All of the examples I've described so far have involved sensorimotor control—movements of the body mediated by sensory inputs. Some recent work suggests, however, that this mirroring tendency isn't limited to motor activities at all. If someone behaves aggressively toward you, you don't have to decide to respond aggressively. That will be your brain's default response. When you observe the aggressive behavior, your brain will already be mirroring it, priming an in-kind response.

The thing that is being mirrored is more complex here, but the concept is the same. Someone is yelling at me, exhibiting a contorted facial expression, and shaking his fist in my direction. Why would he be doing that? Well if I were performing those same actions, what would I be thinking? Those three actions are strongly associated with angry, aggressive feelings. As my brain mentally simulates performing those actions, it will tend to activate the associated systems. Regions of the amygdala associated with the sympathetic nervous system will become active—a fight or flight mode of activity will be inspired.

Things that have tended to make me angry in the past are associated with this information, and the circuits that encode this information in the frontal lobes will become active as well. My brain will be primed to recall words that are associated with anger—hit, hate, hurt, fight, and so on. Similarly, the neural circuits associated with the actions denoted by these words will be primed. It will be easier to think of and perform these behaviors.

And note, I haven't said or done anything yet. I have just seen someone acting in a certain way. It's not that I will necessarily say or do these things.

I will hopefully choose not to respond angrily, but my brain is primed and ready to do so. An angry response will, in a neural sense, be easier.

Conversely, if someone is very warm and friendly to you, your brain will mirror that. To understand when someone is smiling at you, waving, and warmly saying "Hello," your brain will simulate performing those actions. The parasympathetic nervous system will become active. Your brain will prepare itself to say words and perform actions that are typically linked with these observed actions—smiling, hugging, helping, cooperating.

You are likely to make a friendly and warm response back to that person. It's not that you certainly will make this friendly response—maybe you will recognize the person as a bitter enemy and respond aggressively. But, because of your mirroring brain's pattern of activation, a friendly response will be easier.

When you have these two experiences—confronting the angry person or the meeting the friendly person—it will feel as if you decided to say or do a particular thing, but the cognitive neuroscience perspective on this suggests that the conscious part of the decision is often just to release a set of behaviors that were already planned out by your mirroring brain.

This brings us back to our odd tip of being nice to someone who is being mean to you. When someone behaves aggressively toward you and toward your brain, you'll have a natural tendency to respond in kind. Your brain will mirror the behavior that you see, and prepare to respond to mean with mean. Your behavior, of course, will tend to be mirrored by the other person's brain, and the meanness will build between the two of you. If you can short-circuit this cycle, mean can change, sometimes very abruptly, to not mean and sometimes even to nice.

I read an account of a woman driving out of a parking lot who nearly hit an older man on a bike. The man was initially frightened—and reasonably so. He came within inches of being very badly injured. As is often the case, however, that initial fear quickly transformed into intense anger at the person who caused it. He began shouting at the woman in the car.

Screaming at her, actually. Cursing at her for being so stupid and careless, “You almost killed me.”

Now, there’s a standard script to what happens next here. In a near miss accident like this one, the person who is being verbally accosted defends herself. She was, after all, not trying to hurt the man. Indeed, perhaps the man should have been proceeding more carefully himself. This wasn’t all the driver’s fault—at least that’s what the driver will angrily argue.

This particular driver was on the verge of starting into this argument script. She would point out how the biker had been at fault, at how he was being rude to her by screaming and cursing. But then somehow, she didn’t. She chose to not respond aggressively. Actually, she began crying. And she apologized.

The screaming man was more than a little surprised at this. He was geared up for the shouting match they were about to have. The notion that he would be facing a crying person was not anticipated. The man’s anger vanished—at least his angry behavior did. He switched to consoling the woman. He apologized for his role in the incident. The man still asked her to drive more carefully but pointed out that no one had been hurt, and that everyone makes mistakes like this sometimes.

Researchers refer to our tendency to imitate one another as complementarity. Our behaviors tend to match the tone and content of the person with whom we are interacting. It’s just a fundamental tendency of how the human brain is wired up to interpret and respond to the actions of others.

It can be incredibly hard to resist this unconscious complementarity reflex. If I ask you to think of words that are related to the word chair, it’s easy to think of many things that are related, table, sit, dinner, legs, cushion and so on. If I ask you think of words that are not related to chair, that task is much harder. I look around the room. Floor, well, chairs sit on floors. Cat—cats love to sleep in chairs.

When someone expresses anger at you, your brain is good at finding connections to words and actions that are related to anger. Things like yelling. It can be very hard to think of something to say or do that is related to nice, just because anger is so firmly activated in your brain.

But if you do think of those words and actions—if you can respond to aggression with nice behaviors, it can often diffuse a negative interaction, often very rapidly. Researchers refer to this shift away from complementarity as non-complementarity. It is hard to do, but it can be very effective.

I have, like most people, occasionally been in unpleasant arguments—arguments that grew quickly too angry or acerbic to be productive any longer. In these situations, we might be hurling insults or shouting at each other, but not actually listening to each other anymore. At this point, the argument was really of no value anymore. Information was being conveyed, but no information was actually being received. No progress was being made toward actually resolving the disagreement.

My human brain, like everyone else's, has a hard time getting out of the rut of this nasty complementarity behavior. Here's a trick that has worked for me. As you look at the person, think, I love you, over and over again. Don't say it, now, just think the words. I love you, I love you, I love you. Even if you don't actually love the person, it can be downright impossible to think of more nasty things to say while you are doing this. As something positive does come to mind, say or do that positive thing. It might just end the conflict and get you both on to something more pleasant and productive.

Family counselors often use this strategy when dealing with couples who are having relationship problems. If two people argue aggressively with one another a lot, over an extended period of time, in particular, the aggression response will be stimulated even before that first word of a discussion is uttered. The brain gets into a defensive posture even before any actual attack. Once the two people in a relationship are stuck in this mode of processing, it can be very hard to find a way to live happily.

If one, ideally both, but even just one of the members of the couple periodically expresses something positive to the other person, it can help to break this vicious cycle. It can be an uncomfortable thing to do, actually. We're talking here about delivering a compliment or a favor that is undeserved, seemingly unwarranted, and yet as much as possible completely genuine.

Researchers like Myrna Friedlander and her colleagues have found that the technique is often helpful. The one potential problem that she has identified with this approach is that, if the compliment is taken as not being genuine perhaps taken as a sarcastic statement rather than a compliment that it can lead back to more aggressive interactions. If you choose to try this technique then, you should start by finding something to do or say that you can be genuine about. Then be sure to follow through to make clear that you did actually mean what you said or did.

I've urged you to experiment with being nice to someone who doesn't necessarily deserve it. Someone who has been mean or aggressive with you. I'm not really urging that you do it for that person, however, but for yourself. If you can find a way to force yourself, momentarily to be kind to someone, even if they don't deserve that kindness, you can shift how their brain processes additional incoming information. You can avoid, for yourself, the unpleasant experience of an angry confrontation. And ultimately, you can have a greater influence on that other person's behavior.

I've been bad mouthing anger here for a few minutes. That's not completely misplaced. Anger, particularly the extreme anger we associate with rage, can be very destructive. But anger also has the capacity to promote actions that result in a lot of good in the world.

When you hear of one group of people mistreating another group, perhaps due to racial or some other prejudice, you might be very justifiably angry. It would be a bad thing to somehow short-circuit that anger process. If someone is harming you or someone you love, it is quite reasonable to get angry. It would be very bad to figure out some outsmart method to just making that anger go away.

If you are angry and it spurs you to action, I along with just about everyone would say that's a good thing. Go with it. The problem with anger, however, is that it has a pesky tendency to get misdirected at something that isn't really the cause of the anger. For instance, maybe I have a bad morning—a bad interaction with someone early in the day. Some anger is felt, but maybe it wasn't appropriate to express it or deal with the problem at the time. So that anger just gets repressed, it just sits there in my brain. Maybe it feels like it's sitting there as a knot in my stomach. The day continues. I get home later in the day and find that my dog has chewed up one of my socks.

Now, there's reason to be a little upset with the dog for this sock-chewing behavior, but my reaction at this point might be very large; much larger than is proportionately appropriate, yelling "I can't believe you chewed another sock. Bad dog. Bad dog." I've never hit my dog, but extreme anger can lead to irrational violence. In my case, it would just be that I would yell far more loudly and for far too long certainly much more than the poor dog deserves.

I'm not too embarrassed to tell this story because I think all of us have had this experience. When humans get angry, we feel like we get angry at something, but the anger doesn't seem to remember that thing very well. If something else taps into an established reservoir of anger, it can all come rushing out at the same time.

This is obviously a problem that would be good to solve. When you feel anger, a variety of research suggests that you should suppress it, but you should not repress it. Let me unpack what I mean by these two terms.

In the 1970s, primal scream therapy became very popular. The idea here is that you should periodically take a few minutes and just scream your head off. Patients would be asked to think of something in their past that had made them angry—maybe their recent past, sometimes their distant past, even their childhood. Once that experience was called clearly to mind, the patient would engage in unrestrained, full-throated, angry screaming for several minutes.

The theory behind this work is that anger is like a poison that your brain creates. If you express that anger, then you let that poison out. If you don't, then that poison can turn on you, causing anxiety, depression, stress, even heart disease. The primal screaming was a method that was supposed to help that poison get out.

Many other therapies have been developed with similar kinds of goals. Indeed, it has become a part of how we talk about anger. If someone dealing with anger goes for a hard run or punches a heavy bag for a while, we might say that the person is letting off some steam. In this case, the steam is the accumulated anger that needs to find a good outlet to prevent it from inadvertently being vented on someone who doesn't deserve it maybe a sock-chewing dog, for instance.

Screaming, letting off some steam, venting grievances, not bottling up your anger—these are all expressions that focus on the concept of catharsis. By engaging in certain actions, it may be possible to reduce or eliminate anger.

As compelling as these metaphors can be, there is a lot of recent evidence that suggests that catharsis is a myth. Particularly at certain phases during the process of becoming angry, expressing the anger will result in more not less overall anger.

Consider one of many example studies of this. Brad Bushman and his colleagues started their study by recruiting participants and making them angry. They asked all of the participants to write essays on some controversial, sensitive topic—for instance arguing for the pro-life or pro-choice perspective on abortion. The experimenter then told the participants that their essays would be evaluated by an anonymous peer. In reality, the experimenter provided all of the ratings, and, regardless of the essay, gave them very negative reviews. All essays were rated as being of poor quality. A kicker of a comment was also thrown in, that this was perhaps the worst essay ever read. The participants received this feedback and felt angry. No surprises yet.

Half of the participants were randomly assigned to a catharsis condition and allowed two minutes to vent their frustration by hitting a punching bag. The other participants simply waited for those two minutes.

In the testing phase of the experiments, the participants played a game against an opponent in another room. At various parts of the game, the participants were given the opportunity to punish their opponent with loud blasts of noise. The participant was allowed to pick how loud and how long those sound blasts were. The opponent was actually another experimenter, although this was not disclosed to the participant. It was made clear that the opponent was not the person who had just evaluated the essay, either. This was just another person.

The basic prediction here was that if catharsis works, then punching the heavy bag should reduce the amount of anger left in the brains of the participants. This lower level of anger should result in shorter, quieter bursts of noxious sound being directed at the opponents. Exactly the opposite result was obtained. Punching the heavy bag did not reduce the participants' anger. It significantly increased it.

This result has been obtained in a wide range of experimental contexts, using many different potential methods of catharsis, based on many different measures of anger, and over the course of more than 40 years of work. People who play aggressive sports, in which presumably they would be given frequent exposure to cathartic physical activity, tend to be more aggressive than those who do not. In one study, participants were insulted by someone. Then they were allowed to pound nails for several minutes. This resulted in more angry criticism of the person who made the insult—not less. Brad Bushman has become a leading critic of children's frequent exposure to violent video games. Playing games in which a participant experiences simulated aggression is not cathartic. Playing these games results in reliable, significant increases in aggressive behavior.

Most research in this area has increasingly focused more on just why we humans so often think that catharsis works as a strategy for reducing anger; why we think it works even when the data so clearly suggests that it has the opposite effect. There seem to be at least two reasons. One is that catharsis feels good. When you engage in intense physical activity, your brain produces many hormones that result in a sense of pleasure—endorphins, dopamine, and norepinephrine just to name three. A second reason is that sometimes getting away from an angry interaction can help us to more effectively deal with it when we return. If I'm really angry with my sock chewing dog, getting away from the situation for a few minutes can allow me time to develop a more appropriate perspective on the situation. The evidence suggests that it would be better not to punch a heavy bag during that time, but the time away might still help.

So how should we deal with that anger when it arises? One possibility that is problematic it to repress the anger. If you repress some feeling of anger, you do two things. First, you resist expressing that anger, likely due to the pressures of social convention. It doesn't matter how angry you are at your boss—if you fully express that anger, he might not be your boss very much longer. In addition to resisting an expression of the anger, repression involves doing a second thing as well—you pretend that the anger doesn't exist. If I have a bad day at work and head home to my sock-chewing dog without dealing with that anger, then I'm simply ignoring it. Many of the worst outcomes associated with misdirected anger come from this repression process.

An alternative to repression is suppression of the anger. Suppression of an angry feeling involves resisting the urge to scream, yell, and fully express the anger in the most obvious way. In that sense, it's similar to repression. But if you're suppressing the anger, you should still express the anger, as much as possible, but without the overt, aggressive aspects usually associated with that expression.

Let's unpack that sentence a bit. Maybe you do something that makes me really angry. Say you report me to the Humane Society because you've heard that I yell at my dog a lot over a little sock-chewing incident. The

SPCA officials show up at my door and threaten to take away my dog. I would be angry at you. Really angry, actually. I love living with my dog.

I might feel like yelling at you to express this anger—to vent the anger so that I don't blow my top to stick with another steam-based catharsis metaphor. But I know, based on four decades of research on catharsis, that yelling at you will not make me less angry. On the contrary, it will make me more angry. The tip when you are in this situation is to convey the same information about being angry but to do so in the most monotone, boring voice possible.

"I am really furious at you. I think it's really presumptuous of you to have called the humane society and reported me. I love my dog. I've never hurt him. I never would. I might have yelled a little too much, but I only do that rarely. How could you even know what kind of life my dog has? You've never even met us."

Now we're cooking here. We are suppressing the bad parts of the anger, the parts that will inspire an aggressive response on the part of the other person. Better still, I'm making clear to you what my anger is about, what you specifically did that is upsetting to me. Maybe you have some reply about what you did and why. Maybe that explanation is reasonable to me maybe not. But by keeping the discussion calm, we can both use our full complement of frontal lobe brain tissue to resolve this problem.

Suppressing anger isn't about pushing away the anger, but about redirecting the anger response away from the activities—like shouting and cursing—that are often most intuitive.

What if suppression doesn't work? What if we have a perfectly calm discussion that does not reach a resolution. Maybe I am still angry at you and you at me? Now we might be at a place where getting some separation, and perhaps some physical activity can help. If we can both go away and find a way to get away from our disagreement for a while without feeling that intense anger, then when we revisit the disagreement, perhaps a creative solution can be found.

Evolutionary biologists describe the systems that mediate our angry emotions and angry behaviors as ancient and very fast. As our ancestors competed with others for limited resources, being able to get angry quickly—to generate a strong, aggressive response—was a competitive advantage associated with survival. Anger is fast. Thinking calmly, responding, that's slower.

There's an old tip worth mentioning here that is strongly supported by research on the brain. If you feel a surge of anger and want to get it under control, count to 10 slowly. Just waiting for the slower, cortical systems to catch up with the faster, subcortical systems that mediate anger can greatly reduce irrational anger behaviors.

So far in this lecture, I've suggested a variety of ways to deal with problems that can be associated with uncontrolled anger. But it would be a bad thing to completely turn off your ability to get angry. It would be really bad, I think if we could somehow reach into your brain and eliminate your ability to feel anger.

Some anger is extremely appropriate. Is there an upside to anger? Yes, there are at least two different upsides.

If you become aware of people who are victims of poverty or injustice, there are two very different types of responses that you might feel. One is empathy for the victims of the suffering. The other, however, is anger toward the people responsible for the problems. When people who get involved in organizations that seek to reduce the suffering of others, whey they're surveyed, it's actually the anger that is more motivating.

A second upside is the way that anger can motivate our desires. Anger can be like a source of energy. In one clever study on this, participants were shown a series of object images on a computer screen. Just before an object photo was presented, a face image was very briefly flashed on the screen. The face had either a neutral, fearful, happy, or angry expression. After viewing this whole sequence of images, participants indicated how much they wanted the things depicted in the images. In one condition, participants would squeeze a handle as hard as they could in a game in which they were told that the harder they squeezed, the more likely they would be to win the object as a prize. Participants expressed a stronger desire for—and squeezed the handle significantly harder—for objects that were associated with the angry emotion than for the others. It seems that, if we see something and pair it with a mild feeling of anger, that it becomes more attractive. It becomes something that we will work harder to get.

Extreme anger can create many problems, but mild anger can be an emotion of tremendous importance. The key to the tips that I've described here is not to eliminate your anger. There is good evidence that these strategies can help convert anger into positive, productive action. Some of the greatest things humans have ever accomplished began with someone becoming enraged that the world is as it is, rather than as it could be.

Lecture 18

How Little Things Cause Big Persuasion

In this lecture, we look at ways you can outsmart others (or realize how they are trying to outsmart you). Understanding the workings of the brain and human decision making can help enhance our own persuasive abilities. What's more, by exploring how other people's decision making can be influenced, you will come to better comprehend your own decision-making process and avoid some of the biases that affect us all.

The Reciprocity Principle

- Imagine that you are selling raffle tickets. There are two possible scripts you can follow:
  1. "*Hello. My name is Peter, and I'm selling tickets for a charity raffle. All the raffle proceeds go to support the Juvenile Diabetes Research Foundation. Tickets cost 10 dollars, and every ticket gets you a chance to win a prize worth 10,000 dollars. How many would you like today?"*

  2. *"Hello. My name is Peter, and I'm selling tickets for a charity raffle. Actually, I have these cool Juvenile Diabetes Research Foundation pens to give out too. Here, take one! All the raffle proceeds go to support the Juvenile Diabetes Research Foundation. Tickets cost 10 dollars, and every ticket gets you a chance to win a prize worth 10,000 dollars. How many would you like today?"*

- The more effective script is number 2. Across a wide range of studies, it has been found that if you offer people a gift before you ask them for something, they are far more likely to donate and much more likely to make a larger donation. What is remarkable is that the magnitude of the gift almost doesn't matter. The gift can be a pen, a slice of pizza, a cup of coffee. The return on investment from a small gift can be enormous—300 percent in some studies.

- The effect of this strategy, caused by the reciprocity principle, is seen in many areas beyond charitable donations. A classic study of the reciprocity effect was conducted by Robert Cialdini and his colleagues using waiters and diners. Waiters gave their normal service: took orders, delivered food, conversed with the diners, and brought the bill. For half the patrons, the bill was delivered along with a single after-dinner mint. For the other half, the bill arrived without the mint. The researchers recorded the tips that the patrons left.

- The single mints resulted in a 3 percent increase in the size of the average tip. While that is a small increase, it was statistically very significant. What's more, when the bill was delivered with two mints for every person at the table, the tips increased by 14 percent.

- In another condition of the study, the waiters emphasized the gift-giving aspect of the interaction. The waiter would deliver the bill with one mint per person and then start to walk away. The waiter would then stop, turn back to the table, and say, "You've been really nice tonight. Here are some extra mints." Now, the tips went up by 23 percent.

The "Because" Reflex

- Researchers interested in persuasion—very notably Cialdini and his group—have elucidated a wide range of principles that seem to exert a powerful influence on our decision-making processes. When someone asks you to do something, how they ask often has a great deal to do with whether or not you say yes.

- The reciprocity principle is only one of many unconscious reflexes that operate in the human decision-making process. Consider this study of the "because" reflex. Experimenters went to a library where there was

In one study, when a restaurant bill was delivered with two mints for every person at the table, the tips increased by 14 percent.

a public photocopier used by students and faculty. The experimenter would wait until someone was using the photocopier and a second person was waiting to use it next. The experimenter would approach the waiting person and ask if he or she could use the photocopier first. Some people would say yes, but most people would say no.

- If the experimenter asked to go first but also gave a reason for it, a greater percentage of the people said yes. The third experimental condition of this study was the most interesting one, however. It turns out that the word "because" is significant in the request. The word "because" triggers an unconscious reflex that makes us more likely to say yes.

Foot-in-the-Door Technique

- Consider another persuasion method called the foot-in-the-door technique. If you have worked as a salesperson, you might already be familiar with this sales technique. It gets at a central part of how the human brain makes decisions: How we frame the decision makes a lot of difference.

- The basic idea of the foot-in-the-door method is to get people to say yes to some small request. Once you've done this, you can frame future decisions. The most frequently cited study of this phenomenon comes from Robert Cialdini's group. They picked out an area near Phoenix, Arizona, and randomly divided houses into two groups: the foot-in-the-door group and a control group.

- For the control group, the researchers visited each house and asked homeowners to participate in a new safe-driving campaign. They asked each homeowner if they could put a large wooden sign in the middle of their front yard that read "Drive Safely." Think of an enormous wooden sign cluttering up the front yard. Only 20 percent said yes.

- For the people assigned to the foot-in-the-door condition, the researchers first visited the house and asked for something very small. Homeowners would put a small card in their window reading "Drive Safely." A full 76 percent said yes.

- A few weeks later, the researchers visited the foot-in-the-door houses again. During the second visit, they asked to place the large wooden sign in the yard. Now, however, a much higher proportion of the people said yes—55 percent. By asking for the small window display first, the researchers yielded almost three times as many people willing to put in the large yard sign.

Drive for Consistency

- Cialdini and his colleagues interpret this as evidence of humans' drive for consistency. While you don't often think explicitly about who you are and what your values are, every time you make a decision, some part of your brain seems to do that.

- For the people in the safe-driving study, when they said yes to the small window sign, it changed them. It changed their brains. It reinforced in them the notion that they care about driving safety. As they weighed the pros and cons of saying yes to the yard sign, a greater value was put on the self-perceived commitment to driving safety, and 400 percent as many people said yes.

- The foot-in-the-door technique can be adapted to almost any situation in which you are looking to persuade someone to do something. The tip here is to seek an initial small commitment from someone that has three characteristics: voluntary, active, and public. Our unconscious drive for consistency is amplified if we have the sense that others are aware of our decisions. We have an internal drive to be perceived by others as principled, character-driven people.

Minimize Cognitive Dissonance

- To make full use of the consistency reflex, make sure there is a delay between the small request and the large one. The unconscious process of changing our sense of who we are and what's important to us seems to take at least a day. Most studies that have shown the largest effects have involved delays of about a week.

- Methods of persuasion that focus on the unconscious consistency reflex capitalize directly on our desire to minimize cognitive dissonance. Cognitive dissonance is a situation in which we hold two different contradictory beliefs or sets of information. In general, humans do what they can to reduce cognitive dissonance.

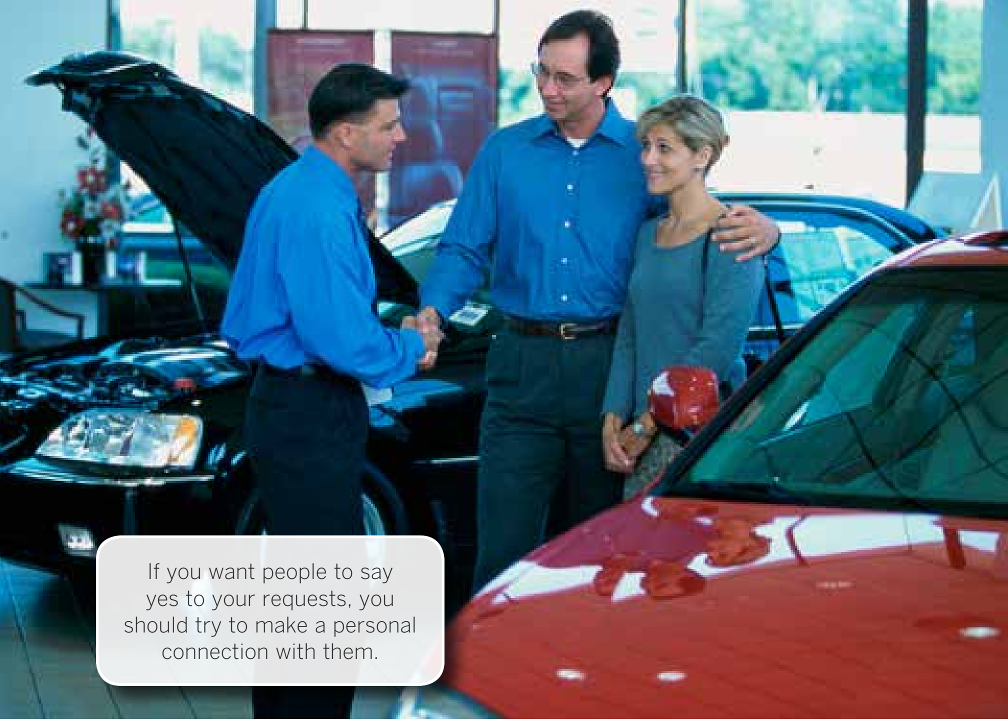
- A state of cognitive dissonance is associated with activity in a variety of regions of the brain, notably the dorsal anterior cingulate cortex and anterior insula. When the person whose initial request you have granted makes a second, larger request, the activation in these regions of the brain are likely increased. You might want to say no to the larger request, but the disconnect between that no and your prior behavior would create a large amount of dissonance.

- The unpleasantness of the dissonance becomes a factor in your decision making. It might be unpleasant to put a giant wooden sign in your yard, but it might be even more unpleasant to have to deal with the negative feeling of cognitive dissonance.

The Personal Connection

- If you want people to say yes to your requests, you should try to make a personal connection with them. Consider this Karen Wynn study of the morality of infants. Infants in her study start by choosing food from one of two bowls—green beans or graham crackers. Not surprisingly, nearly all the infants choose the graham crackers.

- The babies then watch a rabbit puppet make the same choice. Sometimes, the puppet chooses the same food as the child; sometimes the puppet chooses the green beans. The infants then watch the rabbit puppet attempting a task and having some trouble. As the rabbit is struggling with the task, another puppet comes on



stage. Sometimes the second puppet helps the rabbit; in other cases, the second puppet hinders the rabbit.

- After all of this, the babies are allowed to play with a choice of puppets. Two important tendencies were observed in these studies. First, if the rabbit chose the same food as the child, the infant expressed a preference for puppets that had helped the rabbit and an aversion to puppets that had been mean to the rabbit. If the rabbit chose a different food, however, the children expressed a positive preference for puppets that had been unkind to the rabbit.

- If the rabbit is seen as "like me," then the baby seems to want to see that rabbit treated well. If the rabbit is seen by the infant as "unlike me," the kids seem to want to see the rabbit punished.

- Fast forward a few decades, and you have an adult. Adults have learned a great deal, collected thousands of social experiences, acquired language, and made tremendous strides in intellectual and social development. But this tendency to be nice to people whom we perceive as "like me" is still there.

Questions to Consider

1. Many studies demonstrate that we tend to say yes to people who are "like us" more frequently than to people whom we perceive as "unlike us." Which bias is right? If we perceive people as being like ourselves, should we resist agreeing to what they ask? Or should we intentionally say yes more often to people who are very different from ourselves?
2. Many charities collect the bulk of their annual donations around the end of the year. Given the nature of human decision making, what are some of the reasons for this?

Suggested Readings

Cialdini, *Influence*.

Gladwell, *Blink*.

Lecture 18 Transcript

How Little Things Cause Big Persuasion

Hello. My name is Peter, and I'm selling tickets for a charity raffle. All the raffle proceeds go to support the Juvenile Diabetes Research Foundation. Tickets cost $10, and every ticket gets you a chance to win a prize worth $10,000. How many would you like today?

When you are presented with a decision like this, your conscious thinking likely kicks into gear. Ten dollars sounds like a lot for a charity raffle ticket, but $10,000 would certainly be a nice prize. Curing juvenile diabetes is certainly a worthy goal. Maybe you've even heard of this particular research foundation, and feel confident that the proceeds will go to good use—even if you don't win the prize.

If you are mathematically inclined, you might start calculating the true cash value of the ticket. The math is pretty simple. You take the value of the prize and multiply it times the probability of winning. A 100 percent chance of winning $10.00 is 1 time 10 equals $10.00. A 50 percent chance of winning $10.00 is .5 times 10, equals $5.00. So if the prize here is 10,000 dollars, then if your chance of winning is one in 1000, .001 times 10,000 equals $10.00.

If the charity raffle sells more than 1000 tickets, however, then the math says that this 10 dollar price tag is a bad deal—the ticket you buy for $10.00 is worth less than $10.00. But making money isn't the real goal here. It's for charity. A rational thinker should consider how much they are willing to donate to this cause, and then, based on that, determine the number of tickets that he or she wants to buy. Nothing else should really matter here. But it does.

> Hello. My name is Peter, and I'm selling tickets for a charity raffle. Actually, I have these cool Juvenile Diabetes Research Foundation pens to give out too. Here. You can have one. All the raffle proceeds go to support the Juvenile Diabetes Research Foundation. Tickets cost $10, and every ticket gets you a chance to win a prize worth $10,000. How many would you like today?

Across a wide range of studies, it has been found that this second version of the raffle sales pitch works better. And not just a little better—a lot better. If you offer people a gift first, before you ask them for something, they are far more likely to donate and much more likely to make a larger donation. In a situation like the one I've described here, we would expect 150 percent, even 200 percent as many ticket sales.

The tip here is straightforward. If you want someone to do something for you, give them a gift first. This is sort of obvious, on the surface at least. If you do something nice for someone, they are more likely to do something nice for you. What's remarkable, however, is the magnitude of the gift almost doesn't matter. The gift can be a pen, a slice of pizza, a cup of coffee. The return on investment that this can produce can be enormous—300 percent in some studies.

When you tap just the right spot near your knee cap, if you tap the patellar tendon, it causes a reflexive contraction of the quad muscles. There's a motor system reflex that causes this to happen; it happens whether you want it to or not. When someone receives a gift, it seems to do something very similar in terms of our decision-making process. The gift hits an unconscious reflex that causes us to be more receptive to requests, to be more compliant.

People who study this refer to it as the reciprocity principle. There are a lot of just-so stories about where it comes from. We are an inherently social species that has only thrived because of our amazing ability to cooperate with one another, for instance. Perhaps groups of humans who have this reflex tend to be more successful in their cooperating endeavors—building cities, running farms, things that have led to more survival and successful reproduction. Whether or not that's where that reflex comes from, there is tremendous evidence that it exists, and seems to be present in almost every human you will ever meet. If you give a gift to someone, that person will really crave giving something back to you.

I should point out that this doesn't just work in terms of charitable donations. There's a classic study that was conducted with waiters and patrons in a restaurant in Arizona. Waiters gave their normal service—they took orders, delivered food, had conversations with the diners, and eventually, brought the bill. For half of the patrons, a randomly selected half, the bill was delivered along with a single after-dinner mint for everyone at the table. For the other half, the bill just arrived without the mint. The researchers recorded the tips that the patrons left. The mints resulted in a three percent increase in the size of the average tip. That's a small increase, but it was statistically very significant. That is, based on the number of patrons and the typical variation in tip amount, the three percent increase was almost certainly not due to random chance.

In another condition, the bill was delivered with two mints for each person at the table. The tips increased by 14 percent. For a $100.00 dinner bill, now we're starting to talk about substantial money. And that money is given for the same service, the same food, in the same restaurant. The only difference is an extra few mints that cost about 2 cents each.

In yet another condition of the study, the waiters did something that emphasized the gift giving aspect of the interaction. The waiter would deliver the bill with one mint per person, and then start to walk away. The waiter would then stop, turn back to the table, and say something like, "You know what. You've been really nice tonight. Here are some extra mints for you."

The same two mints per person, same very small gift. Now the tips go up by 23 percent. This study, conducted by Robert Cialdini and his collaborators, is one of dozens that they have performed to explore this reciprocity effect. They have found similar effects with tips for people who clean hotel rooms. If the person cleaning the room leaves an envelope, a certain proportion of the people who stay in the room will leave a tip. If the cleaning person leaves a mint, the tips rise. If the mint is accompanied by a personalized note, indicating that the mint is intended as a gift, the tips increase by substantially more.

The amounts of money involved in all of these interactions are relatively small, but the principle scales up to larger transactions as well. Negotiations for multimillion dollar deals can incur swings of enormous amounts of money if a small gift is given early in the process. Sometimes that gift is a cup of coffee or a pen.

Sometimes the gift comes in the form of a small concession early on in the negotiation. People who make their living through negotiating contracts know this reciprocity principle well. As the details of some deal are hammered out, it can often be a really good thing to agree to concede to some small term and then ask for a much larger concession from the other side.

If you ever negotiate over the purchase of a house or a car, this will almost certainly be a useful piece of information. There's a reason that when you show up in the office of a realtor or a car dealer, they will almost immediately offer you at least one small gift. It works.

One recent study even found that it works for computers. Participants in this study completed two tasks. They were not told that they were related to one another. The participants first completed a web research task. An interactive computer system offered to help in completing this task and then provided that assistance. Half of the participants were randomly assigned to the same computer condition. Other participants switched computers; they completed their second task on a different machine that hadn't recently been helpful. The computer then requested assistance from the participants with a color calibration task. The computer would repeatedly present colored rectangles on the screen and ask participants to respond by indicating the shade of that color. The participant was also offered the option of ending this task at any time. After a computer had been helpful, if participants continued working using that machine, those participants performed more color judgments before ending the task. Our reciprocity reflex seems to be so strong that it can even be triggered by inanimate devices.

There are three critical things to keep in mind to make the best use of this reciprocity principle—this reciprocity reflex, actually. First, give a relatively small gift before asking for something. Second, make it apparent to the recipient that it is something you are doing for them, and third, make the gift as personal as possible. If you give a pen or a cup of coffee, it's only going to affect you if you perceive that item as a gift from me to you. If it seems like something that everyone receives as a matter of just regular course, then the reflex won't be triggered.

Researchers interested in persuasion, very notably Cialdini and his group, have elucidated a wide range of principles that seem to exert a powerful influence on our decision-making process. When someone asks you to do something, how they ask often has a great deal to do with whether or not you say yes.

We've been discussing the reciprocity principle for the last few minutes as an unconscious reflex that exists in your very human decision-making process. If this were the only reflex, it would still be interesting. What's really fascinating is that we have a lot of these reflexes.

One quick example of this that has been studied is called the because reflex. In the seminal study on it, experimenters went to a library, where there was a public photocopier that was used by students and faculty. The experimenter would wait until there was someone was using the photocopier and a second person was waiting to use it next. The experimenter would approach the waiting person and ask if he or she could use the photocopier first. Some people would say yes, but most people would say no.

If the experimenter asked to go first but gave a reason for it, a greater percentage of the people said yes. This makes sense. If I just ask, can I go in front of you in line, I am less likely to get a yes than if I say, can I go in front of you in line, because I'm late for class.

The third experimental condition of this study is the really interesting one. It turns out that the word because is really important in that request. Because triggers an unconscious reflex that makes us more likely to say yes. The experimenter would sometimes approach the waiting person and say, "Can I go in front of you in line because I want to go first?"

This isn't really a reason for going first. It's just a restatement of the fact that you'd like to go first. If you take out the word because, and just say those two sentences it would have exactly the same meaning. Amazingly, this version of the request, the one including the word because, led to a significantly higher number of people letting the experimenter ahead in the line.

There's a mini-tip here. If you want people to say yes to your request, you should give them a reason that includes the word because. I don't think that will be especially important in your future, but it illustrates a fascinating point. Human decision-making functions at a largely unconscious level and is subject to a variety of influences that we don't ever really choose. By understanding those tendencies, we can better understand our own decisions, and influence the decision-making of others.

In this course, I have focused on how you can outsmart yourself. Now, we are looking at ways that you can outsmart others or how they can try to outsmart you—how our understanding of the brain and human decision-making can be used to enhance our own persuasive abilities.

I feel the need to note that I'm a little bit on shaky ethical grounds here. I'm going to continue anyway for a few reasons. First, people do use the techniques described in this lecture on you on a regular basis. Every time you watch a television commercial or talk with a salesperson when you are considering some purchase, there are principles of persuasion applied to you. By understanding how other people's decision-making can be influenced, I hope you will understand your own decision-making process. I hope you understand it better and be able to avoid some of these biases that affect us all.

Second, persuading people to do something isn't always or even usually about taking advantage of them. When I try to persuade my children to try an interesting, exotic new food or to go to bed a little earlier, I have their best interests at the forefront of my mind. Persuading people to recycle more is of tremendous value to our society. Persuasion is a power that can be used to accomplish tremendous good.

Let's consider another technique referred to as the foot in the door. This persuasion technique was initially characterized in studies of door-to-door salespeople. If you've ever worked in a sales position like one of these, firstly, you have my respect. It takes a lot of fortitude and self-discipline to make it in that profession. It also takes a lot of cleverness. Salespeople rarely publish their work in academic journals, but a substantial part of our understanding of human persuasion comes from their decades of work; centuries of work, really.

In fact, if you have worked as a salesperson, you might already be a little familiar with this sales technique. It gets at a central part of how the human brain frames decisions. How we frame the decision makes a lot of difference.

Again, most people presume that we rationally weigh the pros and cons of any decision. We consider the costs and benefits of any decision to act—or not act. We then pick the choice, whichever one, that maximizes our benefits and minimizes our costs. Sensible? Of course. A good model for human decision-making? Not really.

Humans don't ever make decisions in a vacuum. The choice we make in the present moment can often be influenced by decisions we have made in the past. Understanding the irrational, but also quite predictable, biases that people have can help us understand decision-making better; can be really valuable.

The basic idea of the foot in the door method is to get people to say yes to some small request. Something that will be easy for them to agree to do. Once you've done this, it can frame future decisions. Humans like to be consistent. We like it when our decisions fit within the pattern of decisions we've made in the past.

The most frequently cited study of this comes from Robert Giardini's extraordinary group. They have a remarkable track record in this area. They picked out an area near Phoenix, Arizona, and randomly divided those houses into two groups—the foot in the door group, and a control group.

For the control group, the researchers visited each house and asked them to participate in a new drive safely campaign. To help increase safe driving and reduce the number of accidents and injuries that come with them, they asked each person if they could put a large, wooden sign in the middle of their front yard. The sign would be highly visible and contain the words drive safely for everyone to see.

I don't know about your neighborhood, but it's not surprising that in this neighborhood, a very large percentage of people said, no way. It's not that they didn't like the idea of supporting safe driving, per se, but an enormous wooden sign cluttering up their front yard. Sorry, but no thanks. Good luck with your campaign; only 20 percent said yes.

OK, those were the control houses. For the people assigned to the foot in the door condition, the researchers first visited the house and asked for something very small. To support their drive safely campaign, they asked people to put a small, index card-sized sign in their window. The sign contained the same words, drive safely, but the sign was very unobtrusive. Barely visible from the front yard, let alone to a passing vehicle. A full 76 percent of the people said yes to this smaller request.

A few weeks later, the researchers visited these foot in the door houses again. During the second visit, they asked the same thing that had been so unpopular with the control condition houses. "Would you be willing to let us put this large wooden sign in your front yard to support the safe driving campaign?" It was just as large, wooden, and generally unattractive as the sign that was so frequently refused in the control condition. But now, a much higher proportion of the people said yes—55 percent overall. By asking for the small sign display first, the researchers yielded almost three times as many people willing to put in the large sign.

At first blush, this is a really strange result. Imagine I ask you if you can lend me a quarter. You are nice, and so you say yes. I then ask you for $20; you are more likely to say yes. Somehow getting something small from you enhances the likelihood that I will get something big from you. That's strange, right?

The foot in the door name also makes a lot of sense, I think. The bane of the door-to-door salesperson is when people aren't even willing to talk to you. "Hi, I'm selling a revolutionary new air filtering product that is better than anything you've ever seen. Can I tell you more about it?" "No," followed by a closing of that front door. "Hi. A lot of the houses in this neighborhood have tested positive for cancer-causing radon gas. For $1, I can provide an assessment of the air quality in your house and determine if you need to take steps to make the air you and your kids breathe safe."

By asking for something small first, it's as if you are one of those salespeople who has gotten his or her foot in the door. Now you are inside and can start asking for something more substantial.

Cialdini and his colleagues interpret this as evidence for people's drive for consistency. This is another one of those unconscious cognitive reflexes that we've been discussing. You don't get up in the morning and think explicitly about who you are and what your values are—at least you don't most days of the week.

But every time you make a decision, some part of your brain seems to do that. If you decide to take the time to have your air tested, then you must be someone who cares about air quality. In the future, your unconsciously controlled decision-making systems will take this into account. In so doing, it will place a higher value on air quality. And you will be willing to spend more money to ensure it.

With the people in the drive safely study, a similar explanation applies. When they said yes to that small, window sign, it changed them. It changed their brains. It reinforced in them the notion that they care about driving safety. Now, not everyone said yes to the big sign. The people in the neighborhood were, and remained, people who care about keeping their yard looking good.

But as they weighed the pros and cons of saying yes to that street sign, a greater value was put on the self-perceived commitment to driving safety, and 400 percent as many people said yes.

This foot in the door technique can be adapted to almost any situation in which you are looking to persuade someone to do something. The tip here is to seek an initial, small commitment from someone that has three characteristics. First, it should be voluntary. If you compel someone to do something, if you coerce their initial response in some way, then it might change their sense of who you are, but it won't tap this unconscious sense of who they are. Second, the commitment should be active. It should be that the person does the small action themselves. Third, if possible, the act should be public. Our unconscious drive for consistency is present even when we're just sitting by ourselves in a quiet room, but it is amplified if we have the sense that others might be aware of our decisions.

Some have suggested that this is an inherently social phenomenon. We have an internal drive to be perceived by others as principled, character driven people. If our decisions seem haphazard, then perhaps it will make us seem less enviable in the eyes of others. Often researchers have found that it's good to have a written, permanent part of that initial, small commitment that gets the foot in the door. Human memory is great in many ways, but it's inherently fallible. If there is a permanent, visible piece of evidence of that early yes, then the persuadee will be much more consistently reminded of and influenced by it.

The one other factor that seems to be important to make use of this consistency reflex is to make sure there is a delay between the small request and the large one. This unconscious process of changing our sense of who we are and what's important to us seems to take at least a day. Most studies that have shown the largest effects have involved delays of around a week.

A variety of different brain regions seem to be involved in this shift in compliance. It has often been studied using fMRI neuroimaging techniques via something called cognitive dissonance. Cognitive dissonance is a term referring to when we hold two different contradictory beliefs or sets of information. Imagine that I don't like noodles that I possess this belief. If for some reason at dinner one night, I find myself eating a lot of noodles, then there is a contradiction present in my mind in my brain. Either I do like noodles or my behavior is being determined by something other than my belief. It might sound a little strange to talk this way, except that you already know about the many unconscious processes that mediate our beliefs and decisions. In this situation, we can presume that I will either stop eating noodles or decide that I was mistaken. Perhaps I do like noodles.

Methods of persuasion that focus on this unconscious consistency reflex capitalize directly on our desire to minimize our cognitive dissonance. It's an unpleasant thing to be in a state of mental dissonance. In general, humans do what they can to reduce dissonance if they experience it.

A state of cognitive dissonance is associated with activity in a variety of regions of the brain, notably the dorsal anterior cingulate cortex and anterior insula. When the person whose initial request you have granted makes a second, larger request, the activation in these regions of the brain is likely increased. You might want to say no to the large request, but the disconnect between your prior behavior and that no would create a large amount of dissonance.

The unpleasantness of the dissonance becomes a factor in your decision-making. It might be unpleasant to put a giant wooden sign in your yard, but it might be even more unpleasant to have to deal with the negative feeling of that dissonance. Your brain determines the best way to maximize its positive emotional state. In many cases, that will involve saying yes to that large request.

Want to recruit someone to serve on a volunteer committee with you but have some concerns that they will say no? Ask them to help out with a simple, 20-minute project that you are working on for the committee. Wait a few days, and then ask for more. Want someone to go on a date with you and have some concern that they will say no? Ask them to get coffee first, then wait a few days and ask for more.

Of course, the flip side of this is to beware of people asking for small favors. When the person returns to ask for something more, you may not consciously feel more inclined to say yes. But your unconscious mind will have changed; that unconscious decision-making system will be more inclined to say yes to other requests, even if the requests are larger.

My next tip is an intuitive one—if you want people to say yes to your requests, you should try to make a personal connection with them, and, ideally, deliver a personal compliment before you make a request. The concept that people will tend to say yes if they like you is very intuitive. What is surprising is just how powerful that tendency is, and how easy it is to strike this very deep-seated reflex in our brain.

Karen Wynn doesn't study adult persuasion. She studies the morality of infants—9-month-olds in this particular case. Infants in her study start by choosing a food from one of two bowls—one with green beans and the other with graham crackers. Not surprisingly, almost all of the infants choose the graham crackers. The babies then watch a puppet—sometimes a fuzzy rabbit. The fuzzy rabbit makes the same choice given the two bowls. Sometimes the puppet chooses the same food as the child—the graham crackers. For other experimental conditions, the puppet chooses the green beans.

The infants then watch the rabbit puppet trying to do some task—trying to get a ball out of a box, for instance. The puppet has some trouble doing this. As the rabbit is struggling with this, a second puppet comes on the stage. Sometimes that second puppet helps the rabbit, holding the box open so the rabbit can get the ball. In other cases, the second puppet hinders the rabbit, pushing down on the lid to stop the rabbit from succeeding.

After all of this, the babies are allowed to see and sometimes play with a choice of the puppets. Two important tendencies were observed in these studies. First, if the rabbit chose the same food as the child—the graham crackers—this little 9-month-old expressed a preference for puppets that had helped the rabbit, and an aversion to puppets that had been mean to the rabbit.

If, on the other hand, the rabbit chose a different food, now the children expressed a positive preference for puppets that had been mean to the rabbit. These are 9-month-old infants—kids who can't walk or talk yet, and they already seem pretty machiavellian here. If the rabbit is seen as being like me, then the baby seems to want to see that rabbit treated well. If the rabbit picks green beans if the rabbit is seen by the infant as different from me, now the kids seem to want to see the rabbit treated badly.

This sort of behavior seems to be present right near the beginnings of our lives. Fast forward a few decades, and you have an adult. We've learned a great deal, collected thousands of social experiences, learned language, and generally developed tremendously. But this tendency to be nice to people whom we perceive as like us is still there.

If you start a persuasive interaction with a conversation, it might seem like chit chat, small talk, but that small talk can have big consequences. "How was your weekend? Did you get outside for some fun in the sun?" "Well, yes, peter, I did. On sunny days, I like to play tennis." "Tennis. Me too. My kids are learning to play, so we batted the ball around a little. A few times, we even managed to play a full game." "I have kids too. They like tennis as well, and they are starting to get good at serving."

Blah, blah, blah right? But this connection can be enough to trigger another of those unconscious reflexes. Both parties in this conversation are people who like to be outside in the sun, play tennis, and have children. There is a lot of evidence that if I make some request after these connections have been made apparent, I will be far more likely to get a yes response. In studies of business negotiation behaviors, the likelihood of a successful outcome is more than tripled in some cases when the negotiation itself is preceded by a few minutes of conversation. In the control condition of one of these studies, pre-negotiation conversation was hindered by noting to both parties that time is money, you should get right down to work. Participants were told to get down to the details of the negotiation directly, so as not to waste any more time.

If indeed, time is money, then the results of the research in this area are clear. If you want to save both, you should definitely invest some time in small talk before you start with any of the other persuasion techniques we've discussed. You will end up saving a lot of both.

I've discussed three main persuasion techniques in this lecture. One, give a gift even a small one and people will unconsciously have a strong urge to give you one in return. For instance, they will be more likely to say yes if you ask them to do something. Two, make small request first in order to get your foot in the door. And, three, make a personal connection, highlight your similarity to someone, and then make a request.

All of these techniques are grounded in solid behavioral and brain science. They work. These are good tools that you can use to promote good things.

I also urge you to look out when someone is asking you to do something. Your unconscious reasoning system may be saying yes, but you still have a choice.

Lecture 19

How Framing Changes Decisions

In this lecture, we continue our discussion of effective persuasion techniques and explore how an understanding of unconscious, automatic reflexes can help us avoid making poor decisions. The persuasion techniques discussed in both these lectures include the following: Give a gift; make your expertise salient and have someone else communicate that expertise on your behalf; emphasize the extent to which your request represents a scarce opportunity; make a small request first to get your foot in the door; make a large request first to make the second request seem smaller; and make a personal connection, highlight your similarity to someone, and then make your request.

Door-in-the-Face Technique

- To increase the probability of persuading someone to say yes to a request, start by asking for something very large. People will almost certainly say no to the large request. Then, when you ask for a smaller favor, they will be more inclined to say yes. This strategy, the converse of the foot-in-the-door method, is called the door-in-the-face technique.

- The best support for this technique comes from a study by Robert Cialdini's research group. The experimenters stood along a busy walkway and asked pedestrians if they would be willing to serve as volunteer youth counselors. The following script was used on the control group:

1. *"Hello. We are recruiting people to chaperone a group of children from the County Juvenile Detention Center on a trip to the zoo. It will take about two hours of your time some afternoon or evening. Would you be interested in applying to help out?"*

- A little less than 17 percent of people said yes to request 1. Another group of participants was randomly selected to hear a much larger request:

2. *"Hello. We are recruiting people to work as volunteer counselors at the County Juvenile Detention Center. If you volunteer, you will need to work for about two hours per week for a minimum of two years. Would you be interested in applying?"*

- There were 72 participants in this study, and different versions of it have been run with hundreds of participants over the years. No one has ever said yes to request 2.

- After participants declined to volunteer for request 2, they were then immediately asked for the smaller volunteer commitment from request 1: to help out with the one-time two-hour trip to the zoo. The control group had said yes about 17 percent of the time. For the people who were first asked for the much-larger favor, however, the proportion who said yes skyrocketed to 50 percent.

Reciprocity Reflex

- One explanation for the success of the door-in-the-face technique is a contrast effect. If you anchor the participants' notion of a standard request as a very large one, then a smaller request seems tiny by comparison. Cialdini and his group believe the explanation goes deeper than that, however. They argue that the unconscious reflex that gets triggered has to do with the discomfort that is created by refusing a favor.

- This phenomenon is closely related to the reciprocity reflex. When someone gives you a gift, it creates a social pressure—and a strong unconscious desire—to give a gift as well. When a person asks you for a favor, your brain activates a deep desire to say yes. You have to exert mental effort not to say yes. If you've already said no once, it's that much harder to say no again.

- Cialdini's group tested the reciprocity effect in a clever way—by having two different people make the initial large and the second small requests. If two separate people make the two requests, the reciprocity effect almost vanishes.

Scarcity Effect

- Consider this story in Mark Twain's *The Adventures of Tom Sawyer*. Tom Sawyer skips school to go swimming and has to whitewash Aunt Polly's fence as punishment. In the events that follow, Mark Twain reveals himself to be a shrewd social psychologist.

- When one of the other neighborhood boys passes by, Tom pretends that he's enjoying the painting task immensely. The boy asks Tom if he can try it. Tom refuses, insisting that only very fortunate people can be lucky enough to perform the task. Of course, the boy suddenly wants very badly the chance to paint the fence. Tom agrees to permit the other children in the neighborhood to paint the fence only if they are willing to trade various toys and trinkets for the opportunity.

- Here, Mark Twain provides an excellent example of a persuasion principle that Cialdini's research group calls scarcity. Most people think the value of something is calculated on the positive aspects of it. In the Tom Sawyer story, painting fences has a negative value—usually, people get paid for painting fences. By making the opportunity to paint a scarce resource, the value to paint becomes a positive—something for which the neighborhood kids will pay.

- A variety of studies demonstrate that the amount people are willing to pay is heavily driven by their perception of how scarce an item is. For example, if there are only 25 tickets left for an upcoming basketball game, people are willing to pay more than twice the amount for exactly the same seats as they would if there were more than a thousand tickets remaining.

Expertise Effect

- In many cases where decisions require a great deal of research or even training, people rely on the decision making of experts. If you have relevant expertise, be sure that you make your expertise known when you prepare to make a request.

- A variety of studies suggest that expertise information can influence people's decision making. Some of the experiments are quite simple. For instance, in some studies, participants view an advertisement for a new health-related product in which a spokesperson describes a series of benefits associated with it.

- A randomly selected group of participants watch the same person deliver the same advertisement, with one small change. At the beginning of the ad, the spokesperson mentions that he or she is a licensed physician with many years of experience. Not at all surprisingly, people indicate a greater willingness to buy the product if it is recommended by someone with relevant expertise. It's no accident that many professionals hang their diplomas on the walls of their offices.

- There have been a range of more subtle studies that further characterize the expertise effect. For example, if an expert wears a suit and tie, people are more likely to follow their buying suggestions. If you want to persuade people to follow your lead, dress for the occasion.

Expertise Effect through Surrogates

- A number of studies have found that the expertise effect is substantially stronger if the information is delivered by a surrogate. The boost in the effect is even greater if the information is delivered

If an expert wears a suit and tie, people are more likely to follow his or her buying suggestions.

by someone who does not have an apparent, vested interest in the goals of the expert.

- One of the best examples of the expertise effect delivered by another person comes from a study conducted with a real estate firm. People frequently call the firm asking for information about properties for rent or sale. The firm tracks the number of calls received as well as data about the percentage of calls that result in a sale or rental contract.

- When a prospective buyer calls, the receptionist's original script was to say, "Okay, you're interested in rental properties. Let me transfer you to Bob. Just one moment, please."

- The researchers in this study asked the receptionist to add a line about Bob's credentials. The receptionist was instructed to say, "Okay, you're interested in rental properties. Let me transfer you to our expert in this area, Bob. He's been working with rental properties in this region for more than 12 years." The number of calls received stayed the same during the course of the study, but two very notable increases were found.

- Fully 20 percent more of the people who called agreed to set up an appointment to come in and meet with the realtor. There was also a 15 percent boost in the number of signed contracts that resulted from those interactions.

Brain Activation in the Expert Effect

- We know that decision-making processes are altered and people become more receptive to suggestions made by an expert. Consider how your brain changes when you are exposed to the expert effect.

- Some recent neuroimaging research by Vasily Klucharev and his colleagues suggests that the primary effects of the expert effect can be found in brain areas associated with memory. Participants in the Klucharev study viewed sequences of pictures while their brain activity was assessed in a functional magnetic resonance imaging (fMRI) scanner. One picture was of a celebrity (tennis pro Andre Agassi, for example) and the other picture was of an object.

- Sometimes the object was something about which participants would infer expertise on the part of the celebrity—for example, Agassi was followed by a picture of a tennis racket. Sometimes, the second picture was of an object where the celebrity would have no obvious expertise—for example, orange juice. After participants viewed the photo pairs, they went home and returned the next day. Now, they viewed all the object pictures without the celebrity endorser and gave a rating of how positively they felt about each item.

- The researchers determined that people remembered an object better if it was paired with an expert. What's more, people rated the object more pleasing after it was paired with the celebrity. Interestingly, in many cases, this seems to happen even when participants don't remember which celebrity was associated with an item. This is the expert effect.

- In examining the areas of brain activation associated with the expert effect, we see a very interpretable pattern. Areas associated with memory—the hippocampus and parahippocampal gyrus—showed increased activation. These areas of the brain play a crucial role in converting our short-term, immediate experiences into more durable long-term memories.

- Greater activation was also identified in the left prefrontal and temporal regions of the cortex. When we remember, we are relating the new information to what we already know. The elaboration part of the memory process is associated with activity in the left prefrontal and temporal cortices.

Questions to Consider

1. Car salespeople often use a technique in which they consider a customer's offer and then take it to the sales manager for final acceptance. Often, the sales manager asks the customer to pay a bit more; often, the customer does. Why does this sales technique work?
2. There is evidence that after a successful negotiation, both the seller and the buyer feel that they benefited from the negotiation. On average, both parties feel they have won. Given the nature of human decision making, why is this exactly what we should expect?

Suggested Readings

Cialdini, *Pre-Suasion*.

Lindstrom, *Brandwashed*.

Lecture 19 Transcript

How Framing Changes Decisions

If you want someone to say yes to a request for something big to make a large donation to a charity, for instance, you can greatly improve your chances by asking them for something small first. In January, you call and make a request, Hello. We're hoping to might be able to donate $20 to our university. You will, Thank you,

If you call again in March and this time ask for $1,000, you will be more likely to get a yes than if you had not made the successful request in January. This is the foot in the door effect. When people say yes to a small request, it changes how the think about their values. This taps into a tendency for our brain to increase its unconscious estimate of how important something—or someone—is based on past choices. An unconscious consistency reflex drives all of us to want to make decisions that match with our values. It's just how the human brain is wired up.

What if you ask for something really big the first time? Rather than starting with the $20 request, what if you had called in January and asked—not for $20—but for $10,000? It doesn't seem like that should boost your chances of getting a yes to that second, $1000 request, but it does.

In order to increase the probability of getting someone to say yes to some request, it can help to start by asking for something really big. The person you ask will almost certainly say no to the big request. But then when you ask for the smaller thing, he or she will be more likely to say yes. As a counterpoint to the foot in the door technique, this is referred to as the door in the face technique.

When people haggle over a price for something, there is an element of this idea that's present. If you want to settle on a particular price—say $1,000—and if the seller is asking for a higher price—say $1,500—then your best bet for your first offer is to aim below that $1000. If you offer $850, then it leaves wiggle room for both the buyer and seller to make concessions. If you are steely and determined, you might get the seller to come down to $1000 by gradually conceding a little more. Coming up from 850 to 900 to 950 and then $1,000.

My other favorite example of this comes from a not very highbrow reality TV show called bar rescue. The producers of the program would target a bar-restaurant that was on the verge of bankruptcy. An expert bar fixer would come in and teach the bar owners how to run a profitable food and beverage business. In one episode, there was an extensive consideration of how to organize and price items on the menu.

The bar expert showed the owners a draft of the drink menu that he was about to have printed up. The owners were upset by the pricing. Some of the drinks looked familiar in terms of price a beer was $4, a martini was $9. The bottom fourth of the menu, however, was devoted to exotic cocktails priced at $20 and more. Surely this was a mistake, they thought. Perhaps the bar fixer didn't understand the types of patrons that this bar attracted. No one is going to pay $25 for a drink here. This is crazy. The bar fixer smiled and calmly explained that those items weren't on the menu in the hopes that people would buy them ever. The purpose of putting a $25 drink on the menu is for contrast. Compared to $25, $4 and $9 seem like a real bargain,

Now, you might be unlikely to find yourself writing a bar menu, but the principle applies in a wide range of interpersonal interactions. The best support for this concept comes from a researcher named Robert. The experimenters in their studies stood along a busy walkway and asked pedestrians if they would be willing to serve as volunteer youth counselors. "Hello. We are recruiting people to chaperone a group of children from the county juvenile detention center on a trip to the zoo. It will take about two hours of your time some afternoon or evening. Would you be interested in applying to help out?"

Fewer than 17 percent of people said yes to this request. Actually, that's a pretty high number. It's a little less than one in five people asked. The students at Arizona State are clearly a pretty community-minded group, But that's not the point of the study. This was the control condition for this study. Another group of participants was randomly selected to hear a much larger request, "Hello. We are recruiting people to work as volunteer youth counselors at the county juvenile detention center. If you volunteer, you will need to work for about two hours per week for a minimum of two years. Would you be interested in applying?"

The two hours part isn't so bad, but the two years was understandably off putting for most people who were approached. There were 72 participants in this particular study, and different versions of it have been run with hundreds of participants over the years. No one has ever said yes to this initial request.

The participants in this condition first heard this request and declined to volunteer. They were then immediately asked for a smaller volunteer commitment—to help out with the one-time, two hour trip to the zoo. Remember the control group said yes 17 percent of the time. For the people who were asked for the much larger favor first, the proportion skyrocketed to 50 percent. Simply being asked for a large favor first made the smaller favor seem much more palatable somehow.

One idea for why this happens is just a contrast effect. If you anchor the participants' notion of a standard request as a very large request, then a smaller request seems tiny by comparison. This is the same reasoning that went into writing that bar menu with the $25 drinks. There is undoubtedly some influence of this contrast effect. If the person seeking volunteers asks for an initial small volunteer commitment—rather than the initial large commitment that was used in this experiment—the boost in the percentage of yes responses drops significantly.

But Cialdini and his group think it goes deeper than that. They argue that the unconscious reflex that gets triggered has to do with the discomfort that is created by refusing a favor. This is very related to the notion of the reciprocity reflex we discussed in the previous lecture. When someone gives you a gift, it creates a social pressure—and a strong unconscious desire—to give a gift as well. When a person asks you for a favor, your brain activates a deep-seated desire to say yes. We have to exert mental effort not to say yes. If you've already said no once, it's that much harder to say no again.

They tested this in a really clever way—by having two different people ask for the initial large and second small volunteer requests. If you have two separate people make the two asks, the effect almost vanishes. People who hear the initial request and those who don't hear it, say yes to the smaller request with about equal frequency.

OK, so we have the foot in the door effect and the door in the face effect. It's good to start with a small initial request that gets a yes and it's good to start with an initial large request that gets a no. Huh? Seems like only one of these things should work. How can we reconcile these two? And most importantly, which one should we use?

The short answer is that both techniques tend to work; the data absolutely support that. Either one is a clear improvement over using neither. If your goal is to increase the number of people who say yes to things you should use one. The foot in the door technique where you start with the small request seems to require more time to be most effective. If you ask for a small favor and then immediately ask for the larger favor, the benefits of the technique are substantially smaller.

Remember the brain mechanism that supports this effect are based on a shift in one's personal evaluation of how important some issue or person is. That takes time—ideally a few days. If you want to increase the number of yes responses in a single meeting a single interaction with someone, then the door in the face technique is the better one to choose. Studies of this technique demonstrate large effect sizes even when there is a delay of only a few seconds between the first and second request. Indeed, increasing that delay is likely to diffuse the tension that is created by the initial refusal of the first request.

In general, researchers in this area suggest experimenting with both to see which one works best for the particular kind of request that you are making. The one very key point on which all researchers would agree is that we don't evaluate particular requests in isolation. If you ask someone for two things, for two favors, for instance, the answer that they give for the second is clearly influenced by the first—sometimes to an impressively large degree.

Everyone is likely to have heard the story of Tom Sawyer whitewashing his Aunt Polly's fence. Tom skips school one day to go swimming and has to whitewash the fence as a punishment. He doesn't especially want to do this chore, in fact, he definitely doesn't want to, especially given how nice the day is, but he is compelled to do so. In the events that follow, Mark Twain reveals himself to be a pretty good social psychologist.

When one of the other neighborhood boys passes by, Tom pretends that he's enjoying the painting task. The boy asks Tom if he can try it for a moment. Tom refuses, insisting that only very fortunate people can be lucky enough to get to do this task. Of course, the boy suddenly wants to get a chance to paint the fence. Tom ends up agreeing only to let people paint the fence—to let them do a task that he didn't want to do in the first place—unless they are willing to trade various toys and trinkets for the opportunity. Tom Sawyer—actually Mark Twain—provided a great example here of a principle of persuasion that Cialdini's group often refers to as scarcity. Most people think of the value of something—some product, service, or opportunity—as something that we can calculate based on the positive aspects of it. I value my car because it can get me from point A to point B reliably. I like my watch because it lets me know the time of day with great precision. I will pay money to visit a beach because I have had fun experiences there when my family and I have visited in the past. When I'm deciding whether or not to say yes or no to an offer of purchasing these things for a given price, a big part of that decision is based on an unconscious calculation about how rare the opportunity is. If I believe that the car I'm considering is only very rarely available maybe if the car is even labeled a limited edition model, then it will seem more attractive to me.

In the Tom Sawyer case, there is something that actually has a negative value. Usually, people get paid for painting fences. By making the opportunity to paint seem to be a scarce resource, the value not only becomes less negative but shifts to being something positive something for which those neighborhood kids will trade things.

A variety of studies has shown that the amount people are willing to pay for things is heavily driven by their perception of how scarce the item is. If there are only 25 tickets left for an upcoming Kentucky basketball game, people will be willing to pay more than twice the amount—for exactly the same seats—as they will if there are more than 1000 tickets remaining.

Salespeople know this well and have provided a lot of data supporting the notion. When trying to sell a particular car, salesmen will often arrange for two potential buyers to see it at the same time. If person one chooses not to buy the car that day, then there is a clearer possibility that this particular car will be purchased by person two. The perceived value and the likelihood of a sale rise substantially.

The general tip for persuasion here is straightforward. If you want to convince someone to say yes to some request, then you should avoid just describing the benefits of saying yes. If there are benefits, of course, you should convey that. But be sure to mention the aspects of this particular opportunity that are relatively unique and special. You shouldn't lie about these things, of course, but in some cases, the opportunities that you offer people are subject to some scarcity. If you help someone see the potential loss associated with not saying yes, then it will tap directly into that subconscious estimation and decision-making system that is so important for our everyday behaviors.

Let's consider another way in which you can influence the unconscious thoughts and actions of others. There's a shortcut that we humans often use when we make decisions. We could gather and process all of the relevant information. In some cases, we would have to do a lot of work to complete this task properly. Especially if it's a decision about something we don't already know a lot about, there might even be some training and education involved in getting to a place where we could make a fully considered decision. In a lot of cases where decisions require a lot of effort and even in a lot of cases where decisions require even a little effort, we choose to rely on the decision-making of experts.

This is a totally sensible strategy, in many cases, of course, it's exactly what makes sense to do. If I am sick, I'm not going to medical school so I can diagnose myself. I'm going to find a good doctor and then trust her or him to tell me what to do to get myself healthy again. If my roof starts leaking, I'm going to find an expert maybe a team of qualified craftspeople to figure out how to correct the problem.

Perhaps because we do this so often, for so many different types of problems, there is an unconscious tendency—another one of these cognitive reflexes—that influences our tendency to be compliant with the advice and requests of someone. We assess their expertise, determine whether or not to trust them, and then largely stop thinking for ourselves. If you have relevant expertise, be sure that your expertise is known as you prepare to ask someone to do something. There have been a variety of studies suggesting that this type of expertise information can influence people's decision-making. Some of the experiments are quite simple. For instance, in some studies, participants view an advertisement for a new health-related product, in which a spokesperson describes a series of benefits associated with it. A randomly selected group of the participants watch the same person deliver the same advertisement, with one small change. At the beginning of the ad, the spokesperson mentions that he is a licensed physician with many years of experience. Not at all surprisingly, people indicate a greater willingness to buy the product if it is recommended by someone with relevant expertise. It's not an accident, I think, that many professionals hang their diplomas on the walls of their offices in a place where potential clients will typically see them.

There has been a range of more subtle studies, however, that further characterize the effect. For instance, just wearing a suit and tie makes people more likely to follow the buying suggestions of someone in a business setting.

This applies outside the business setting as well. One study was conducted on a street corner with a traffic light and a crosswalk. On this particular street, there were many instances in which the lighted sign clearly indicated a don't walk signal, even though there were no cars near the intersection. If you are standing on a corner in this situation, do you cross the street? What if someone else starts across the street first. Would you follow? In general, it turns out that people are more likely to cross against the signal if someone else does first. People are significantly more likely to follow if that person who starts walking into the street is wearing a suit and tie. If someone in shorts and a T-shirt walks first, people are less likely to follow—presumably because greater expertise and authority is attributed to the person in that standard business attire. So if you want to persuade people to follow your lead, dress for the occasion.

OK, so I've suggested that your expertise should be broadcast, in a way, before you try to persuade someone about something. A central goal here is to convince the persuadee that he or she should trust you, convince that person's unconscious decision-making processes to take the shortcut of just following your lead, literally in the case of the street crossing study, and more figuratively in terms of decisions about buying and other choices.

Now, if you want someone to trust you, it's often not the best thing to walk into a room and begin blustering about how accomplished you are. Indeed, it will often come across as bragging, or worse it might come across as you intentionally trying to persuade someone to do what you ask. It might not cause the person's thought processes to align with your own, but rather to become extra vigilant and suspicious about the things you say.

A key to broadcasting your expertise, then, is to get the information across without doing so personally. A number of studies have found that this expertise effect is substantially stronger if the information is delivered by someone else. The boost in the effect is even greater if the information is delivered by someone who does not have an apparent, vested interest in the goals of the expert.

Perhaps the best example of this comes from a study conducted with a real estate firm. People would call the firm, often asking for information about properties for rent or sale. The firm had tracked the number of calls they received for many years. They also had data about the percentage of those calls that resulted in a sale or rental contract. Calls would come in to the office, and a receptionist would answer the phone. She would ask about the caller's needs and then the receptionist would then ask the person to hold while the call was transferred to the relevant person in the office. OK, you're interested in rental properties. Let me transfer you to Bob. Just one moment, please.

The researchers in this study asked the receptionist to add one small sentence to this standard interaction. In addition to mentioning Bob, the receptionists were instructed to provide a line about the realtor's credentials. So, instead of transferring to Bob, the receptionist might say, OK, you're interested in rental properties. Let me transfer you to our expert in this area, Bob. He's been working with rental properties in this area for over 12 years. The number of calls received stayed the same during the course of the study, but two very notable increases were found. Fully 20 percent more of the people who called agreed to set up an appointment to come in and meet with the realtor. There was also a 15 percent boost in the number of signed contracts that resulted from those interactions. Just by subtly highlighting someone's expertise about something can make people much more receptive to their suggestions and requests. With this phone greeting intervention study, the suggestion only required a few seconds. The information also had the benefit of being true. The realtors did have the level of experience that the receptionists described on the phone. It would be unethical to describe experience and expertise that you don't have. But, to the extent that you do, even a mild reminder of it can make a big difference in subsequent interactions.

What happens in your brain when you talk with an expert, as opposed to a non-expert. Actually, I should more correctly restate that as what happens in your brain when you are aware that you are talking with an expert, as opposed to someone about whose expertise you are unaware of? We know that decision-making processes are altered—that people become more receptive to and compliant with the suggestions made by someone whose expertise is more salient. How does the brain change when this occurs?

Some recent neuroimaging research by Vasily Klucharev and his colleagues suggests that the primary effects can be found in brain areas associated with memory. Participants in their study viewed sequences of pictures while their brain activity was assessed in an fMRI scanner. The participants viewed a sequence of picture pairs. One picture would be of a celebrity—the tennis player Andre Agassi, for example. The other picture would be of an object. Sometimes the object was something about which the participants would infer expertise on the part of the celebrity. Andre Agassi was followed by a tennis racket for some participants. Certainly, we should expect that Andre is an expert about those. Sometimes, that second picture was of an object where the celebrity would have no obvious expertise. Orange juice, for instance. Andre Agassi, we presume, has no particular expertise about orange juice.

This isn't exactly how advertisers use celebrity endorsements, but it's certainly similar. Actually, it's not so different from a print ad in which a smiling celebrity is shown next to some product, presumably endorsing it for consumers, hoping that they will be more likely to buy it. After participants viewed all of these photo pairs—360 of them—they went home and returned the next day. They viewed all of the object pictures—without the celebrity endorser—and responded about whether they remembered seeing the item; they also gave a rating about how positively they felt about each one of the items.

Across different participants, we can ask how pairing Andre Agassi with an item boosts our memory of it—both when it is something he is expert about and when it isn't. By using many object items with both and expert and non-expert celebrity, we can partial out the particular effects of spokesperson expertise on our reasoning about various objects.

OK so first, people remember objects better—more accurately pick out when they have seen it—if it is paired with an expert. Something about seeing an expert causes the details of the object to be more reliably encoded in our memory. Second, we tend to rate the item as more pleasing more favorable just a day after it was paired with the celebrity. Interestingly, in many cases, this seems to happen even when participants don't remember which celebrity was associated with an item.

It goes something like the following—you see the expert next to the object. It causes you to associate positive things with the object—to remember it better and think good things about it. A day later, you still think those positive things still have those vivid memories about the object even though you don't remember that they were produced by the expert endorsement,

If you later see two tennis rackets next to one another that are almost identical—maybe exactly identical in quality and price—which one do you think will look better? Which one do you think you're more likely to purchase? The expert authority effects in effect.

When you look a the patterns of brain activation associated with this, you see a very interpretable pattern. Firstly, areas associated with memory show greater activation—the hippocampus and parahippocampal gyrus show increased activations. These areas of the brain are well established as playing an important role in converting our short-term, immediate experiences into more durable long-term memories. Greater activation in the expert endorsement condition was also identified in the left prefrontal, temporal regions of the cortex. When we remember things, especially if we remember them well, we achieve that by relating the new information to things that we already know. So, if I ask you to remember a particular tennis racket as well as you can, you will look at how it is similar and different to other tennis rackets you have seen. You might imagine what it would feel like to hold and swing this particular tennis racket. You might imagine a famous tennis star playing with it. As we produce these thoughts, we relate the tennis racket we are seeing to other experiences and memories that are encoded in our brains.

This elaboration part of the memory process is associated with activity in these two areas that showed increased activation—the left prefrontal and temporal cortices. If I asked you to remember a tennis racket very well, you would engage these processes. It seems that simply placing that tennis racket next to an expert celebrity endorser makes you produce very similar processes in the brain, even when no one specifically asks you to.

OK, so we've discussed two principles of persuasion so far—door in the face and expert authority. There are several others that Cialdini and his cohort have explored. One of my personal favorites is scarcity. Basically, when something is in short supply, it becomes increasingly attractive.

There are good studies supporting this, but even before the first data point was collected, I knew that this principle would work on me. One time, I was up about three in the morning, flipping through TV stations. I ran across what was, at the time, a relatively new phenomenon—a home shopping channel. I watched for a bit and saw a watch that looked pretty cool to me. The price was pretty reasonable. I decided to call and ask about it. I did not call to buy it. I was thinking about it, but I certainly didn't have that intention when I dialed the 800 number.

I started asking the nice lady who answered the phone questions about it. Who made it? Is there a guarantee that it will keep working for more than a few weeks? Is it water resistant? things like that. The lady politely answered my first few questions and then said, "Oh, I see we only have nine of them left in stock. Do you want one?" I started to ask another question, and she said, “Oh, only eight left now seven. Oh, now there are only six. It looks like they are really going fast. I think you’d better buy one now if you want it.”

I ran across the house, searching for my wallet, and found my credit card. I ran back to the phone and, thank goodness, I managed to get one of the last couple watches. How lucky I was. For what it’s worth, I was happy with the product when it arrived. Well a few nights later, I noticed that it was still available and a few nights after that. And a week later. Now, I don’t want to call that nice operator a liar, but I’m pretty sure she was lying to me. By indicating that the watch was in short supply, she didn’t make the watch any better; she didn’t make the price any lower, or the value any better. What she did was change my reasoning about it in such a way that the watch seemed much more attractive.

There is evidence that when something is described as scarce, it creates a fear of missing out, a fear of the negative emotions that will accompany the many days in the future when I might be regretting not deciding to say yes to some opportunity. Several neuroimaging studies suggest that the brain produces activity associated with distress when we hear messages like this. The sympathetic nervous system is even somewhat activated in response—that area associated with the fight or flight response that we use for survival.

If you want to persuade someone to select something, to agree to do something, to say yes to your request, our intuition is usually to make it as easy as possible for someone to do so. If I’m asking for someone to volunteer to work on some charitable activity, it feels like my yes responses will increase if I say that they can work for an hour or a half hour any time that would work with their schedule. Monday, Tuesday any day you want, anytime between 8 am and 8 pm, whatever is easiest for you.

This tip suggests that this can backfire. In fact, the best way to nudge someone over to a yes, in this case, might be to mention that almost all of the available volunteer times are already taken. Monday morning would be the best time. No oh, someone has already taken that. How about Tuesday I think 3-4 is still open. Maybe Wednesday, but only if it's very late. By creating a scarcity, the opportunity is made far more attractive.

I've discussed a wide range of persuasion techniques during these last two lectures. First, give a gift, even a small one and people will unconsciously have a strong urge to give you one in return. For instance, they will be more likely to say yes if you ask them to do something. Two, make your expertise salient, and people will unconsciously shift to agreeing to the things you suggest and request—especially if someone else communicates that expertise for you. Three, emphasize the extent to which your request represents a scarce opportunity and opportunity that, if missed, would result in some regret. Four, make small request first in order to get your foot in the door, or five make a large request first in order to make a second request seem smaller by comparison. And six, make a personal connection, highlight your similarity to someone, and then make a request.

Humans are an inherently social species—and it's a good thing. We are subject to biases that make us more likely to do things for, and with other people. It's our ability and tendency to cooperate with each other that has enabled humans to achieve so many of our greatest accomplishments. How you use and avoid falling prey to these many automatic reflexes can help you resist making bad decisions—and also accomplish much more.

Lecture 20

How Language Changes Your Brain

In this lecture, we explore how language processing works in the brain. Words matter: The mere fact of speaking can have a strong influence on how you think. Words you simply imagine in your mind can affect your brain functions. Every day, numerous words pass through our stream of consciousness. By intervening in and altering the flow of that stream of self-talk, we can change our behaviors, our emotions, and even our physical health.

Language Determines Thought

- Can't find your keys? As your walk around your house looking for them, say the word "keys" aloud over and over again. You will be more likely to find them.

- Kit Cho and her colleagues performed a study of how humans visually search for target objects among distractor objects. In some trials, the participant would simply search for the target object. In other trials, the participant would repeat the target label (such as "key" or "dog") over and over again while searching. Simply saying the target word aloud made the search go faster.

- When you say the word "keys," your visual system changes the way that it processes incoming information. It becomes more sensitive to the visual features that are associated with keys, and you become faster at finding them.

Whorfian Hypothesis

- A theory that has moved in and out of fashion among cognitive neuroscientists is the Whorfian hypothesis, sometimes called the linguistic relativity hypothesis. It is named for Benjamin Whorf, who suggested that language may determine our thoughts.

- The strongest form of this hypothesis is that you cannot think anything that you cannot put into words. It suggests that the language or languages we know comprise the system that our brain uses whenever it processes information. According to the strong version of this theory, language and thought are, in many respects, the same.

- While the strong version of the Whorfian hypothesis has largely disappeared from serious consideration, a weaker version of the Whorfian hypothesis has gone through a bit of a revival. Language doesn't seem to determine or preclude what our brains can think; however, language very much seems to influence our brain's performance in significant, measurable ways.

Broca Area

- Production of language takes place in the Broca area of the brain, named for its discoverer, Pierre Paul Broca. Broca studied patients who could no longer talk after suffering a brain injury. Based on careful work, Broca found that the patients could still understand spoken and written language. The Broca area is located in the frontal lobe just behind the prefrontal cortex. Neuroimaging studies have confirmed the importance of the Broca area for language production.

- Whether you are right handed or left handed affects how your brain is organized for language production. For right-handed people, language processing causes a large increase in activity in the Broca area in the left hemisphere of the cortex. For right-handed people, damage to the right side of the brain rarely results in language deficits. Damage to the left side is far more likely to produce these problems.

- Left-handed people are a little more complicated in this regard. One might presume that the organization would be reversed—that is, lefties would exhibit language dominance on the right side. They don't, however; most lefties show a more equal activation across the two hemispheres. The Broca areas of both hemispheres seem to participate more equally in language production.

Wernicke Area

- Like Broca, Carl Wernicke worked with brain-injured patients. He found that damage near the back of the temporal lobe often produced a loss of the ability to comprehend written or spoken language. This area has come to be known as the Wernicke area. Neuroimaging studies have shown the same lateralization of function associated with the Broca area. Right-handers tend to show strong activation in the left hemisphere when engaged in comprehension. Lefties show a more balanced pattern of activation.

- Language production and comprehension are implemented by these two different brain regions. Given the close relation between speaking and listening, it is surprising how far apart the two regions are. Speech production is accomplished by the Broca area near the front of the brain, while language comprehension is accomplished by the Wernicke area near the back.

- The Broca area is located closer to the motor cortex in the frontal lobes. The motor cortex is involved in controlling voluntary movements, including those that produce speech. The Wernicke area is located very near the auditory cortex, a region of the brain devoted to processing incoming sounds.

External and Internal Motivation

- Language affects many kinds of brain activity that might not appear to depend on language at all. For example, if you want to change a certain behavior, how you talk about that process greatly affects the outcome. Changing how you talk about it to others (and yourself) can increase your chances of succeeding. Specifically, you should use the word "don't" rather than "can't."

- Vanessa Patrick and her colleagues explored this phenomenon with the task of promoting healthful eating, but related studies suggest that the results apply to other behaviors as well. Imagine you are at a dinner with someone. You've decided to cut down on desserts. Many people would say, "No thank you. I can't eat desserts anymore." It is more effective to say, "No thank you. I don't eat desserts anymore."

- Patrick and her colleagues drew from a range of research on how people respond to different types of motivation, whether external or internal. When people are motivated by external controls, they tend to be less consistent in their behaviors over the long term—especially if the external controller is absent. The phrase "I can't do X" is associated with external controls. "I don't do X" is associated with more robust internal controls.

Linguistic Distancing

- The language we use also seems to affect our emotional responses. Ethan Cross and his colleagues have found that self-talk can help us regulate our own emotions. If you want to reduce your levels of stress and anxiety about a situation, refer to yourself in the third person. This is known as linguistic distancing.

- Cross and his colleagues studied linguistic distancing in the context of social anxiety. In one study, they recruited participants and had them try to make a good first impression during a conversation with a stranger. The conversations were videotaped, and participants provided a rating of how anxious they were during the process.

- The key experimental manipulation here took place before the videotaped conversation. Half the participants were randomly assigned to a first-person condition and asked to reflect on their

If you want to change a certain behavior, changing how you talk about the process to others (and yourself) can increase your chances of succeeding.

feelings using "I" and "my." The participants randomly assigned to the non-first-person condition were urged to make use of second-person ("you") and third-person ("he," "she") pronouns or to use their own names.

- Two clear differences emerged from the groups. The first-person group reported higher levels of anxiety during the interaction with the stranger. In addition to reporting lower levels of anxiety, the non-first-person group performed substantially better than the first-person group in terms of a variety of social-performance criteria, such as perceived nervousness, vocal quality, and eye contact.

Language and the Emotion Centers

- Language areas are strongly connected to many areas of the brain, including the emotion centers. A couple of synapses away from the Wernicke and Broca areas is the limbic system. A particular emotion can influence the language we use; what's more, particular words can influence those emotion centers.

- Alison Brooks has published research using a simple linguistic strategy for dealing with anxiety: Restate that anxiety as excitement. When participants in her studies are feeling anxious, they are instructed to say, "I am excited." This not only reduces the anxiety somewhat, but it seems to enhance performance. Anxiety and excitement are both states of high arousal, and so the trick is to capture that high state of arousal for positive purposes.

- Both anxiety and excitement are associated with diffuse frontal cortex activation in the brain. The primary difference is that anxiety shows additional activation in the amygdala and the sympathetic nervous system.

- Usually, when people try to reduce their anxiety, they are urged to become calm—to reduce activation across all the brain regions associated with anxiety. The Brooks method suggests instead that the anxious person use the power of language to alter the pattern of activation.

Language and Physical Fitness

- The language centers of the brain seem to connect to the systems in your body that regulate your expenditure of calories. To be more physically fit, if you associate your daily physical activities with the word "exercise," your fitness level will improve.

- Alia Crum and Ellen Langer recruited a group of hotel room attendants and explained that they were interested in better understanding physical fitness in the workplace. For the experimental group, they presented information about the caloric expenditures associated with different aspects of their work. They noted that when you add up eight hours of work, it is clear that the attendants easily exceed U.S. recommendations for daily physical exercise. For the room attendants in the control group, researchers specifically did not provide information about how their work could be described as exercise.

- For both the experimental and control groups, a variety of physiological measures were taken: blood pressure, height, weight, percentage of body fat, waist-to-hip ratio. The experimenters then waited for one month and returned. The two groups didn't change their eating or exercise habits outside of work.

Language and Eating

- Alia Crum, one of the researchers involved in the physical fitness study, found that the words you use to describe eating also have an effect on your sense of satiation. Participants in her study consumed a 380-calorie milkshake. Half the participants thought of the shake as an indulgent 620-calorie milkshake. Others thought of it as a sensible 140-calorie milkshake.

- The participants who used the word "indulgent" felt more full and satisfied than did the group that used the word "sensible." What's even more surprising is that the body's response to the food was physiologically different. The intestinal cells of the "indulgent" participants produced significantly lower levels of the hunger-related hormone called ghrelin than did those of the "sensible" participants.

- Same milkshake—but with a different mind-set, even the digestive system alters its function.

Questions to Consider

1. Repeating the words "I am excited" seems to mitigate the negative effects of anxiety on performance. What other phrases might be expressed to mitigate the effects of other negative emotions? What phrases seem unlikely to work in this fashion?
2. Electronic devices that track daily activity and record exercise and fitness have recently become very popular. How might a personal activity tracker promote fitness through the language centers of the brain?

Suggested Readings

Schwartz, *The Paradox of Choice*.

Lakoff, *Metaphors We Live By*.

Lecture 20 Transcript

How Language Changes Your Brain

Language matters to us even more than we realize. Can't find your keys? As your walk around your house looking for them, say the word keys aloud, over and over again. When you look in a cluttered drawer, or at a collection of things sitting on your table, saying keys, keys, keys, keys, keys saying it aloud will make it more likely that you will find them.

Kit Cho and her colleagues performed a study of how humans visually search for targets among distractors. The targets were things like keys, dogs, and other common objects. In some cases, the participants merely searched for them among a set of distractor objects. The trial would start with a label of the next search target on a computer screen, for instance—keys. The label would then vanish, and a display consisting of many objects would appear. The task of the participants was to look for the named target. As soon as the target was found, the participant would press a button indicating that they had found it.

For some trials, the target was not present. Once the participant was certain that the target wasn't there, he or she would press a different computer key. Including these no target trials is important to make sure that the participants weren't just always pressing the key indicating that they had found the target without necessarily doing so.

For some trials, the participant would simply search and find the target as quickly as possible. For other trials, the important trials in this study, the participant would repeat the target label over and over while searching. As soon as the label appeared, the participant would start with the repetitive verbal labeling. This would continue until the target was either found or until the participant was confident that the target was not present.

Amazingly, just saying the word aloud made the search faster and it did so without sacrificing accuracy in any way. When I speak the word keys, my visual system changes the way that it processes incoming information. It becomes more sensitive to the visual features that are associated with keys, and I become faster at finding them. So whenever you are looking for something, don't keep it to yourself. Name the thing that you are looking for out loud, and you will be faster and more likely to find it.

This is a clever little tip that can be of some use all by itself. Actually, if you are ever having trouble finding your keys, your glasses, your phone it can be a clever, important tip. But it highlights a major aspect of how language processing works in your brain. The mere fact of talking, as well as how we talk, and what we say, can have a strong influence on how and even what we think. The way you describe something can change how you evaluate that thing. By choosing your words carefully, and, in some cases, by expressing them aloud, you can enhance your thinking about all sorts of things.

Notice what I said there, you can enhance your thinking. Now, there's a theory that has waxed and waned in popularity among cognitive neuroscientists over the years referred to as the Whorfian hypothesis. Sometimes it is also referred to as the linguistic relativity hypothesis. It is named for Benjamin Whorf, who suggested that language may determine our thoughts.

The strongest form of this hypothesis is that you can't think anything that you can't put into words. It suggests that the language we know—or the languages we know—are the system that our brain uses whenever it processes information. According to the strong version of this theory, language and thought are, in many respects, the same thing.

The strong version of the Whorfian hypothesis has largely vanished from serious consideration. But a weaker version of the Whorfian hypothesis has gone through a bit of a revival. Language doesn't seem to determine or preclude what our brains can think. But language very much seems to influence our brain's performance—in important, very measurable ways.

We know a lot about the systems in your brain that control language processing. The central point here is that whenever you talk, write, listen, or read, many different areas of your brain tend to be activated. Two areas seem especially important for language processing.

Production of language takes place in Broca's area—named for its discoverer, Pierre Paul Broca. He found patients who, after suffering a brain injury, could no longer talk. Based on careful work with these patients, however, he found that they could still understand spoken and written language just fine. As long as their responses were restricted to simple yes and no answers, they seemed almost completely unimpaired. This critical area of the brain is located in the frontal lobe, just behind the prefrontal cortex.

In addition to research on patients with damage to this region, neuroimaging studies have confirmed its importance for language production. When participants engage in language production—or even thoughts about language production without any actual speaking—this segment of the cortex becomes active. When you have a thought, an idea of something you want to say, and you translate that thought into a sequence of words to convey it, it is Broca's area that accomplishes that task.

Whether you are right-handed, or left-handed, affects how your brain is organized for language production. Most people have a preference to use their right hand when they perform challenging motor activities—everything from writing to throwing a ball. For right-handed people, language processing causes a large increase in activity in Broca's area in the left hemisphere of the cortex. Usually, only a small increase in activity occurs in the right hemisphere. For people who are right-handed, damage to the right side of the brain rarely results in language deficits. Damage to the left side is far more likely to produce these problems. For right-handers, it can be said that language production is lateralized, with a specialization localized in the left hemisphere.

Left-handed people are a little more complicated in this regard. One might presume that the organization would be reversed. Maybe lefties would exhibit language dominance on the right side, but they don't. Most lefties show a more equal activation across the two hemispheres. The Broca's areas of both hemispheres seem to participate more equally in language production.

OK, that's language production. What about language comprehension? Carl Wernicke, like Broca, worked with brain injured patients. He found that damage near the back of the temporal lobe often produced a loss of the ability to understand language—either written or spoken. Interestingly, these patients seemed to fully retain their ability to produce language. This area has come to be known as Wernicke's area. Neuroimaging studies have shown that the same lateralization of function associated with Broca's area is present. Right-handers tend to show strong activation in the left hemisphere when engaged in comprehension. Lefties show a more balanced pattern of activation.

When you hear or read a series of words—as you are listening to me talk right now, actually—your brain takes those words and translates them into a set of ideas; ideas you will understand and remember. You can relate that idea to other things you already know. That translation process—from words to thoughts—is accomplished by Wernicke's area. If you describe these ideas to someone else, Broca's area will produce those words for you.

Language production and comprehension are implemented by these two different brain regions. Given the close relation between speaking and listening to language, it is surprising how far apart the two regions are. Speech production is accomplished by Broca's area near the front of the brain, while language comprehension is accomplished by Wernicke's area near the back.

Broca's area is not just located near the front, it is located closer to the motor cortex, in the frontal lobes. The motor cortex is involved in controlling voluntary movements, including those that produce speech. So locating Broca's area near the front makes sense there. Wernicke's area is located very close to the auditory cortex, a region of the brain devoted to processing incoming sounds. Of course, for understanding spoken words, that location seems to make sense.

Regardless, even though they are located relatively far away from one another in the brain, the two regions are highly interconnected, both with one another and with other parts of the brain.

Both regions are also very large—and with good reason. Human language is truly remarkable in its scope and complexity. Most high school graduates know the meanings of more than 25,000 words. College graduates tend to know more than 35,000.

One of my favorite statistics in all of developmental cognitive science comes from the study of the enormous task of creating this internal lexicon. Most two-year-olds know the meanings of about 200 words. By the time they are 10 years old, they know about 10,000 words. If you do the math on this, it means that kids learn about one new word, every hour that they are awake, for eight full years. Even kids who don't attend school do this, by the way. Just talking with other people on a regular basis seems to do the trick here. Our brains seem built to soak up vocabulary just by being exposed to language.

And it's not only vocabulary that we acquire, and are shaped by, even without conscious effort. There are also many grammatical rules that you know implicitly, but that were never taught in a direct fashion. They probably never even enter your conscious thought process at all. For instance, when you use the phrase "going to" there is an implicit rule that you are allowed to contract this into the word "gonna." If I say, "I'm gonna go write for an hour." That is a completely appropriate sentence. Well, it turns out you know a more precise rule. You can only use this "gonna" contraction if the phrase that follows conveys a verb. "I'm gonna write." Yeah, that's fine. "I'm gonna work. I'm gonna go see Bob." All verb phrases; all fine. If the following phrase is a location, however, now you are not allowed to use the "gonna" contraction. "I'm going to Ohio," that's a fine sentence, but "I'm gonna Ohio?" Suddenly you know that something is wrong.

No one ever taught you this rule. Most people don't even know that they know this rule, but we use it in our own speech production, and we expect it in the speech of others. As you listen to me talk, if you hear me use that "gonna" contraction, your Wernicke's area knows something about what's coming next. As it parses my sentence, as it is translating those words into thoughts, it doesn't have to consider the travel meaning of the word "go" anymore. It knows that the next phrase will contain an action verb.

Language is a central feature—not just of our communication, but of how our brain makes sense of the world around us—even when we are not paying attention. From this perspective, it's not at all surprising that the language we use can greatly affect our thinking, even below the level of conscious awareness. Language affects many kinds of brain activity that might not appear to depend on language at all.

The fact that saying the word keys makes it easier to find your keys is a perfect example of such a result. There are many others.

If you want to change some behavior, for instance, to quit some unhealthy habit, researchers have recently found that how we talk about that process greatly affects the outcome. Changing how you talk about it to others—and yourself—can increase your chances of succeeding. Specifically, you should use the word "don't," rather than the word "can't."

Vanessa Patrick and her colleagues explored this with the task of promoting healthy eating, but related studies suggest that the results apply to other behaviors as well—any situations in which we want to reduce doing one thing and increase doing an alternative. It could be you want to stop unhealthy eating, stop smoking, stop playing video games whatever.

Imagine you are at a dinner with someone. You've decided to cut down on desserts. It is, however, time for dessert at the dinner. You feel tempted. Perhaps someone offers you a delicious slice of cheesecake. How would you respond? Many people would use a sentence like the following, "No thank you. I can't eat desserts anymore." We might also phrase this instead as "No thank you. I don't eat desserts anymore". The key words here in these two sentences are "can't" and "don't." Most English speakers know the difference between the definition of those two words, but we use them almost interchangeably in regular conversation about changing our behaviors.

Patrick and her colleagues drew from a range of research on the nature of how people respond to different types of motivation. In some cases, our behaviors are influenced by external controls. If your boss tells you to be at work at 8 am, or else, then your early morning behaviors will be influenced by this external control. In other cases, our behaviors are motivated by internal controls. Maybe I decide that I would like to feel more productive during the day, so I decide that I'm going to start work by 8 am. The behavior here is the same in both cases—I get to work by 8 am, but the causes are very different.

When people are motivated by external controls, they tend to be less consistent in their behaviors over the long term—especially if the external controller is ever absent. If I know my boss is on vacation this week, the external control will be greatly weakened, whereas the internal control won't be affected. When you say I can't do x, your brain activates things associated with that word can't. One of those associations is with external controls. If you instead say don't, your brain is more likely to activate associations with internal controls.

To test whether the differential use of these words affects actual behavior, Patrick recruited a large group of participants who were interested in improving their eating habits. They were asked to rate some instructions about a new method that would be used in a future study to improve other people's eating behaviors. Note that in this study the participants weren't being enrolled in the program at all. The experimenters were just asking them rate how they felt about this new technique. The experimenters randomly assigned half of the participants to a "can't" condition, and the other half to a "don't" condition. The "don't" condition participants read about a program in which participants would be asked to say a particular sentence whenever they felt a temptation to eat something unhealthy; I don't eat x. They would fill in the tempting food for x there, of course. The "can't" condition participants read about a program that worked in almost exactly the same way, but with a slightly different temptation response sentence; in this case, I can't eat x.

At the end of the study, all participants were offered a snack to say thank you for participating. Two options were available—less healthy chocolate candy bars or more healthy-looking granola bars. Of the participants who chose a snack, fully 64 percent in the "can't" condition picked a less-healthy chocolate bar; the others picked the healthy granola bars. In the "don't" condition only 39 percent of the participants who took a snack chose that candy bar. Just having people think about using the word "don't" seems to spur them to more healthy eating even when they are merely hearing about the don't eating plan.

Other studies have confirmed this effect. Perhaps the best was conducted with a group of participants who were already engaged in a healthy eating plan. The participants were asked to try to stick to their plan for 10 days at a time. Whenever they felt like eating something that was not in their plan, they were instructed to think or say a particular sentence to help them resist. The experimenters randomly assigned the participants to one of three groups. The "don't" group used the sentence "I don't eat x." The "can't" group used the sentence "I can't eat x." A third, control group used an alternative sentence, "Just say no."

The participants would keep careful records of their eating for 10 days at a time. The measure of effectiveness used here was the number of days out of 10 that the participants managed to resist their problematic eating behaviors. The effects were very clear and statistically significant. The "don't" group persisted for an average of 9.2 out of 10 days. The "can't" group, only 2.9. Actually, the "can't" group was even worse than the "just say no" group, who persisted for an average of 5.2 days.

The language that you use matters. If you are talking with your friends or even just thinking to yourself and say I don't eat French fries it is taken to have the same meaning as I can't eat French fries. But your brain hears these two different things when you say these words. The difference is subtle, but it plays a critical role in how you frame the process that you are undertaking as you seek to change your behaviors. The language we use also seems to affect our emotional responses to the events around us. Ethan Cross and his collaborators have found that self-talk can matter a lot in terms of how we regulate our own emotions. Their experiments are insightful, and I've enjoyed how this research group offers great examples of their findings in the real world.

Want to reduce your levels of stress and anxiety about some situation? Refer to yourself in the third person—like LeBron James. In 2010, LeBron James left the Cleveland Cavaliers to play basketball with the Miami Heat. A large proportion of the population of Cleveland was mortified, to say the least. Announcing this move on prime time television, with an audience of millions of people, was, we can presume, a really stressful experience. James employed a linguistic strategy that has been shown repeatedly to be very effective at coping with such stress—linguistic distancing.

During his televised announcement, he said, "One thing I didn't want to do was make an emotional decision. I wanted to do what's best for LeBron James and to do what makes LeBron James happy." He used the first-person pronoun I twice there, but then quickly switched to using his name in a third-person fashion. It was as if he was talking about someone else who happened to be named LeBron James rather than himself. When people are in high-stress situations, they tend to do this. Cross and his colleagues have studied this in the context of social anxiety. In one study, they recruited participants and had them try to make a good first impression during a brief conversation with a stranger. This isn't nearly as stressful as making an announcement on national television, but meeting new people does produce a measurable increase in anxiety in most people—certainly relative to, say, having a conversation with friends or just sitting and reading without any social interaction. The conversations were videotaped, and participants provided a rating of how anxious they were during the process.

The key experimental manipulation here took place before the videotaped, first impression conversation. Half of the participants were randomly assigned to a first-person condition. For these participants, the experimenter explained that the researchers were interested in how the language that people use to understand their own feelings was. To explore that, the participant should spend one minute reflecting on his or her feelings using the pronouns I and my as much as possible. For instance, why do I feel the way I do? What sorts of things affect my feelings. Everyone's thoughts during this minute are up to them. The experimenter simply urged them to phrase their internal thoughts—whatever they were—in terms of these first person pronouns.

The procedure was the same for the other participants, who were randomly assigned to the non-first-person condition. During their one minute of introspection on their feelings, they were urged to make use of second and third person pronouns or to use their own names. For instance, well, when you start, you don't know what you're going to do. Or, what sorts of things affect Peter's feelings.

Two clear differences emerged from these two groups. The first-person condition reported higher levels of anxiety during those brief interaction with a stranger. In addition, judges rated the social performance of these participants as being worse. They used a variety of different criteria, ranging from how nervous the participant seemed, how good their vocal quality was, how often they made eye contact with the stranger, and several other aspects of their social performance.

In addition to reporting lower levels of social anxiety, these non-first-person participants performed substantially better than the first-person group—by a lot. The differences found here were highly significant. And the only difference between the two groups was their use of pronouns during a one-minute introspection process prior to the meeting.

The tip here is really clear. If you feel anxious about some meeting with someone, especially if you want to make a good first impression, spend a minute thinking about your feelings. And when you do so, use words that describe your feelings as if you are talking to and about someone else. Peter feels a little anxious about this. Why does he feel anxious? There's no reason for him to be worried, it's just a meeting he's doing with one other person. Or if that seems strange, try saying it in second person—you feel a little anxious about this, but there's no reason for you to be worried. You're just meeting with another human being you feel a little anxious, but you'll get over it.

Language areas are strongly connected to many areas of the brain, including the emotion centers of the brain. Wernicke's and Broca's areas are both located in their respective regions of the cortex, but a couple of synapses away, there are strong connections to the limbic system. When we feel a particular emotion, it certainly influences the language we use. Apparently, when we use particular words, it can also influence those emotion centers.

Alison Brooks has published research using an even simpler linguistic strategy for dealing with anxiety in particular—reappraise that anxiety as excitement. When participants in her studies are feeling anxious prior to a karaoke singing or public speaking task, they are instructed to say, "I am excited." This not only reduces the anxiety somewhat but seems to enhance performance. Anxiety and excitement both involve states of high arousal, so the trick is to capture that high state of arousal for positive purposes.

Excitement is associated with activation in many regions of the brain, as is anxiety. If the source of the excitement or anxiety is visual in nature, high levels of activity will be found in the visual cortex, in the occipital lobe. If the anxiety or excitement is caused by something you hear, then high levels of activity will be found in the auditory cortex, located in the temporal lobe. Both are also associated with diffuse frontal cortex activation. The primary difference for anxiety is additional activation in the amygdala and the sympathetic nervous system.

Usually, when people try to reduce their anxiety, they are urged to try to become calm—to reduce activation across all of the regions associated with anxiety. The Brooks method suggests instead that the anxious person should use the power of language to alter the pattern of activation. By using your language, you can quickly change on into the other.

This last tip is perhaps the most counterintuitive of the bunch, but there is really good data supporting it. The language centers of the brain seem to connect to the systems in your body that regulate your expenditure of calories. In order to be more physically fit, think of the daily activities that you already do as exercise. You don't have to physically change the activities, just associate them with that word—exercise—and your fitness level will improve.

Alia Crum and Ellen Langer recruited a group of housekeepers who worked at a hotel. The more appropriate term in the industry is room attendants. Working as a room attendant is physically demanding. You're on your feet all day, walking from place to place, often up and down stairs. You're pushing a vacuum cleaner back and forth. This stresses many large muscle groups, from the muscles around the body's core to the biceps and the triceps as well. Wiping down surfaces, sweeping, lifting trash cans, carrying piles of sheets and towels—all of this adds up to a lot of exercise.

Interestingly, most room attendants don't think of it as exercise. It's their job. They don't head to the gym to do these things. They go to a hotel. Crum and Langer wondered if changing the way they described and thought about their jobs would change how their bodies reacted to it. So they recruited room attendants from eight different hotels. Some of the hotels were randomly assigned to the experimental condition. The researchers met with the room attendants at the experimental hotels and explained that they were interested in better understanding physical fitness in the workplace. They presented information about the caloric expenditures associated with different aspects of their work. For instance, for a 140-pound female, changing sheets and towels for 15 minutes burns about 40 calories. Vacuuming for 15 minutes burns up 60 calories. Add up eight hours of work in a given day, and it is clear that the attendants easily exceed the Center for Disease Control's recommendations for a proper amount of physical exercise.

The researchers also met with the room attendants in the randomly assigned control condition hotels. They explained the interest in fitness in the workplace, but they specifically did not provide the information about how their work could be described as exercise. For both the experimental and control groups, a variety of physiological measures were taken—blood pressure, height, weight, body fat percentage. They measured the waist and hip size of the attendants and calculated a waist-to-hip ratio as well. Other studies have found that this ratio is a measure of fitness that is related to a variety of health outcomes.

The experimenters then waited for one month and returned. The researchers collected a lot of data about the health-related habits of the attendants over the course of that month. The general result from these measures is that the two groups didn't change their eating or exercise habits away from work very much. For instance, the experimental group was no more likely to start a new eating or exercise plan than the control participants.

What was really different was the general fitness levels of the experimental participants. Weight, percentage of body fat, and blood pressure all dropped. And it dropped without any change in behaviors. All that changed were the words that participants would use as they thought about what they were doing at work. If I'm vacuuming, that burns some calories. If I'm exercising, that burns more calories. The amazing thing is that if the vacuuming and the exercising are the same activity, that difference is still present.

Remember that merely imagining exercise activities, for instance lifting a weight, has positive effects on fitness and muscle strength. Those imagery effects are enhanced by semantic labeling of the activity. Here, when we refer to an activity with the semantic label of exercise it changes how your brain processes those activities—vacuuming, changing sheets, things like that. It also changes how your body processes it.

When the language centers of the brain are active, they modulate the activity of many other regions in your brain. Thinking about your everyday physical activities as exercise—just working around the house and making your way through your day—associating that word exercise with those tasks—enables your body to get more out of it.

Alia Crum, one of the researchers involved in this study, found that the words you use to describe eating also have an effect on your sense of satiation. Participants in her study consumed a 380 calorie milkshake. Half of the participants thought of it as an indulgent, 620 calorie milkshake. Others thought of it as a sensible 140 calorie milkshake. Same shake for everyone, just a different mindset about what they were consuming. The indulgent participants? They felt more full and satisfied than their sensible shake counterparts. What's even more surprising is that the body's response to the food is physiologically different.

The intestinal cells of the indulgent participants in this study produced significantly lower levels of the hunger-related hormone called ghrelin than the sensible shake participants. Same milkshake, but with a different mindset, even the digestive system alters its function.

When you do indulge—or even when you don't—take time to celebrate your indulgence. Think about the indulgence. Maybe even talk about the indulgence. And your body will respond better, more fully. Words matter. Your own words shape you, perhaps even more than they affect anyone else. How you talk about yourself—and to yourself can affect how your own brain functions. Even the words you think, without ever saying them even these words affect your brain and your body, all the time, whether you're aware of these effects or not .

We all engage in an almost continuous inner monolog. Every day, thousands of words pass through our stream of consciousness. By intervening in, and altering, the flow of that stream of self-talk, it seems we can—often quite easily—change our behaviors, our emotions, and even our physical health.

How Your Brain Falls in Love

Love is perhaps the most powerful of all human emotions; in fact, the desire to be loved is a fundamental human drive. In this lecture, we consider how love is mediated by systems in the brain and examine what the brain looks like when it is in love. We also explore phenomena such as the significance of eye and pupil size, the mere-exposure effect, the Stockholm syndrome, and universal markers of attractiveness. Cognitive neuroscientists have discovered a great deal about love circuits in the brain, offering us a far better understanding of the implications of love at first sight and the potential for love addiction.

Eye and Pupil Size

- Cognitive neuroscience has demonstrated that our brain captures information from the eyes that is significant to the incidence of attraction and the formation of romantic relationships. Some studies suggest that the ratio of eye size to ear size is a predictor of reproductive success. As we age through adulthood, our ears continue to grow, while our eyes tend to remain about the same size. Thus, as we get older, the eye-to-ear ratio gets progressively smaller. Evolution may have selectively bred us to look for potential mates with eyes that are especially large in relation to the rest of the face.

- The pupil of the eye operates as a key mode of social communication, especially in potentially romantic situations. Your brain is wired to dilate the eye muscles when you see someone for whom you feel romantic attraction.

- Humans are very sensitive to changes in pupil size when looking at another person's face. A variety of studies have been conducted in which participants were asked to view a selection of face pictures and rate them according to attractiveness. In many studies, faces with very large pupils had significantly increased ratings. Even participants' ratings of how much they trust someone were increased when viewing people with larger pupils. Trust and love certainly tend to operate in tandem.

Mere-Exposure Effect

- If you want someone to love you, a brain-based strategy is to maximize the amount of time they spend with you. Brain-imaging studies have shown that particular brain systems are activated when you look at attractive or unattractive faces. It will be no surprise that systems associated with pleasure—subcortical circuits near the nucleus accumbens—show greater activity when you perceive a face as attractive. For very unattractive faces, increases appear in the amygdala—a region associated with negative emotions and even the fight-or-flight response.

- As you continue to stare at an unattractive face, however, it gradually seems to become less distorted. That feeling of aversion dissipates. Over time, it starts to look much more normal. This is called the mere-exposure effect. The mere-exposure effect applies to almost all the stimuli we encounter, not just faces. Robert Zajonc demonstrated it with words and even line drawings.

- The mere-exposure effect stimulates the brain in many different ways. As stimuli are presented repeatedly to the sensory systems, the brain requires less and less activity to process them. Repeatedly presented stimuli are also generally processed more quickly than novel stimuli. This processing ease—or sensory fluency—may be related to the sense of pleasure that comes with familiarity.

- Novel stimuli also tend to cause at least a slight activation of the sympathetic nervous system—that part of our autonomic nervous system that prepares our bodies for a fight-or-flight response. As you become familiar with people and places, this response is reduced.

Stockholm Syndrome and Reaction Formation

- There have been numerous documented cases of the Stockholm syndrome, which occurs in situations in which a captor holds someone hostage for an extended period of time. In some cases, the hostages develop an emotional attachment to—and sometimes a love for—their captors.

- Perhaps the most famous case of this was the 1974 kidnapping of Patty Hearst, a 19-year-old woman from a wealthy and prominent California family. Members of the Symbionese Liberation Army (SLA) kidnapped her from her apartment. Although Hearst had no political affiliation with the SLA, after her capture, she released a tape announcing that she had decided to change her name and join the SLA. She even participated in bank robberies with the group.

- Hearst is not the only documented case of Stockholm syndrome. The term comes from a hostage situation that emerged from a failed bank robbery attempt in Stockholm, Sweden, in 1973. During negotiations between police and the robbers, it gradually became clear that the hostages felt sympathy and even a strong affinity for their captors. At several times during the negotiations, the hostages communicated with the police—and in one case, the prime minister of Sweden—to criticize the operation and request that the robbers be set free.

- Stockholm syndrome has been described by Freudian theorists as a result of reaction formation. The idea here is that the mind, to protect itself from breakdown in a high-stress situation, changes the framework that it uses to interpret the surrounding situation. This theory would describe a hostage as initially feeling a strong hatred for the kidnappers. This powerful level of emotion creates an increasing stress on the mind and body. To reduce that stress, the mind reacts by focusing more on the positive aspects of the kidnappers.

Stockholm syndrome occurs in situations in which a captor holds someone hostage for an extended period of time.

Love at First Sight

- Consider the notion of love at first sight. Most relationship-science experts would refer to it as lust at first sight, but the phenomenon is still a viable one. The idea is that you see someone and then some undefined feeling arises—or doesn't. Cognitive research, however, suggests that real life doesn't work that way. How attracted you are to someone on day 1 isn't a perfect predictor of how attractive you will find them on day 7. For day 700, the connection is even weaker.

- There's an important tip here about searching for love. It sounds a little corny, but the data support it. You should keep an open mind and an open heart. Even if love at first sight doesn't show up at all, it doesn't mean that "love at thousandth sight" is not on its way.

Skin-Conductance Level

- One of the most consistent neuroscience markers for love or longing is found completely outside the brain, in the skin. Your skin contains some water and can conduct electricity. When you are generally aroused by something, your body ramps up its activity and begins to push more water into the skin. If the process continues long enough, you will begin to sweat. Long before the sweating starts, however, this greater water concentration results in a lower electrical resistance.

- When you look at a picture of someone you love, your skin-conductance level rises within a few seconds and continues rising for several seconds after.

- At the same time, at least two other operations occur in the peripheral nervous system. First, the zygomatic muscles of the face become slightly tensed—a tension that can be measured in terms of electrical activity. If you place an electromyograph over the cheek muscles in the face, an increase in electrical activity is found. When these particular muscles are fully tensed, they pull the sides of your mouth upward into a smile.

Love Addiction

- The state of the brain in love is often studied by recording nervous-system activity while a person thinks about or looks at a photograph of someone they love. The data is then contrasted with the nervous-system activity while the person is looking at other kinds of photos. Helen Fisher and her colleagues have run several studies in which they looked at people experiencing those sensations of love while in a functional magnetic resonance imaging (fMRI) scanner.

- The research team found activation in a variety of regions—most notably in the ventral tegmental area, a small region located near the bottom of the brain. The ventral tegmental area shares numerous connections with the nucleus accumbens, which is one

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of the areas associated with desire in general—desire for food and water as well as a loved one. When you introduce dopamine into the cells in this nucleus accumbens region, the experience is of a rush of pleasure.

- If you are hungry and you take a bite of a food you like, the nucleus accumbens area is activated. If you have a goal of completing a project and you make progress on it, the nucleus accumbens area is activated. What's more, if you take a dose of cocaine, you get an enormous amount of activation at the nucleus accumbens.

- Cocaine is obviously an addictive drug. You might feel as if some people you've known—perhaps even yourself—are addicted to love (or at least to the rush that they feel with a new love). This brain-imaging work suggests that a love addiction is certainly a possibility because many of the same brain circuits are involved.

- Many of our moment-to-moment behaviors are driven by our subcortical brain systems. Interestingly, while the system is activated by cocaine or other drive-based activities, it also becomes very active even before the need is met. That is, this isn't so much a pleasure system of the brain; rather, it's more of a craving system.

Significance of Symmetry

- A great deal of research has gone into what makes certain people seem more attractive than others. Several universal characteristics have been identified.

- In a typical study, researchers recruit a group of 50 participants and show them all a set of 100 pictures of faces. For each picture, they ask the participants to rate how attractive the faces are, where 1 is unattractive and 10 is absolutely gorgeous. Studies like this have been conducted many times and have shown a remarkable amount of consistency. One of the very striking results from this kind of work is that it generalizes cross-culturally.

- Researchers have identified several characteristics that humans seem to favor. The closer a face is to perfectly symmetrical, the more attractive it will be rated. There is strong evidence that even young infants like symmetry. Babies will look longer at faces that are symmetrical than at those that are asymmetrical.

- David Buss and his colleagues have argued that symmetry is a basic instinct of reproductive fitness. On average, people with highly symmetrical features tend to live longer and be healthier. They tend to have fewer problems with fertility. It may be that through many generations of evolution, we have been bred to favor symmetry.

Questions to Consider

1. Some have suggested that we place too much emphasis on physical attraction in our selection of romantic partners. Given your understanding of the brain's process of falling in love, might it make sense to be somewhat shallow in this regard?
2. The mere-exposure effect seems to make people and things more attractive (or less unattractive) as the amount of time you spend with them increases. Might that be explained, at least in part, by our tendency to discover complexity and inner beauty as we spend more time with something or someone?

Suggested Readings

Buss, *The Evolution of Desire*.

Gottman and Silver, *What Makes Love Last?*

Lecture 21 Transcript

How Your Brain Falls in Love

Love. ... When I think of the woman I love, I think about her eyes—other things too, of course, but those eyes just come to mind immediately. Eyes matter a lot when it comes to attraction and love. When surveys are done asking people what their favorite feature is in romantic partners, eyes is always near the top.

Eyes can be beautiful, of course. That's part of it. But cognitive neuroscience has also revealed a variety of information that our brain captures from eyes that's important to attraction and the formation of a romantic relationship.

Some studies have suggested that the ratio of eye size to ear size is a predictor of reproductive success. As we age through adulthood, our ears continue to grow, while our eyes tend to remain about the same size. Thus as we get older, the eye-to-ear ratio gets progressively smaller. Evolution may have thus selectively bred us to look for this ratio, to look for potential mates with eyes that are especially large relative to the size of the rest of the face.

There's a particular part of the eye that works as an important form of social communication, especially communication in potentially romantic situations—the pupil.

Many things make your pupils vary in size. Normally the muscles that control the size of your iris—the thing that surrounds your pupil—are based on the amount of light hitting your eyes. In bright light, the pupils contract. In dim light they dilate to allow more light into your eye so you can see better. Interestingly, your brain is wired up to also dilate the eye muscles when you see someone for whom you feel romantic attraction.

Humans are very sensitive to these changes in pupil size when they're looking at another person's face. A variety of studies have been conducted in which participants were asked to view a selection of face pictures and rate them. Sometimes those ratings are of how beautiful or attractive the faces are. Sometimes the ratings are of how likely you would be to do something altruistic for this person. For many ratings of this type, if the face is looking directly at you with very large pupils, your ratings will be significantly increased.

And it's not just that beautiful people tend to also have large pupils. If you modify an image to make the pupil larger, the ratings will increase. Even participants' ratings of how much they trust someone can be increased by artificially causing pupils to dilate. I think it's intuitive that trust and love certainly tend to go together.

The tip from this research is to make sure that someone can see your eyes if you want attraction in a relationship. Phone calls and texts are nice, of course, but face-to-face interactions are central. As you develop an affinity for someone, your pupils will communicate that, but only if they can be seen.

Dark glasses can look really cool, but make sure that you don't wear them all of the time that you're interacting with your potential romantic partner. This could hinder their sense of how attractive you are, and of how much you can be trusted.

The results also suggest why we tend to take potential romantic partners to dimly lit restaurants. Large pupils make everyone, it seems, look more beautiful by candlelight.

Love. ... It's the stuff of poetry—the stuff of life. All's fair in love and war. A flower cannot blossom without sunshine. A man cannot live without love.

Love is composed of a single soul who inhabits two bodies. Where there's love there's life. And those are just the first of about 15,000 quotes you get from a simple Google search.

Love is perhaps the most powerful of all human emotions. It can inspire us to great creation or terrible wars. The drive to be loved might be the most basic of human drives. No culture has ever been found that didn't have a word for love, or even for whom love was not a central, highly celebrated aspect of existence. Even if a human child receives all of the required biological needs for existence—food, water, air, shelter, warmth—even if all of these needs are met, if a child doesn't experience a loving connection with at least one other person, the child will die. We don't just crave love. We need it.

We all know what love is. Or at least we think we do. In this lecture, we'll consider how love is mediated by systems in the brain. What does your brain look like when it's in love? More specifically, how is your brain different when it's in love versus when it isn't?

In this lecture, we'll consider how you can make yourself more attractive and even more loveable via something called mere exposure. I'll also describe how compensating for small facial asymmetries will activate attraction systems in other people's brains more effectively. Finally, I'll present a tip for how you can ease the pain in rejection of someone that you had hoped you could be in love with.

Cognitive neuroscientists, like all people, are very interested in love. A lot's been discovered about love circuits in the brain and, in the process, I think a better understanding of just what love means to humans.

Want to love something? Look at it, listen to it, and generally experience that thing, or that person, a lot. Want someone to love you? A brain-based tip here is that you should try to maximize the amount of time that they spend with you.

One thing that cognitive scientists have known about love for a while is that your preferences for things are greatly influenced by how much you're exposed to them.

Let's consider a simple example. Imagine we have a photo of someone's face. Just a straightforward frontal view works fine. If I digitally squash or stretch the features on that face, the face will, understandably, look a bit unattractive.

If you stare at one of the faces for a few minutes, a strange thing starts to happen.

Actually, because of the way the features on this face has been stretched, it has a negative, scowling expression on it. When you first look at the distorted face, it looks, well—distorted. The face looks unattractive. If you were to see someone with this face, just like this, walking down the street, you'd very unlikely to hustle over to talk to the person. The notion of love would simply not come to mind.

When you see someone with a beautiful face, there's a feeling of pleasure that many people report. It just feels good to look at someone who's handsome or beautiful. Most people, when seeing this distorted face would report that it looks—aversive. It generates a mildly unpleasant sensation.

Brain imaging studies have shown that particular brain systems are activated when we look at attractive versus unattractive faces. It will be no surprise that systems associated with pleasure, subcortical circuits near the nucleus accumbens, show greater activity when we perceive a face as attractive. For very unattractive faces, increases appear in the amygdala—a region associated with negative emotions or even that fight or flight type of response.

As you continue to stare at a distorted face, however, a strange thing will start to happen. It gradually seems to become less distorted. That feeling of aversion dissipates. Over time, it starts to look a lot more normal.

In fact, if you get used to a distorted face for a long enough, then when you then look at a version of this face that is not distorted, it's the not distorted face that now looks a little strange.

For example, if the distorted face you've been looking at has the features squashed toward the center of the face, then when you look at the normal face, an opposite after effect is produced. The features of the normal face seem to look a little stretched away from the center of the face.

The most powerful version of this effect requires staring at the distorted face for a full five minutes or so, but with even a minute of viewing the general effect is already somewhat apparent. If you looked at the face for days—saw it for months or years—the adaptation would have a semi-permanent effect on how you judge the appearance of faces.

Now, people don't usually just stare at photographs of faces. Usually those faces talk and smile and do social things that promote a relationship. But this effect demonstrates that merely looking at a face over time makes it seem more and more attractive.

One of the best demonstrations of this comes from a clever study in which an experimenter started by taking a photo of the participant's own face. They then made two copies of that photo. The first was merely the photo itself. The second photo was digitally flipped over, so that the left side of the image was on the right, and vice versa. The experimenter then presented these two photos to the participant and asked her or him to choose which one looked better.

A significant majority of people pick the mirror image photo as looking better. Any guess why that is? The explanation that the experimenters offer is fully based on the mere exposure effect. We rarely see our face with the right side of the face on the left of our visual field and vice versa. That's the way a standard image is projected. Most of the time when we look at our face, it's in a mirror. We've been exposed to the mirror image of our own face far more than to the standard image. Thus, even though we don't actually look that way to other people, that's what we prefer.

The mere exposure effect actually applies to almost all stimuli we encounter, not just faces. Robert Zajonc demonstrated it with words and even scribbly line drawings. If you see something for a while, then later, if you're asked about it, you'll tend to see it as more attractive than you would have the first time you encountered it.

If you really don't like jazz or classical music, and you wish that you did—all you may need to do is listen to it a lot. Over time, it's likely to become increasingly attractive to you. Eventually, just due to the mere exposure effect, you may come to even say that you love it.

However, there are limits to this effect that I should note here. An avant-garde piece of music that's so complicated that you don't discern any pattern at all may not grow on you. The stimulus may seem just too chaotic, too lacking in coherence to become familiar.

On the other hand, almost everyone has experienced some tune that's repeated so many times that sheer over-exposure eventually makes the familiarity unattractive. Some studies have suggested that mere exposure may be most effective with roughly 10–20 exposures to something. The optimal level can vary, but eventually, at some higher number of exposures, as with any food, for instance—no matter how delicious it is—saturation can set in. And beyond that point of saturation, attraction may even begin to decline.

Mere exposure effects may also depend on the initial experiences being closer to puzzlement than to aversion. Mere exposure may not be sufficient to overcome strong aversion, for instance. Repeated exposure to a person who's regarded as directly responsible for some very negative outcome may actually increase aversion.

Mere exposure affects the brain in many different ways. It's not exactly clear which parts of those effects are related to the increased sense of pleasure associated with merely exposed stimuli. As stimuli are presented repeatedly to the sensory systems, they seem to require less and less activity in order to process them. Repeatedly presented stimuli are also generally processed more quickly than novel stimuli. This processing ease—this sensory fluency—may be related to the sense of pleasure that comes with familiarity.

Novel stimuli also tend to cause at least slight activation of the sympathetic nervous system—that is, the part of our autonomic nervous system that prepares our bodies for a fight or flight response. Now, if it's a novel face, you aren't going to react in the same way as if there's suddenly a giant, snarling tiger in the room with you. The fight or flight response won't be nearly as big for a novel face, but a small activation will take place. As you get familiar with people and places, this response is reduced. You can relax more, and that may lead to that better sense of pleasure that comes with familiarity.

Regardless of how the brain mediates the mere exposure effect, the tip here remains the same. If you spend a lot of time with something, or someone, you'll tend to like it more and more. If you want to be that something, or someone, that is liked more—maybe even loved—then increasing the amount of time that your image is falling onto people's eyes and ears will help.

I'm presuming here that you aren't initially perceived by the person as strongly aversive. Mere exposure doesn't seem to overcome that. But presuming that someone finds you at least not strongly unattractive, mere exposure will tend to lead to increases in their sense of how attractive you look.

There's a pair of old adages here that most people agree are true, but which contradict one another. First, there's: "Absence makes the heart grow fonder." Second is: "Out of sight, out of mind." In terms of the mere exposure effect—not out of sight equals not out of mind—that's much more supported by the data.

There have been numerous documented cases of something called the Stockholm Syndrome. This is where a captor holds someone hostage against his or her will for an extended period of time. Being kidnapped and held at gunpoint is something that's obviously a really terrifying. It's obviously a really negative experience. You'd presume that the hostages would at the very least have strong, negative associations with their captors. It might be reasonable to presume that they would despise them.

Not always, but sometimes, the hostages develop an emotional attachment—in some cases a love for their captors. Perhaps the most famous case of this was the 1974 kidnapping of Patty Hearst, a 19-year-old from a wealthy, very prominent family who lived in California. Members of a group called the Symbionese Liberation Army, the SLA, kidnapped her from her apartment.

Patty had no political affiliation with the SLA, nor any known affinity for their cause. Yet, on April 3rd, she released a tape announcing that she had decided to change her name and join the SLA. She even participated in bank robberies with the group.

And Hearst is far from the only documented case of this Stockholm Syndrome. The name actually comes from a hostage situation that emerged in a failed bank robbery attempt in Stockholm, Sweden in 1973. The police arrived before the bank robbers could escape the bank with the stolen money. The robbers took refuge and took several hostages with them into the vault of the bank. A six-day standoff followed.

During the continuing negotiations between the police and the robbers, it gradually became clear that the hostages felt sympathy for their captors—even a strong affinity. At several times, the hostages would get on the phone with the police and, in one case, the prime minister of Sweden. They would criticize the police and plead the case that the robbers should be set free.

The standoff ended after several days when the police drilled a hole into the vault and pumped gas into the vault that drove everyone out. Everyone survived.

Some have reported that some of the hostages later married the robbers. This isn't true, but what is clear is that an affinity formed between the hostages and captors during this experience.

Stockholm syndrome has classically been described by Freudian theorists as resulting from something called reaction formation. The idea here is that the mind, in order to protect itself from breakdown in a high stress situation, changes the framework that it uses to interpret the surrounding situation. This theory would describe a hostage as initially feeling a strong hatred for the person who's kidnapped them. This powerful level of emotion creates an increasing stress on the mind and body.

In order to reduce that stress, the mind reacts by focusing more and more on whatever the most positive aspects of the kidnapper are. Maybe the kidnapper let the hostage stand up and walk around for a minute or gave the hostage a chair to sit in. These aren't really very positive things, but the hostage, according to the theory, greatly exaggerates them in order to cope with this situation. This reaction formation, according to the theory, ultimately leads to a sense that the captor is wonderful—and love ensues. That's the story anyway.

Research on the mere exposure effect suggests a much simpler account. Now, a human response to being held hostage for many days is undoubtedly very complex. The experience is very traumatic, and the kind of trauma has a wide variety of effects on many systems within the brain.

It seems likely, however, that the mere exposure effect has at least some impact. While the kidnapped person is in close proximity to the kidnapper for an extended period, several days—maybe several weeks—being continually exposed to those people and their ideas may change the victim's ideas about what seems good and right and attractive.

Now, my tip here is not that you go kidnap someone in the hopes of finding love. But if the mere exposure effect can function even in this very negative context, the idea that it will have positive effects in more normal circumstances seems quite clear.

There's a notion that many people have about "love at first sight." Most relationship science people would refer to it, more correctly, as "lust at first site," but the phenomenon is still there. The idea is that you see someone and something's there—or it isn't. You see that special someone. The music swells and love begins. This research suggests that real life doesn't often work that way. How attracted you are to someone on day one of knowing him or her isn't a perfect predictor of how attractive you will find them on day seven. For day 700, the connection is even weaker.

There's a tip to be had here about searching for love. It sounds a little corny, but the data support it. You should keep an open mind and an open heart. Even if "love at first sight" doesn't show up at all, it doesn't mean that "love at thousandth sight" isn't on its way.

Neuroscientists, along with poets and many other writers, have struggled for a good, operational definition of love. Certainly, there are many different kinds of love. There's parental love, sibling love, love of friends, love of music and art, love of community. The first definition of love that comes to mind for most people, however, is romantic love. Most people accept a working definition of romantic love as: "a state of intense longing for union with another."

How does the brain function differently when you feel this state of intense longing? This has often been studied by recording nervous system activity while a person thinks about or looks at a photograph of someone for whom they feel romantic love. The data's then contrasted with the nervous system activity while looking at other photos—for instance of other very familiar people for whom the participants do not feel love. Note that this is important, since we know that familiarity matters a lot in terms of how the brain responds.

One of the most consistent neuroscience markers for love or longing is found completely outside the brain—in the skin. Your skin contains some water—at all times, really—such that it can conduct electricity. When you're generally aroused by something, your body ramps up its activity and begins to push more water into the skin. If the process continues long enough, you'll begin to sweat. Long before that sweating starts, however, this greater water concentration results in a lower electrical resistance.

When you look at a picture of someone you love, your skin conductance level rises within a few seconds—quite consistently, actually.

Within about three seconds of the appearance of an image, the skin conductance rises and continues doing so for several seconds thereafter.

At the same time, at least two other peripheral nervous system things happen. First, the zygomatic muscles of the face, here, become slightly tensed, with tension that we can measure, actually, in terms of electrical activity. If you put an electromyograph over these cheek muscles in the face, an increase in electrical activity is found. When these particular muscles are fully tensed, I should note, they pull the sides of your mouth upward in a smile.

The brain itself is also affected by those feelings of love and attraction, of course. Helen Fisher and her colleagues have run several, really great studies in which they looked at people experiencing those sensations of love while in an fMRI scanner—while viewing an image of someone they felt loving attraction to, for instance.

This research team found activation in a variety of regions, but most notably in an area referred to as the ventral tegmental area. This is a small region located near the bottom of the brain. It shares a lot of connections with the nucleus accumbens, which is one of the areas associated with desire in general—desire for food and water, as well as a loved one. Indeed, many people consider the ventral tegmental area and the nucleus accumbens to be part of the same overall neural circuit. When you introduce dopamine into the cells in the nucleus accumbens region, the experience is a rush of pleasure.

If you are hungry and you take a bite of a food you like, this nucleus accumbens area is activated. If you have a goal of completing some project, and you make progress on it, the nucleus accumbens area is activated. Actually, if you take a dose of cocaine, you get an enormous amount of activation at the nucleus accumbens. The ventral tegmental region seems to function in the same way for romantic attraction.

Cocaine is obviously something to which people become addicted. You might feel as if some people you've known, perhaps including yourself, have seemed addicted to love or, at least, to the rush that they feel with a new love. This brain imaging work suggests that a love addiction is certainly a possibility—many of the same brain circuits are involved.

A lot of our moment-to-moment behaviors are driven by these subcortical brain systems. Interestingly, while the system is activated by cocaine or other drive-based activities, the system also becomes very active even before the need is met. That is, this isn't so much a pleasure system of the brain. It's more of a wanting system of the brain. When someone is craving a hit of a drug or craving a bite of food, there's a lot of activity in this reward system.

That happens with love as well. Some studies have also been conducted with people who have recently been dumped by someone they love. This experience of being rejected is one of the worst things in most people's lives. If you love someone and they don't love you back, it would be completely reasonable to love them less because of it. Unfortunately, that's not how most people experience it. When someone doesn't love you back, it can often lead to the sense that you want them more than you did before.

That pattern matches the results of these fMRI studies as well. The recently dumped participants, upon seeing and thinking about that person who dumped them, show levels of activity that are as great—sometimes even greater—than those of people who are in a reciprocal loving relationship with someone.

This is also why it's understandable that many people respond to being dumped by eating a lot of ice cream or other forms of binge behavior. The experience of being jilted ramps up the activity of a system that can be quelled by replacements—forms of subcortical activation.

You can outsmart this behavioral tendency by engaging in other, more healthful activities that will activate these same brain circuits—work, exercise, and other goal directed behaviors, for instance. When you set some goal and achieve it, the same type of dopamine release is triggered.

Now, the fact that mere exposure can make anyone more attractive doesn't mean that everyone is equally attractive. A lot of research has gone into what makes certain people seem more widely attractive than others. Several universal characteristics have been identified.

Imagine that I recruit a group of 50 participants and show them all a set of 100 pictures of faces. For each picture, I ask the participants to rate how attractive the faces are, on a scale from, say, 1 to 10, where 1 is unattractive and 10 is absolutely gorgeous.

When I look at all these ratings, there will, of course, be differences. Not everyone thinks that the same people are most attractive. But there will be a remarkable amount of consistency. The photos that get scored as 9s by some people and maybe 9s and 10s by others. Those will almost certainly be rated as 9s and 10s by almost everybody in the group. The same consistency will show up for the faces that receive low ratings.

Studies like this have been conducted many times. One of the very striking results from this kind of work is that it generalizes cross culturally. That is, if I show you pictures of a set of Japanese faces or Brazilian faces or faces from anywhere in the world—the faces you pick as most attractive will tend to be the ones that people from other parts of the planet would pick as well.

Certainly, there are great cultural variations across the different parts of the earth, but not so much in terms of what we humans tend to find attractive. Researchers have identified several characteristics that we seem to like. Symmetry is a big one. Faces are generally symmetrical of course. We have one eye on one side—one eye on the other side. One eyebrow on each side. The left part of the face is close to being a mirror image of the other side of the face—but not exactly.

Most people's eyes are slightly different in size, and one will be slightly farther from the midline of the face than the other. For all of us, one side of the mouth will be ever so slightly larger than the other side. The closer a face is to perfectly symmetrical, the more attractive it will tend to be rated. Humans like symmetry.

Actually, there's good evidence that even young infants like symmetry. Babies will look longer at faces that are symmetrical than asymmetrical. The faces you pick out as attractive will tend to attract more looking from infants as well. There's something very basic about this symmetry that fits with what our brain likes to see and to be around. Why would that be?

David Buss and his colleagues have argued that it's a basic instinct of reproductive fitness. On average, people with highly symmetrical features—they tend to live longer and be healthier. They tend to have fewer problems with fertility. It may be that, through many generations of evolution, we've been bred to like symmetry. At least that's the theory.

A general tip for looking more attractive to other humans then, is to try to be more symmetrical. Now, you can't easily change the shape of your face, but you can do things with haircuts, eyebrow trimming, and even careful use of makeup to create a more balanced facial appearance.

Many people refer to wanting pictures from their good side. That is, rather than looking straight at a camera, someone might turn to the side—give a three-quarters angle view of their face. The data here suggests that we can predict which side is best. If one side of your face is slightly larger than the other, then turning that side so it's slightly further away from the camera will produce a more symmetrical image.

It's not so much that one side of the face is the good one, but rather that the viewpoint is the good one. You can try measuring your face, but even just a bit of experimenting will likely give you a sense of which perspective looks best. Of course, if you're very symmetrical already—firstly, lucky you. Secondly, you probably won't have much of a good side or a bad side.

Let's consider how this all fits together.

Whenever we talk about your brain in love, a natural starting point is attraction, and what we might call your brain in lust.

A lot of research has explored how the brain decides what is attractive and loveable, and what is not. Symmetry and other physical characteristics do play a role, but mere exposure turns out to be a powerful means to make something, almost anything, seem more loveable.

I've discussed some characteristics of what makes certain faces seem more attractive than others. Again, evolved, fundamental drives seem to control that process.

Visual exposure gets the most attention here, but similar effects occur with the exposure to the sound of a person's voice.

Love is a drive, as much as hunger and thirst are, and for young children, at least, just as biologically necessary for their survival. This is a part of why love is so powerful—even into adulthood, and why it can be addictive.

But all of these topics, from mere exposure effects of body symmetry—they really just scratch the surface of what love really is. So in the next lecture, I'll delve beyond the rush of new love to consider the cognitive neuroscience of deeper, more meaningful loving relationships.

Lecture 22

The Neuroscience of Lasting Love

Falling in love is much more common than staying in love. What's more, cognitive neuroscience demonstrates that falling in love and remaining in love involve separate and distinct brain systems. In this lecture, we explore the underlying neural systems that mediate lasting love and suggest strategies to nurture lasting love: overwhelm your partner with five or more positive events for every negative one, avoid being dismissive or aggressive in arguments, and seek exciting new experiences with your romantic partner.

Avoid Dismissive Behaviors

- When you have an argument with your partner, don't roll your eyes. This kind of dismissive behavior impacts your partner's brain in consistent and negative ways. Your partner's amygdala, for instance, will become more active. As it does, the negative emotions that are associated with that subcortical brain region will emerge, making the rest of the argument that much more difficult.

- Long-term love and attachment are associated with oxytocin, a hormone produced by your brain that promotes deep social attachments. Amygdala activity and its associated fight-or-flight response weaken those bonds. If you too frequently tip the scales in favor of that amygdala system, love will lose.

- Moreover, oxytocin itself can influence behavior in two very different ways. It can promote social cohesion and cooperation, but it can also strengthen the memory for negative events. Examples of this can be seen among couples who find themselves in a toxic divorce situation. The same oxytocin that creates love can contribute to its destruction.

Gottman's Approach to Arguments

- John Gottman and his colleagues have done scientific research on how to make love last. He and his team have become celebrated for being able to predict—with greater than 90 percent accuracy—which marriages will last and which will end in divorce. A key part of Gottman's process is to ask the two members of the couple to discuss something that has been a point of disagreement. In essence, Gottman asks them to engage in a bit of conflict. A typical Gottman study involves collecting data and then waiting—in some cases, for several years.

- After this time interval, some of the participants are still married; others have divorced. The research team then analyzes the data to see if there is anything in those records that was consistently present for the still-married couples that was not present for the now-divorced couples. They determined that there are several features that are present for the divorced couples that are only rarely present for the still-married couples. The significant factors center on how they argue.

- An unhealthy way to start an argument is with blame and harsh criticism. Several processes will kick in if the argument begins this way. First, the blood pressure, heart rate, and skin-conductance levels of the recipient of the criticism will rise. His or her cognitive function will decline as the fight-or-flight system is activated. If the recipient of criticism rolls the eyes, looks away, and is dismissive of the criticism, then this discussion is already doomed. The marriage may be as well.

- Many other conflict-related behaviors can lead to a downward spiral of negativity in a close relationship. The most important strategy that Gottman's research has yielded is the following: If you want to

An unhealthy way to start an argument is with blame and harsh criticism.

maintain a lasting romantic relationship, learn to argue without being sarcastic, overly critical, or dismissive of your partner.

- Gottman and his colleagues have repeatedly found that marital arguments that involve a gentle start-up lead to better outcomes. An argument with a gentle start-up specifically avoids assigning blame. Following are examples of an unhealthy beginning and a gentle start-up.
  Wrong: "The problem is that he doesn't want to spend time with the family. He just spends all his time working."

  Right: "I feel unhappy that he doesn't spend more time with the family. I wish that we could find a way he could spend more time with us, even though I understand that might involve taking some time away from work."

- Gottman has found that if arguments and discussions begin the right way, they tend to become more productive; they become more like group problem-solving activities.

Three Brain Systems

- Three distinct brain systems are involved in falling in love and staying in love. Consider the three-tiered system proposed by Ruth Feldman and her colleagues.

- The first system is associated with general sexual libido. Many subcortical brain systems are involved in coordinating human sexual behavior and regulating the hormones estrogen and androgen. The hallmark of this aspect of physical attraction is that it is rarely directed at any particular individual. This system is often mapped to the general term "libido."

- A second brain system is associated with more focused romantic attraction. These brain areas are related to feeling the desire associated with a romantic attraction to one person. The system connected to falling in love is a dopamine-based system associated with the nucleus accumbens and the ventral tegmental area.

- Deeper, more lasting love is associated with a third system, which is affected by specific brain regions and hormonal systems. The basic systems involved in the attachment aspects of love seem to function from the time that we are born, if not before. They are associated with two hormones: oxytocin and vasopressin. Oxytocin affects attachment behavior in the brain.

Impact of Oxytocin

- Perhaps the strongest of human attachments is that between a mother and child. This attachment is heavily mediated by a large production of oxytocin. In circumstances in which the mother and child are separated for weeks after the child is born, this attachment does not form normally. It's not that the mother will never be able to have an attachment and loving relationship with the child, but the intensity of that initial attachment relationship seems quite difficult to replace.

- The effect of oxytocin on attachment don't stop with the mother-child relationship, however. Oxytocin seems to cause all our strong attachment bonds to form with other humans. Oxytocin binds to many receptors in the brain, but the area most implicated in the attachment facets of love are located in the anterior insula, part of the outer cortical layer of the brain. The insula is on the side, tucked deep within one of the folds of that cortical sheet. The anterior cingulate cortex is an adjacent area of the brain with a high density of oxytocin-related receptors.

- In studies of how oxytocin relates to human behavior, including romantic behavior, researchers take a blood sample and test for the density of oxytocin. The more oxytocin in the bloodstream in general, the more oxytocin is present in the brain as well. In fact, when people are involved in a new romantic relationship, they tend to produce higher levels of oxytocin.

- Ruth Feldman and her research team conducted studies by recruiting people involved in a new relationship. They saved that data for six months and then re-contacted those participants. The greater the levels of oxytocin produced by the new couples, the more likely that they were still together six months later. There is an abundance of evidence that our bodies produce oxytocin as a central part of forming and maintaining attached romantic relationships. The greater the oxytocin concentration, the stronger the bond.

Seek New Experiences Together

- A strategy that emerges from our understanding of the three brain systems affecting love is that if you want someone to fall in love with you, do exciting and novel things together. When we are excited by something—not simply by a potential romance but by our environment or activities—our brain produces adrenaline, norepinephrine, and dopamine. This dopamine is the same neurotransmitter that activates the system of falling in love.

- Many relationship experts suggest the importance of breaking out of routines with your partner from time to time. Doing novel activities together can be very important for maintaining those dopamine-related circuits that spark the romantic, loving connection.

Effect of Antidepressant Drugs

- Some researchers have expressed concern that certain drugs might be antithetical to the love and attachment processes in the brain. The use of antidepressant medications in the United States

Doing novel activities together can be very important for maintaining the dopamine-related circuits that spark the romantic, loving connection.

has skyrocketed in recent years. Most antidepressants function by boosting serotonin function in the brain. For instance, the class of drugs referred to as serotonin selective reuptake inhibitors (SSRIs) greatly increase the amount of time that serotonin remains in a synapse after it is released. It therefore greatly increases the general amount of freely active serotonin molecules in the brain as a whole.

- When you boost serotonin systems in the human brain, you reduce the activity of dopamine-related systems. A common side effect of SSRIs is reduced libido and sex drive. This is a direct result of the suppression of that nucleus accumbens and ventral tegmental area system associated with arousal and falling in love.

Strive for Five

- John Gottman's research about improving a couple's argument style fits in with our understanding of the oxytocin-related attachment system in the brain. When a romantic attachment is formed, it's not set in stone. Over time, that attachment can erode. Unless there are regular, periodic releases of oxytocin that are associated with the partner, the attachment will decline.

- Oxytocin doesn't simply make us all love one another unconditionally. In fact, it makes us become more cooperative and positive with in-group members and more negative with those we perceive as the out group. A fascinating memory study suggests that the release of oxytocin can produce very vivid and detailed memories for any negative events that are experienced along with that oxytocin. If a partner accumulates enough negative associations, the process will undo the positive attachment that is essential to meaningful love.

- Gottman has explored this aspect of his data and found that a 1:1 ratio doesn't seem to be enough. If you experience an equal number of positive and negative associations with a romantic partner, the most likely outcome is divorce. In fact, a full 5:1 ratio seems to be needed.

- If you were in a Gottman study, you might be asked to write down a summary of each positive event and negative event you can remember taking place with your partner over the past week. The number of items on each list turns out to be critically important. Partners who tend to stay together can report five positive events for every one negative event that has happened over the past week. For people in Gottman's studies whose ratios were substantially lower, the most likely outcome was divorce.

Questions to Consider

1. Arranged marriages were the norm for many centuries and are practiced in some cultures even today. Numerous arguments can be made against this system, but how might it fit well with the human brain's love processing? How might it contrast with it?
2. Excitement seems significant to promoting strong social bonding. What types of romantic activities seem in line with this? Are romantic couples always thrill seekers?

Suggested Readings

Berns, *How Dogs Love Us*.

Gottman, Gottman, and DeClaire, *Ten Lessons to Transform Your Marriage*.

Lecture 22 Transcript

The Neuroscience of Lasting Love

Falling in love is a lot more common than staying in love. There's a great deal of evidence from cognitive neuroscience research that falling in love is also different from staying in love. Distinct brain systems are involved in the two activities. We discussed the brain processes that mediate falling in love. In this lecture, we'll return to that in order to focus our attention on how your brain manages to stay in love—or not. We'll also consider how these different systems interact with one another over the course of a relationship.

Here's a tip that you can use to substantially increase the chances of staying in a long-term relationship with a long-term love. When you have an argument with your partner—don't roll your eyes.

When you do an eye roll during an argument, or something similar, it impacts the brain of your partner is some consistent and negative ways. Your partner's amygdala, for instance, will become more active. As it does, the negative emotions that are associated with that subcortical brain region will emerge, making the rest of the argument that much more difficult. Rolling your eyes for a moment might not seem like a very big thing, but several studies suggest that it reduces the likelihood that a couple will stay married—that a couple will stay in love.

Long-term love and attachment are associated with oxytocin, a hormone produced by your brain that promotes deep, social attachments. The amygdala activity and the associated fight or flight type of response weaken those bonds. Maintaining a relationship—staying in love is, in many ways, a competition between these two different systems. If you too frequently tip the scales in the favor of that amygdala system, love will lose.

Moreover, oxytocin itself can influence behavior in two very different ways. It can promote social cohesion and cooperation, but it can also strengthen memory for negative events and even increase aggressive responses to anyone who's not perceived as a member of the same family or social group. Examples of this can be seen among couples who find themselves in a toxic divorce type of situation. The same oxytocin that creates the love can contribute to its destruction.

How to make love last—this is a topic about which you can find a remarkably large amount of advice—some of it's good, some of it's not so good—some of it's contradictory. As is often the case, most useful advice, I believe, comes from careful, scientific work on the topic. A leader in developing just this type of scientific work in this area is named John Gottman. He's the one responsible for this "don't roll your eyes" tip.

Gottman and his collaborators have become quite famous for being able to predict, with greater than 90% accuracy, which marriages will last, and which will end in divorce. In their studies, Gottman's research team almost always collects a lot of data. They recruit couples to come into their research center and subject them to a wide range of tests. There are many questionnaires, video and audio recordings. Participants are often hooked up to devices that record their physiological responses to things—blood pressure, heart rate, muscle tension—a lot of things like that.

A key part of the procedures that they use is to have the two members of the couple have a conversation in which they discuss something that's been a point of disagreement in their relationship. In essence, Gottman asks them to engage in a bit of conflict—to have at least a little bit of an argument. A typical Gottman study involves collecting all of this data and then waiting—in some cases several years.

After this time interval, some of the participants are still married. Others have divorced. The research team then analyzes their data to see if there was anything in those records that was consistently present for the still married couples that was not there for the now divorced couples. They also do the reverse.

Turns out there are several things that are present for the divorced couples that's only rarely present for the still married couples. The important factors are a few key features of how they argue.

Now, all couples argue. OK, I've talked with a few people who've been married for decades who claim that they've never argued. I'm not sure if I believe them, actually. Regardless, no one's been following them around with a camera to confirm that data one way or the other. Almost all romantic partners argue, even romantic partners who are extremely happy in their relationship.

A bad way to start an argument is with blame and harsh criticism. Imagine one partner starts by expressing something like, "The problem is that he doesn't want to spend time with the family. He just spends all of his time working." Several things will happen if the argument begins this way. First, the blood pressure, heart rate, and skin conductance levels of the recipient of the criticism will rise. His cognitive function will decline as his fight or flight system is activated.

If this next thing happens, Gottman almost doesn't need to collect any more data. If the recipient of the criticism rolls his eyes, if he looks away and is basically dismissive of the criticism—then this discussion is already doomed. The marriage may be also.

In addition to the eye rolling, there are many other conflict-related behaviors that seem to lead to a downward spiral of negativity in a close relationship. The most important tip that Gottman's research has ever yielded is the following: If you want to maintain a lasting romantic relationship, learn to argue without being sarcastic, overly critical, or dismissive of your partner.

Gottman and his colleagues have repeatedly found that marital arguments, discussions, that involve a gentle start up lead to better outcomes. An argument with a gentle start up specifically avoids assigning blame. So instead of saying, "The problem is that he doesn't want to spend time with his family. He just spends all of his time working," Gottman's research suggests that the discussion begin with something like, "I feel unhappy that he doesn't spend more time with the family. I wish that we could find a way he could spend more time with us, even though I understand that might involve taking some time away from work."

The same information is conveyed—the same desires—but without the blame part. Now, if the recipient still rolls the eyes or is generally dismissive, the problem is likely to still persist. Gottman would likely predict divorce, but not as confidently as he might have. More importantly, if arguments and discussions begin this way, Gottman has found that they tend to become more productive. The arguments become less upsetting. Group problem solving activities is what they turn into rather than a session primarily about venting frustrations.

Now, I've described this as something that's the fault of the person who started the discussion, but it's clear from Gottman's work that this isn't the case. That's not how it works. Arguments don't exist in a vacuum. They only exist in isolation. It's often the case that the aggressive start to an argument happens because the partner has been dismissive of the discussion in the past.

There's a point to be made here—that just because one argument starts aggressively doesn't mean that a marriage is doomed to divorce. Gottman's research group might only assess one argument, but it's the patterns that emerge from many arguments that are the inherent problem. They key tip here is to learn to argue better—to not be afraid of or defensive about arguments and disagreements in general. Being a better listener can lead to much better problem solving.

Recall that it's not the arguing that is bad per se, but arguing that leads to activation of aggression systems such as the amygdala. One way to achieve this is to make a point of suppressing a fiery outward expression of anger—even if you're feeling some anger at the time. If you shout, "But I need to spend that time at work," you may convey that information and activate a defensive response.

If instead, you say, as calmly as possible, "But I need to spend that time at work," you can move forward with the discussion without activating your partner's amygdala. It might feel odd to do this the first few times—to suppress that angry response that you're feeling—but there's good evidence that it will safeguard against eroding the attachment that's so important to lasting love.

If you want your love to last, it's not enough to just start arguments gently and suppress your inclination to roll your eyes. The bigger tip here is to make yourself available on a regular basis for discussions about things that are the concerns and needs of your partner.

What happens in your brain when love is forming and then lasting or not lasting? Most researchers in this area believe that there are several distinct systems involved. Let's consider the three-tiered system proposed by Ruth Feldman and her colleagues.

The first, and in many ways the simplest system, is associated with general sexual libido. Many subcortical brain systems are involved in coordinating human sexual behaviors. The regulations of this most basic arousal are associated with the estrogen and androgen hormones. The real hallmark of this aspect of physical attraction is that it's rarely directed at any particular individual. A variety of studies have focused, for instance, on men and women who receive testosterone treatments for various reasons. These patients consistently describe increased feelings of sexual arousal and increased frequency of sexual behaviors. But the patients rarely describe feeling greater love for their particular partner.

A second system in this group is associated with more focused romantic attraction. Biologists often associated this system with mate selection behaviors. These brain systems are related to feeling the desire associated with that romantic feeling of attraction to one person—of wanting a particular individual a lot. There's a love component to this, but it's still not the deep, lasting emotional state that we associate with lifelong loving relationships.

Falling in love seems to be driven by simpler processes than staying in love. That falling in love system is a dopamine based system. It's associated with the nucleus accumbens and the ventral tegmental area. These two regions are both tucked up underneath the cortex, with the nucleus accumbens near the front of the brain and the ventral tegmental area near the back. Those are falling in love systems. When we discuss deeper, more lasting love, we have to discuss other hormonal systems and other brain regions. We need to talk about oxytocin and vasopressin.

The basic systems involved in attachment aspects of love seem to function from the time that we're born, if not before. They're associated with these two hormones, oxytocin and vasopressin. The two hormones are produced by mothers' brains in abundance, actually, during child labor and breastfeeding. This is true in the brains of both the mother and the child. Oxytocin plays an important role in stimulating labor and stimulating milk production in the mother, but it also affects attachment behaviors in the brain.

Perhaps the strongest of human attachments is that between a child and a mother. This attachment is heavily mediated by this large production of oxytocin. In circumstances in which the mother and child are separated for weeks immediately after the child is born—this attachment doesn't form normally. It's not that the mother will never be able to have an attachment and loving relationship with the child, but the intensity of that initial attachment relationship seems quite difficult to replace.

There are a lot of reasons to suggest that mothers should breastfeed if at all possible, even if it's only for a few days after the child is born. Many of those reasons have to do with the development of the child's immune system. But a big reason that many physicians suggest breastfeeding is also to promote the good emotional and social development of this early attachment.

The effects of oxytocin and attachment don't stop with the mother-child relationship, however. The oxytocin and vasopressin hormone seems to impact—and even cause—all of our strong attachment bonds to form with other humans. Oxytocin binds to many receptors in the brain, but the areas most implicated in the attachment facets of love are located in the anterior portion of the insular cortex—the anterior insula. It's a part of the outer, cortical layer of the brain. The insula is on the side, tucked deep within one of the folds of that cortical sheet. The anterior cingulate cortex is an adjacent area of the brain with a high density of oxytocin related receptors that's activated as well.

Occasionally, people with damage to these regions of the brain have been identified. Their brains seem to function in a normal way in terms of a broad range of cognitive testing. But they tend not to experience the strong attachments that we associate with love. Neuroimaging studies have provided broadly converging evidence for this.

When you put someone into an fMRI scanner and ask them to think about people they love, for instance, to think about their wife or husband of many years or about their children—these areas of the brain increase in activity relative to when they think about other people. For instance, other familiar people whom they don't love.

Researchers who study love ask many different types of questions, but there's one that's a particularly telling. When asking about deep, meaningful love, the experimenter will often ask if the participant would be willing to die for the person they love. The experimenters aren't holding a weapon when they ask this, or it might feel rather upsetting.

They just want to know, in principle, does the participant feel this sort of love for that person—a love in which the life of that person is as important, or maybe even more so, than the participant's own life. When the answer is a clear yes—a yes with no real hesitation or weighing of pros and cons—

you can be quite confident that this participant's anterior insula and anterior cingulate are going to light up when they think about the person.

Jean Decety and his colleagues have identified a related phenomenon by presenting images of people who suffered some physical injury. They present those images to participants while they're laying in a fMRI scanner.

If you look at an image of an injury, where the person is someone you love, there's striking increase in the activity of the sensorimotor cortex regions of the brain—the regions that would be activated if you, yourself, had suffered that same injury. Once we've formed strong attachments to someone, it's really true that we can feel their pain.

When oxytocin and vasopressin are produced by the brain, when they diffuse through it and impact these cortical regions—the processing and memory devoted to particular stimuli are altered. If you're looking at a particular face when this system is activated, your brain will make strong associations with that face—associations we think of as love. The same for the sounds and smells that that person happens to produce.

There's been a lot of research aimed at identifying pheromones that might influence human behavior. Certainly for some animals, dogs and cats for instance, certain pheromones are released by females when they're in a state of reproductive fertility. Those pheromones can greatly influence the behavior of nearby males. If you've ever been around male cats or dogs while a nearby female is in heat you'll know what I'm talking about. Even a few molecules of the right pheromone can cause nearby males to change their mode of behavior radically.

This research hasn't identified anything like this in humans. Infants respond to the odor of breast milk by making sucking motions with their mouths, but in there's of universal pheromones—that's about it. There's a multi-million dollar fragrance industry that occasionally hints at pheromone qualities in their products, but there's just no substantial evidence for any universal human pheromones.

While there aren't any universal pheromones, learned associations between individuals and odors can exert a strong effect on our behaviors. Each of us produces a complex cocktail of different molecules. It consists of the sweat and oils that our body produces—also compounds produced by the millions of bacteria that live on our skin, and even things like the type of laundry soap that we tend to use. If someone experiences regular surges of oxytocin while simultaneously smelling this combination of aromas, then later smelling those aromas will activate these oxytocin sensitive regions of the brain.

Later, if you smell the shampoo or shirt of that person, even if they aren't there, the attachment related regions of the brain will become active.

In studies of how oxytocin relates to human behavior, including romantic behavior, researchers often take a blood sample and test for the density of oxytocin. The more oxytocin in the blood stream in general, the more oxytocin is present in the brain as well. You won't be surprised to hear that when people are involved in a new, romantic relationship, they tend to produce higher levels of oxytocin. What is surprising is just how much. The enormous spike in levels is almost twice as large as that observed in new mothers.

Ruth Feldman and her research team conducted these studies by recruiting people involved in a new relationship. They saved that data—that oxytocin concentration data—for six months and then recontacted those participants. The greater the levels of oxytocin produced by the new couples, the more likely it was that they were still together six months later. There's a real abundance of evidence that our bodies produce oxytocin as a central part of forming and maintaining attached, romantic relationships—and the greater the oxytocin concentration, the stronger the bond.

Oxytocin also seems to affect non-romantic social relationships. In one study of this effect, pairs of participants were recruited to participate in a cooperative game. Both participants were assigned a particular amount of money at the start of the game—let's say $10. When one participant agreed to share their money, they would lose that money for themselves, but it would be multiplied by two for the other participant. So if you and I were playing this cooperative game, the best outcome for the group—for both of us—would be to give all our money to the other participant. We would both lose our $10, but both gain $20.

The best outcome for any individual would be to take the other person's money, but then share none of their own. In that case, one person might leave with $30, while the other person would leave with $0. When money is shared with you in this context, your oxytocin levels increase. In general, people with higher levels of oxytocin tend to cooperate with each other more—to consider the success of their group as being just as important, if not more important, than their own success. That sort of sounds like a definition of love, actually. It's certainly a definition of good team building.

These findings have been consistent and strong enough that some have suggested that oxytocin could be used therapeutically. Actually, it's already given to mothers at the end of a pregnancy on a regular basis for the purposes of inducing labor, so there's a lot of data suggesting that it's generally safe as a pharmaceutical. What if that same oxytocin drug was given to autistic people—people who have difficulty forming attachments and meaningful connections with other people? Could that reduce the problems that they have?

Another thought—is oxytocin a love potion? It would be very unethical, of course, but if someone were given oxytocin injections while they were on a date, would they helplessly fall in love with that person? Is there a difference between oxytocin activity in the brain and loving attachment? Or are they the same thing? If we added oxytocin to the water supply, would people all love one another and live in perfect harmony?

Several research groups are exploring these issues—not the water supply issue, but the other ideas. It may be that it will be effective and valuable in some contexts to use oxytocin in this way, but there's a reason to suspect that this may not be a human relations wonder drug. Oxytocin does seems to boost our compassion, cooperation, and love for our fellow humans, but only if we perceive them as being a part of our social group.

That same oxytocin that makes humans so loving toward family and friends seems to make them more aggressive and uncooperative with people who are perceived as members of other groups. It seems that oxytocin focuses our cooperative in-group biases, but, in the process, it also boosts our competitive out-group biases. To the extent that this is true, then ironically, adding oxytocin to the water supply might increase competition even more than love.

Let's quickly review the three love systems of the brain. We have the androgen/estrogen arousal system, the dopamine-based new love system, and the oxytocin-based lasting attachment system. Let's consider some ways in which these three systems interact with one another as you fall into love, and what happens when you stay in love.

First, the standard, adult courtship process. The general lust system is in place for many people, although not focused exclusively on anyone in particular. The falling in love system targets someone—someone in particular—based on particular characteristics. A dopamine-based circuit is activated that causes a craving for that individual—craving of time, interaction, and ultimately physical contact.

Regular, close interaction will cause the release of oxytocin and vasopressin, resulting the development of a more long-lasting attachment. Sexual interaction results in an tremendous release of oxytocin. For a couple seeking a long-lasting romantic relationship, sex is important. Medicines for erectile dysfunction have been prescribed more and more over the past decade. That's not just good for sex, but for love. There is good evidence that sharing those interactions is important not just for establishing close attachments, but for maintaining them.

Here's another tip that emerges from our understanding of these three systems. Want someone to fall in love with you? Do exciting and novel things with them. When we get excited by something, not just excited by a potential romance, but excited by the general environment around us or the activities that we're pursuing—our brain produces a lot of adrenaline, norepinephrine, and dopamine. This dopamine is the same neurotransmitter that activates that falling in love system.

Now, doing exciting things with someone won't guarantee that they'll fall in love with you, but it can help sometimes. There's a great story that Helen Fisher likes to tell about two of her graduate students. One of them, a guy, was very attracted to a female who also worked in the lab. The woman thought of this guy as a friend, but she didn't feel the romantic, falling in love attraction for him that he felt for her. One of the great tragedies of life is when the person you fall for just isn't ready to catch you. Well, he had fallen.

To his credit, this guy was resilient in his pursuit, and he knew a lot about the brain systems that mediate love. He decided, during one particular conference trip to China, that he was going to boost his friend's dopamine levels. He invited her to join him for a rickshaw ride around the city.

The evening went really well. The rickshaw driver pulled them around an exotic and beautiful city. The sights and smells, along with the bouncy ride around town were, indeed, very exciting. At the end of the trip, the smitten guy turned to the woman and asked if she had enjoyed the evening. "Yes!" She said. "The ride was great. This is an amazing and beautiful part of the world, and it was exciting to see it from the perspective of the traditional rickshaw."

"And," she finished, "Wasn't that rickshaw driver adorably handsome?"

So no guarantees here, but doing exciting things is associated with people falling in love and remaining excited about their love for one another. Many relationship experts suggest the importance of breaking out of routines with your partner from time to time. Going someplace new. Eating at a different restaurant. Trying something new together. Those are things that are just good to do in general to enhance the quality of your individual life. But doing it together can be very important for maintaining those dopamine-related circuits that spark—not just the attachment—but the romantic, loving connection.

Some researchers have expressed concern that certain drugs might be antithetical to these processes. The use of antidepressant medications in the U.S. has skyrocketed in recent years. A remarkably large number of people take them. In some cases, I should say, these drugs have been life saving. If someone's involved in a severe depression, perhaps one in which suicide or other drastic actions are being pondered, then, by all means, antidepressants are in order. I don't want to suggest that you can't fall in love if you're also on antidepressants.

But, most antidepressants function by boosting serotonin function in the brain. For instance, the class of drugs referred to as serotonin selective reuptake inhibitors—SSRIs—greatly increase the amount of time that serotonin remains in a synapse after it's released. It, thus, greatly increases the general amount of freely active serotonin molecules in the brain as a whole.

The way the human brain is wired, when you boost serotonin systems, you—almost by definition—reduce the activity of dopamine-related systems. A common side effect of SSRIs, actually, is reduced libido and sex drive. This is a direct result of the suppression of that nucleus accumbens and ventral tegmental area system associated with arousal and falling in love.

Ironically, if someone is depressed about their love life, antidepressant medication might be antithetical to solving the problem. Without the falling in love part, the long-term attachment system can't play its normal role.

My tip here is, except in the case of extreme depression, to explore non-drug related treatments like exercise, meditation, and increased social interaction. Ideally, the problem will pass, and if you aren't taking the medication, you won't have to deal with this unfortunate side effect.

How does Gottman's advice about improving a couple's argument style fit with our understanding of the oxytocin attachment system in the brain? When a romantic partnership forms—when that attachment is formed, it's not set in stone. Over time, that attachment can erode. Even in the absence of anything negative, unless there are regular, periodic releases of oxytocin that are associated with the partner, this attachment will decline. This is part of the reason that researchers suggest that a healthy sex life can be so important for a couple—maybe even as important as learning to argue better.

Remember that oxytocin doesn't just make us all love one another unconditionally. It makes us become more cooperative and positive with in-group members and also more negative with those we perceive as not being a part of our group. One fascinating memory study suggests that the release of oxytocin can produce very vivid and detailed memories for any negative events that are experienced along with that oxytocin. If a partner accumulates enough negative associations, it will undo the positive attachment that's so critical to meaningful love.

Gottman has explored this aspect of his data as well, and found that a 50–50 ratio doesn't seem to be enough. If you experience an equal number of positive and negative associations with a romantic partner, the most likely outcome is divorce. In fact, a full five to one ratio seems to be needed.

Let's try this here. How many positive events can you remember taking place in which you and your partner were together, say, over the past week? If you were in a Gottman study, you might be asked to write down a summary of each one of those or just describe them aloud. Take a moment. Let's think of as many as you can.

OK, now how many negative events can you remember taking place in which you and your partner were together over the past week? Think of as many as you can.

I didn't give you enough time to really develop those positive and negative lists fully, but I urge you to take a few minutes some time soon and actually write them down. The number of different types of items on each list turns out to be critically important. Partners who tend to stay together can report five positive events that have happened over the past week for every one negative event. For people in Gottman's studies whose ratios were substantially lower, the most likely outcome was divorce.

The tip here is simple. Maintain your romantic relationships—for that matter, maintain all of your attached relationships by overwhelming them with positive associations. If something bad happens—a negative interaction—don't panic, but make a mental note of it. Be sure that you find a way to have five positive interactions before you let another negative one creep in. There's really good scientific support that adopting this practice will result in more meaningful and long lasting relationships—with romantic partners and friends in general.

Falling in love is a pretty common event. What is more rare is for love to last—for two people to not only come together into a loving relationship, but to remain in love—in love with one another for months, years, decades, for lifetimes.

By contrast, people fall in love every day. When I was in my teens, I think I fell in love about once a week—sometimes more.

By understanding the underlying neural systems that mediate lasting love, I think we can have a greater appreciation for our own feelings and nurture lasting love to a greater extent.

If you shower your partner with five or more positives for every negative, if you avoid being dismissive or aggressive in arguments, if you if you seek exciting new experiences with your romantic partner—in other words, if you are loving—then the data suggests that you will also be loved.

Lecture 23

How Your Brain Creates Happiness

Cognitive neuroscientists have long sought to identify the patterns of neural activity associated with happiness. A range of studies have found that there are consistent differences between happy brains and unhappy brains. Happy brains show more activity in left frontal regions of the cortex, while unhappy brains tend to have more activity in the right frontal and amygdala areas. In this lecture, we examine cognitive research that demonstrates that the greatest happiness is possible when we create it ourselves—through the processes of imagination, mindfulness training, expressing gratitude, or other actions that boost left prefrontal cortex activity.

The Power of Imagination

- Imagine being happy. There is strong evidence that this simple strategy will lead to increased happiness.

- In one happiness study, Nakia Gordon and her colleagues had a group of participants pretend to laugh or pretend to cry. After participants had practiced actually performing the actions, they shifted to imagining performing the actions. The researchers found that when participants imagined crying, they later produced lower mood ratings. Thinking about crying makes you feel a little sad. Conversely, thinking about laughing makes you feel a bit happier.

- Most people presume that we decide to do something before we actually do it. However, a series of studies suggest that the feeling

you are making intentional decisions actually follows the moment when you start to make those decisions. One of the areas in which automatic processes of the brain are most directly relevant is in the domain of happiness.

Adopt an Attitude of Gratitude

- To make yourself happy, find something to be thankful for, and then thank the person most responsible for it. Write, call, or visit this person and communicate how much you appreciate his or her positive impact on your life. Expressing gratitude will likely make the person you thank feel good, but you will also feel happier. Thank people on a regular basis and you will find yourself becoming a happier person.

- The science is quite clear on this. Researchers conducting experimental studies recruited a group of participants and then randomly assigned half to a gratitude condition. The participants were asked to spend several minutes a day for a week thinking about aspects of their lives for which they were grateful. The control group spent equivalent amounts of time thinking and writing about recent experiences; however, the control participants were not explicitly asked to focus on gratitude.

- Across a range of different situations, the participants who focused on gratitude later reported feeling happier about their lives and themselves. That is, the results strongly suggest that there is not simply a relationship between gratitude and happiness; this is an actual intervention that works.

- An underlying theme in much of the research on happiness is that happiness is generated by the brain itself. This is counterintuitive to most people, who presume that things or people or events are what make us happy.

Money Buys Happiness—to a Degree

- It is often said that money can't buy happiness. A research team led by Daniel Kahneman recently shed some light on a fundamental question related to money and happiness. His team set out to determine just how much money buys happiness and at what point will money no longer buy additional happiness.

- The simple answer here is an annual household income of about 81,000 dollars (in 2016 dollars). It's important to note that this number varies quite a bit from place to place. In an expensive location such as Hawaii, additional money keeps increasing happiness up to about 122,000 dollars of annual household income. In Alabama, the cost of happiness is quite low, with happiness peaking around 65,000 dollars per year.

- Kahneman and his colleague Angus Deaton analyzed about 450,000 responses given by U.S. residents in a telephone survey conducted by the Gallup organization. A set of questions included in that survey was used to calculate people's emotional well-being. The survey also included questions about the level of household income. The primary analysis here explored the relationship between the amount of money a person made per year and the level of general happiness.

- Not surprisingly, there was a clear positive relation between income and happiness. The crucial result, however, was that the amount of extra happiness you get for each additional dollar becomes smaller as the income rises. By the time you get up to an annual household income of around 50,000 dollars, the increases become extremely small. By the time the income rises to another plateau—around 81,000 dollars in many locations—the average happiness score peaks. There were some increases beyond that level, but the increases were neither statistically significant nor substantively large.

- Therefore, money can buy you happiness—at least to a degree. To become truly happy, however, you will need to look beyond money.

Basal Ganglia Activity

- In older models of brain activity, our sense of pleasure and happiness are associated with stimulation of a particular subcortical structure of the brain: the basal ganglia. The nucleus accumbens—which is part of the motivation circuit in the basal ganglia—and the subcortical automatic motivation systems crave the release of dopamine within this pleasure circuit.

- In the 1950s, James Olds and Peter Milner found that if they delivered mild electrical stimulation to this brain region in rats, the rats acted as if it was a powerful positive reinforcement. When the researchers hooked up their system so that the rats could obtain this electrical stimulation by pressing a bar in their enclosure, the rats stopped eating and drinking and continued to press this bar for hours on end.

- It's not surprising that many addictive drugs increase activation in this same brain region. Activity in the basal ganglia is directly connected to our experience of intense pleasure. However, if you interview most heroin addicts, they don't seem very happy. Indeed, even when they receive a dose of heroin, they often describe feeling relief, not happiness.

- More modern work on brain activity has re-characterized basal ganglia activity with the emotional feelings of liking or wanting—but that is not the same thing as happiness.

Affective Neuroscience

- The search for the brain circuits that are active in humans and other animals when they are actually happy or unhappy has spawned an entirely new subfield of cognitive neuroscience.

- Richard Davidson is often described as one of the founders of a field that people now call affective neuroscience. This branch of neuroscience seeks to determine how the brain regulates emotion, how changes in emotion are mapped onto various patterns of brain activity, and the how we can change emotional states by changing the brain.

- By studying hundreds of people in different emotional states, Davidson and his colleagues have begun to develop an outline of the characteristics of a happy brain and the ways that the brain activity of a happy person differs from that of an unhappy person.

The Happiness Ratio

- In general, when you are unhappy or feel stressed or anxious, particular regions of your brain become active. The amygdala is a relatively small subcortical region of the brain. It is an important part of the limbic system, a highly connected brain structure that seems to regulate negative emotions. If you stimulate a particular part of the amygdala of most animals, they become strikingly agitated and aggressive. What's more, when animals are agitated and aggressive, it turns out that their amygdala is highly active.

- If you feel angry, anxious, or unhappy, it's very likely that your amygdala is exhibiting high levels of activation. Along with the amygdala, negative emotions are associated with activity in the right prefrontal cortex. When you are distressed, this right prefrontal cortex seems to regulate a heightened state of vigilance.

- In contrast, the brains of people who report relatively high levels of happiness and enthusiasm are associated with low activities in both the amygdala and right prefrontal cortex regions. Instead, higher activity is found in the left prefrontal cortex.

When heroin addicts receive a dose of heroin, they often describe feeling relief, not happiness.

- If you put someone into a functional magnetic resonance imaging (fMRI) scanner and examine the activity produced in the right prefrontal cortex and the left prefrontal cortex, you can calculate a ratio of activity: the amount of left prefrontal cortex activity divided by activity in right prefrontal cortex and amygdala. This ratio is a remarkably effective predictor of someone's reports of their everyday happiness. Happier people tend to show a larger ratio. Unhappier people tend to show a substantially smaller ratio.

Mindfulness Training

- In addition to quantifying the happiness ratio, Davidson and his colleagues have explored several methods to alter this ratio. One of the most successful is mindfulness training.

- Although mindfulness training is associated with the practice of meditation, you can engage in mindfulness at any time. Training aimed at enhancing mindfulness will typically involve spending 15 to 20 minutes per day in quiet meditation. Often, this method involves focusing your attention on your breathing and not dwelling on thoughts about the past or plans for the future.

- There is another aspect of the mindfulness training that is particularly relevant to happiness. As you quietly sit and meditate, you may become aware of the emotions you are feeling—specifically, you might feel happy or you might feel sad. Mindfulness training instructors will typically tell you to simply feel that feeling. Be aware of it. Embrace it. Students of mindfulness training are taught to focus periodically on being very aware of what is happening right now—that is, to be self-aware in the particular moment.

- Most people spend much of their day thinking about what has happened in the past and making plans for the future. As important as this is to our daily cognition and decision making, the focus on what is outside the domain of our immediate context seems to generate stress, anxiety, and unhappiness.

- Consider the intervention that Davidson and his colleagues used. After several weeks of mindfulness training, the happiness ratio became larger. It's not clear what aspects of the mindfulness training accomplish this, but across many studies, when mindfulness training is used as an intervention, the brains of the participants change. Their brains produce different patterns of activity, and participants report that their everyday happiness levels increase.

Questions to Consider

1. Students of Buddhism pursue a goal of reducing desire rather than satisfying it. How does this align with our description of happiness as having a thermostat-like set point?
2. If you win a large lottery jackpot, you will be happy, but there is evidence that the happiness will fade as you adapt to the changes associated with it. If a lottery paid out prizes in gradually increasing amounts over time, could this lead to greater happiness?

Suggested Readings

Pink, *Drive*.

Thaler, *Misbehaving*.

How Your Brain Creates Happiness

Imagine being happy. If you try this simple tip, there's really good evidence that you will become happier. These three words distill a great line of research from cognitive neuroscientists, who have long sought to identify the patterns of neural activity associated with feelings of happiness.

The basic design of all these studies is pretty simple. First, find some people who are especially happy and some other people who are not. Second, compare the brain anatomy and the patterns of activation of these two different groups. Whatever you find more of in the happy people, you can associate that thing with happiness. The advice to imagine being happy is one of the results that this type of study, that it tends to produce—something that you can use whenever you want to feel a bit happier than you are right now.

Now, if you're feeling unhappy, then to imagine being happy is likely the last thing that will naturally come to mind. When you're sad, you tend to think about sad things. You might think about the problems that are making you unhappy, or at least that you think are making you unhappy. You're more likely to think about other things that have made you unhappy in the past. You might think about how much less happy you feel than the people you see around you. All of this, as you would expect, will tend to make you feel more unhappy.

In one really nice example of this kind of study that I'm describing here, Nakia Gordon and her colleagues had a group of participants practice pretending to laugh or pretending to cry. After all the participants had practiced actually performing these laughing and crying actions, they shifted to just imagining performing an action without actually moving. They just sat completely still. The researchers found that for the participants who imagined crying, they later produced lower mood ratings. Thinking about crying makes you feel a little sad. Conversely, thinking about laughing has the opposite effect and makes you feel a bit happier.

It's important to note that all the participants here act out both laughing and crying. Some participants spent several minutes imagining crying after that. Others imagined laughing. It's this later imagination activity that significantly impacted the participants' emotional states.

This is all very directly related to the idea of using your body to alter your mind. Remember there's a lot of support for the notion that you can, in a sense, fake it until you make it. If you act happy, or it turns out simply imagine acting happy, your brain seems to sense that action and to increase your internal sense of happiness.

Most people presume that we decide to do something before we actually do it. But a series of studies suggests that the feeling you have—that feeling that you're making an intentional decision to do or say something—actually follows the moment when you start to make those responses. Certainly, your brain is where the decision to act occurs, but the automatic part of your brain is not the only part that seems to control those decisions. One of the areas in which automatic processes are most directly relevant is in the domain of our happiness. The things that make us happy are very often very different from the things that we think make us happy.

Here's a simple thing you can do right now to make yourself happy. It might sound a little strange, but it's very simple, and there's good evidence that this one works. Find something to be thankful for—something that is in your life now, already in your life—and then go thank the person most responsible for it. Write them an email or a letter. Maybe call them. Better yet, go visit them in person. Talk to them for a few minutes, and then let them know how much you appreciate the thing that they've done that has had a positive impact on your life.

The science is quite clear on this. Expressing gratitude will likely make the person you thank feel good, but that's not the reason I'm suggesting it right now. You will feel happier, and not just while you are thanking the person. For the rest of the day—maybe longer you're likely to feel happier. And if you do it again tomorrow, it will work again. Thank people on a regular basis, and you just might find yourself becoming a happier person in general.

There's a lot of correlation-based evidence for this. If you ask people to write about recent experiences, the people who spontaneously report gratitude for the things in their lives tend also to report greater happiness. There are also experimental studies of this as essentially an intervention to make people happier. Researchers who conduct these studies recruit a group of participants and then randomly assign half of them to a gratitude condition. These participants are asked to spend several minutes a day for a week or so thinking about things in their lives for which they're grateful. In some cases, they're asked to compose letters expressing that gratitude.

Other participants—the control group participants—spend equivalent amounts of time thinking about recent experience and, in some studies, writing about those recent experiences. But the control participants are not explicitly asked to focus on gratitude in that thinking and writing that they do. Across a range of different situations, the participants who do focus on gratitude later report feeling happier about their lives and themselves. That is, the results strongly suggest that there's not just a relationship between gratitude and happiness, but this is an intervention that works. If you want to feel happier, think about the things for which you're thankful. Adopt an attitude of gratitude, and you're likely to feel better. You'll feel happier.

How does this work? Why should saying thank you affect your personal happiness? There are a wide range of different answers to that question. One of my favorite is that expressing gratitude serves to call your attention to the good things in your life. Almost everyone has both positive and negative aspects of their lives at any given time. It's just the nature of human existence. In many cases, our current happiness or unhappiness isn't based on the particular amount of good stuff and bad stuff in our lives. In many cases, our current happiness is strongly influenced by which stuff is commanding our attention and our thoughts.

By thinking of the good things—the parts for which you're presumably most grateful—those good things come to be more central to your thought process, and voila, life gets better or seems to get better anyway. Regardless, you get happy. If you take the step of writing those thoughts down or putting them into action in the form of a conversation or a face-to-face meeting, the effects are even greater, but the mechanism here is the same. There's an underlying theme that shows up in a lot of the research on happiness and what causes it. We are not made happy by the things around us. The happiness we feel is generated by our brain itself. That's a strange concept for many people when they first hear it. Indeed, the notion that we aren't happy or unhappy because of the things around us seems downright counterintuitive. It's easy to think of things that we'd like to see happen in our lives that would make us happy. It's also easy to think of things that would presumably make us very unhappy.

It's often said that money can't buy you happiness. Well, maybe, but there's an aspect of this that seems almost certainly wrong. Money might not be able to buy happiness, but a lack of money—a lack of money such that you are maybe living in poverty—seems almost guaranteed to bring you unhappiness. If you have enough money to buy food and a get a roof over your head, it seems intuitive that you'll be a lot happier than you would be without those basic, fundamental needs.

Even then, once your food and shelter needs are met, if you didn't have any money at all to spend on entertainment of any kind—maybe buying some basic luxuries, going out to dinner every once in a while, or watching a movie, maybe even just a movie on television—if you had a little money for something extra, it seems like that would make you a little happier, right?

A research team led by Daniel Kahneman has recently shed some light on this fundamental question. Certainly, if you have no money, then a little extra money is likely to buy you some happiness. Certainly happiness of the everyday happiness type that influences those happiness ratings that people give. A little more money would likely buy you some more happiness. But how much is enough? At what point will money no longer buy you additional happiness, or is there no upper limit? Maybe enough money will buy you happiness!

The simple, very direct answer here is an annual household income of about $75,000. Certainly, inflation matters here relative to the data that Kahneman reported, so let me be clear that I mean $75,000 as of the year 2010. According to the Social Security Administration, as of 2016, a US dollar was worth about 8.3% less than it was in 2010. That adjusts to about $81,000.

I should mention that this number varies quite a bit from place to place actually. Happiness, it turns out, is especially expensive in places with a high cost of living, for instance, Hawaii and New York. In Hawaii, additional money keeps increasing happiness up to about $122,000 of annual household income. In Alabama, the cost of happiness is quite low, with happiness peaking around $65,000 per year.

Kahneman and his colleague, Angus Deaton, analyzed about 450,000 responses given by US residents in a telephone survey conducted by the Gallup organization—that's where all these numbers are coming from. A set of questions included in that survey were used to calculate people's emotional well-being. For instance, participants were asked "Did you experience the following feelings during a lot of the day yesterday? Happiness? Sadness? Anxiety? Enjoyment? Fear?" A whole of feelings like that. There were also questions aimed directly at happiness: for instance, "Did you smile or laugh a lot yesterday?"

The survey also included questions about the level of household income. The primary analysis here explored the relation between the amount of money that the person made per year and the level of general happiness.

Not surprisingly—if only for the reasons that we considered here—there was a clear, positive relation between income and happiness. People who make more money tend to experience positive emotions more frequently. But—and this is the critical result here—the amount of extra happiness you get for each additional dollar gets smaller and smaller and smaller as the income rises. It's not that making extra money doesn't seem to increase happiness, but by the time you get up to an annual household income of around $50,000, those increases get very, very small.

By the time the income rose to another plateau there—again, around $75,000 for many locations, $125,000 for more expensive states like Hawaii or New York—the average happiness score had essentially peaked. There were some increases beyond that level, but the increases were neither statistically significant nor substantively large.

So money can buy you happiness, at least some. But there's a clear limit to how much happiness it can get you. Indeed, the results suggest that once you get to that plateau annual income level—perhaps $75,000 to $125,000—working harder to make more money, especially if it's a job that you don't really love, might actually make you less happy.

This study result is a tip in and of itself. Working hard, working efficiently, working a lot, these things tend to bring more money into your life. But to become really happy, you need to look beyond money.

If I were to win a major Powerball jackpot, I would presume that the millions of dollars I would receive would make me happy, or at least happier. I wouldn't even be picky here. I don't need to pull down one of the really big, hundred million dollar jackpots that make the news. A few dozen million dollars that should be plenty. I'd never have to worry about money again. My kids' college, paid for. Mortgage payments? Finished. I could travel the world anytime I wanted.

These might not be your particular dreams, but I'm confident you can imagine your own version of this. It would be nice to have access to essentially unlimited resources. How could that not make you happy?

I can also imagine some terrible things that, presumably, would make me unhappy. If I were in a bad car accident and lost the use of my legs, it stands to reason that I would be less happy. Distance running, it turns out, is one of my favorite activities, has been since I was a kid. If I couldn't do that anymore, it stands to reason, I would be less happy, maybe much less happy.

While it stands to reason that these life events would impact happiness—either increasing it or decreasing it—there's good data to suggest that our intuitions are wrong here. Philip Brickman and his collaborators published a classic study on this in the 1970s that has since been replicated and extended many times. They recruited three groups of people to look at how recent life events would affect their happiness. The first was a control group of people. They hadn't experienced any major life events in the recent past. They contacted these people and assessed their overall happiness. They used a validated set of ratings questions. Several of the key questions assessed the participants' everyday happiness on a scale from one to five, where one is very unhappy, and five is very happy.

Brickman's team also recruited a group of people who had recently won the Illinois state lottery, including several people who had won more than a million dollars, and many of them who had won more than $500,000. Finally, they recruited a group of people from a local rehabilitation facility who had recently become paraplegic.

The control participants' ratings of everyday happiness had an average of about 3.8 out of 5. The lottery winners, they gave an average rating of 3.3—lower than that of the control participants. The paraplegic participants, 3.5. The control participants produced the highest everyday happiness ratings. The paraplegic participants second. The lottery winners seemed to be the least happy on average.

Okay, first a statistical inference note here as an aside. The mean scores are different here, but you shouldn't make too much of the small differences. In all three of those conditions, there was a fair amount of variability within the different groups. In fact, the amount of that variance within the groups was substantially bigger than the differences between groups. These differences are not statistically significant from one another. So I can't really conclude that winning the lottery will make you, on average, less happy than if you don't win the lottery. What I can say with a certain amount of confidence is that if you do win the lottery, it will not greatly increase your everyday happiness, certainly not in a substantial way.

Now, winning the lottery might make you happy for a little while. I suspect on the day you win, you'll be excited and quite happy, maybe even blissful. Conversely, in the immediate aftermath of some terrible accident, you're almost certain to be really unhappy. This particular study that I'm describing here was conducted with people several months after the event, however. The lasting effects of the major life event were still present, but the initial change in happiness level, that consistently fades.

I often liken this result to the experience of an air conditioned house on a hot, humid summer day. You might be outside, doing something you want to do—going for a walk, playing with the kids. If it's hot, you might be sweating, but I'm imagining a scenario here where you're mostly focused on the fun activity that's brought you outside—whatever that is. Your body is dealing with the heat. Your mind, certainly at an explicit level, barely notices it.

After you've been outside, now you walk back into the house for lunch. The air conditioning has cooled things down to a delightful 70 degrees. As you walk through that front door, the rush of cool air is just delicious. It can feel so good to be bathed in that cool, dry air. But no matter how good it is, within a few minutes, you can't even feel it. If there's anything else going on that warrants your attention, you probably don't think about it at all anymore. Your body adapts to the change, as does your mind.

That everyday feeling of happiness level seems to work in the same way. If you're fortunate enough to win the lottery, you feel great. If you're unfortunate enough to suffer a negative life event, you will feel terrible.

But research indicates that neither of these feelings will last. Within a few months, you will have adapted to that change.

If you win a bunch of money, you'll initially take great pleasure in not having to worry about bills and perhaps greatly enjoy the freedom to take vacations whenever and wherever you want. But after a while, that will become the new normal. You'll get used to it.

If you suffer a horrible accident, you'll miss the many things that you used to do, but your brain will learn to take pleasure in the small things that you used to take for granted. Either way, over an extended period of time, your level of happiness seems to come, not from how the external world has treated you, but from inside your own mind—from inside your own brain.

The tip that emerges from this research is a little negative and a lot unsettling for many people. The tip isn't to do something, but rather to avoid doing something. If you feel unhappy and you want to do something about it—if you want to increase how happy you feel—you shouldn't look for that happiness in the things that the world has to offer. You might think that getting a better job or solving some persistent problem will make you happy. Accomplishing those things will make you happier, but only in the short term. In the long term, you need to look elsewhere.

In isolation, part of the reason that this study and this tip are so unsettling is that it suggests that your happiness level is set. Maybe there's nothing you can do to change it. The study of lottery winners and accident victims suggests that maybe you can't change your happiness. Maybe your happiness is subject to some internal set point, like the temperature on a thermostat. You might shift that happiness level up or down temporarily, but unless you can somehow keep winning the lottery—and bigger and bigger jackpots at that—the study suggests that you might not be able to do anything to change how generally happy you are, or can you?

There's an old idea that our sense of pleasure and happiness are associated with stimulation of a particular, subcortical structure of the brain—the basal ganglia. In this course, I've talked about the nucleus accumbens and the notion that our subcortical, automatic motivation systems crave the release of dopamine within this pleasure circuit. The nucleus accumbens structure is a part of this motivation circuit in the basal ganglia.

In the 1950s, James Olds and Peter Milner found that if they delivered mild electrical stimulation to this brain region in the rat, that the rat acted as if it was a powerful positive reinforcer. When they hooked their system up so that the rat could obtain this electrical stimulation by pressing a bar in their enclosure, the rats would press that bar frequently all day long. They stopped eating and drinking, doing just about everything else in favor of continuing to press this bar for hours on end.

It's not surprising that many addictive opiate drugs increase activation in this same brain region. Activity in the basal ganglia is directly connected to our experience of intense pleasure. But if you talk to most heroin addicts, they don't seem very happy. Indeed, when they receive a dose of heroin, they often describe feeling relief, not happiness.

More modern work on brain activity has recharacterized the basal ganglia activity with the emotional feelings of liking, of wanting, but that's not the same thing as happiness. In many ways, liking and wanting are kind of the opposite of contentedness, the opposite of happiness.

So what are the circuits that are active in humans and other animals when they're actually happy? What circuits are active when they're unhappy? How about stress, anxiety, all of the other emotions that we all feel on a regular basis? These questions have spawned an entirely new subfield of cognitive neuroscience.

Richard Davidson is often described as one of the founders of a field that people now call affective neuroscience. How does the brain regulate emotion? How might changes in emotion be mapped onto various patterns of brain activity? If our emotions come from our brain, can you change the brain and thus change emotional state? Affective neuroscientists have devoted their careers to understanding just these sorts of questions.

Relevant to our discussion here, what characteristics define a happy brain? How is the brain activity of a happy person different from that of an unhappy person? By studying hundreds of people in different emotional states, Davidson and his colleagues have started to develop a very concrete set of answers to these and many other questions.

In general, when you are unhappy—when you feel stressed when you feel anxious—there are particular regions of the brain that are active. The amygdala is a relatively small, subcortical region of the brain. It's an important part of the limbic system. It's this highly connected structure that seems to regulate negative emotions. If you stimulate a particular part of the amygdala of most animals, they become strikingly agitated and aggressive. Conversely, when animals are agitated and aggressive, it turns out that this same spot in the amygdala is highly active.

If you feel angry, anxious, or unhappy, it's very likely that your amygdala is exhibiting high levels of activation. If we were to put you into an fMRI scanner, we would see high levels of blood flow to this particular region of the brain.

Along with the amygdala, negative emotions are associated with activity in the right prefrontal cortex. When you're distressed, this right, prefrontal cortex seems to regulate a heightened state of vigilance. When you're unhappy, all of these regions of the brain are likely to be active.

In contrast, the brains of people who report relatively high levels of happiness and enthusiasm are associated with low activities in both the amygdala and the right prefrontal cortex regions. Instead, higher activity is found in the left prefrontal cortex.

If you put someone into an fMRI scanner and look at the activity produced in these two different sets of regions, you can calculate a ratio of activity: the amount of left prefrontal cortex activity divided by the activity in right prefrontal cortex and amygdala. This ratio is a remarkably good predictor of someone's reports of their everyday happiness. Happier people tend to show a larger ratio. Unhappier people tend to show a substantially smaller ratio.

The study of lottery winners and paraplegics suggests that there's a set point of happiness in all of our brains. This ratio, according to Davidson's work, is that set point. It might vary as positive and negative life events come and go, but the ratio seems to be a fairly consistent factor. It is, in many respects, a neural signature of a stable personality characteristic.

In addition to quantifying this ratio, Davidson and his colleagues have explored several methods to alter it. One of the most successful has been something called mindfulness training. Mindfulness training is associated with the practice of meditation, but also a practice of thinking that you can engage in at any time even if you're not meditating. Training aimed at enhancing mindfulness will typically involve spending 15–20 minutes per day in quiet meditation. You find a time and place where you can be in a relatively quiet set of surroundings and a place where you're unlikely to be interrupted. You sit with your eyes closed and your back straight and aim to focus on yourself and your surroundings only in the immediate moment.

Often this method involves focusing your attention on your breathing and not on thoughts about things from the past or things that you're planning to do in the future. You just focus on being present in that particular moment. While you're doing this, your thoughts will naturally wander during this practice. As you become aware of these intrusive thoughts, you simply choose to stop thinking about them and then return to simply being—not thinking—about the particular moment.

There's another aspect of the mindfulness training that's particularly relevant to happiness, however. As you quietly sit and meditate, you may become aware of the emotions you're feeling—specifically, you might feel happy, or you might feel sad. Mindfulness training instructors will typically tell you to simply feel that feeling, to be aware of it, in a sense to embrace it.

From a scientific perspective, this mindfulness description always sounds a bit fluffy to me. It's tough to imagine how we would measure how much someone has embraced their emotional state. But what we can measure is what happens when someone regularly listens to this instruction and tries to perform that embrace of their own thoughts, whatever that is.

A lot of the mindfulness training program is centered around meditation, but there are substantial parts that are not. Mindfulness is not just about self-awareness while engaged in meditation. Students of mindfulness training are taught to periodically focus on being very aware of the thing that's happening right now, whatever that is—to be self-aware in the particular moment.

Most people spend a lot of their day thinking about things that either have happened in the past or thinking about making plans for the future. As important as this is to our daily cognition and decision making, that focus on things that are outside the domain of our immediate context seems to generate stress, anxiety, and generally reduce happiness.

When I eat breakfast, I often do so while checking emails, listening to the radio, thinking about what I'm going to do for the rest of the day, and so on. Mindfulness training would encourage me to resist that—at least on some days—to instead focus on the eating while I'm eating. Think about the taste of the food, the experience of taking each bite, being aware of the way my sense of hunger goes away over the course of the meal.

I could talk about the details of this mindfulness training a bit longer, but I think you probably have a good sense of the intervention that Davidson and his colleagues have used. After several weeks of this type of training, that ratio of activity—the left frontal cortex activity divided by the sum of amygdala and right frontal activity, that happiness ratio—that ratio gets larger. It's not clear just what parts of the mindfulness training do this, but across many studies now, when mindfulness training is used as an intervention, the brains of the participants change. They produce different patterns of activity, and the participants report that their everyday happiness levels increase.

This is an easy tip for you to use in your own life. The next time you do anything, try to focus on experiencing that particular experience. Don't think about the past or the future. Be in that particular moment. If you do that on a regular basis, this research suggests that your brain will tend to alter its happiness ratio, and you will find yourself being happier.

So your happiness might vary up and down around a particular set point like temperature varies. The bulk of your happiness and unhappiness seems to come from within you rather than from the external environment. But it seems that there are some ways that you can change the temperature on your happiness thermostat. Mindfulness and meditation, they seem to do the trick.

A range of studies have found that there are consistent differences between happy brains and unhappy brains. Happy brains show more activity in left frontal regions of the cortex. Unhappy brains tend to have more activity in right frontal and amygdala regions of the brain. When you imagine smiling or laughing, you activate the systems of your brain that are associated with happiness. This activation seems to spread, and you get more happy.

Thinking about gratitude, and better still expressing that gratitude, will not only make the people around you be happier but will make you feel happier too. Indeed, just devoting some attention every day to being mindful of your surroundings and experiences seem to unlock this sense of happiness.

Studies have suggested that money can buy you some happiness, but only to a certain point. Beyond the happiness money can buy, greater happiness is possible when you make it yourself. This is true whether by expressing gratitude, through mindfulness training, or other things that tend to boost left prefrontal cortex activity. But there are many more. In particular, your thoughts about how you relate to your surroundings—both physical and social—can lead to even more happiness.

Lecture 24

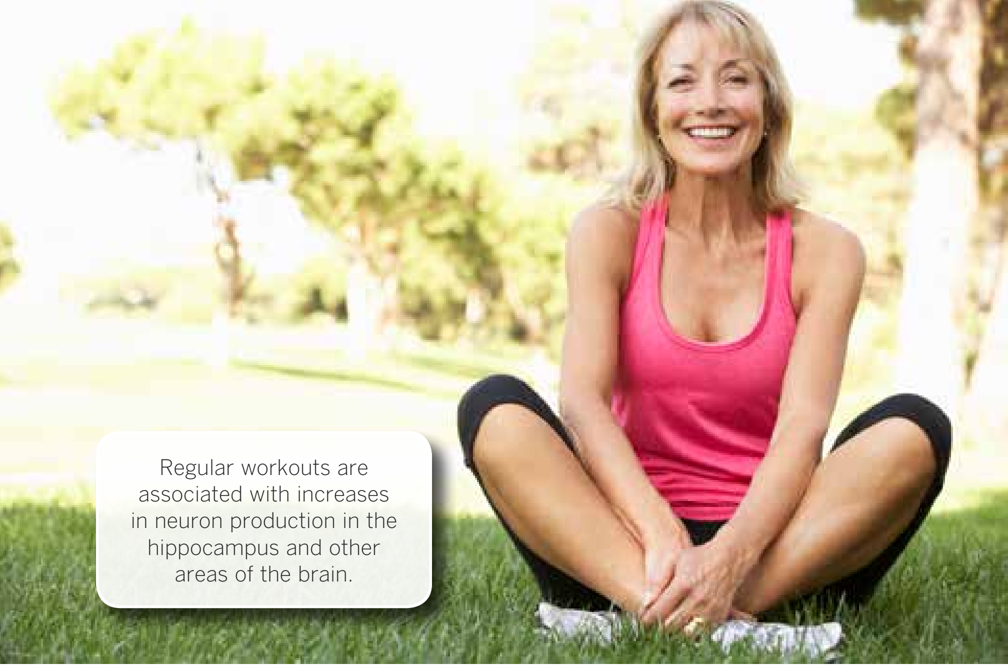
Happy Brains Are Smart Brains

Cognitive neuroscience research can help you understand how to make yourself happier. For example, when people are exposed to natural surroundings, their brains show patterns of activation associated with relaxation and happiness. Focusing on the value of time can affect automatic, unconscious processes in your brain that can lead to greater happiness. What's more, across several studies using different types of happiness-induction procedures, the results are the same: Happy workers are more productive. Happy people also demonstrate enhanced immune function. Moreover, by intentionally practicing optimism, there is strong evidence that you will become more optimistic, leading directly to higher levels of happiness.

Significance of Green Spaces

- A simple way to make yourself happier is to go outside and visit a place that is rich in natural vegetation—a forest, an open field, a city park, or a desert landscape. Studies demonstrate that this visit to nature will have an effect on your brain that is on par with taking a dose of prescription antidepressants. Even better, while you are out there, get some exercise.

- Clearly, physical exercise is good for your brain. Regular workouts are associated with increases in neuron production in the hippocampus and other areas of the brain. In fact, several recent studies suggest that it's even better if you perform that exercise in green, natural surroundings.



Regular workouts are associated with increases in neuron production in the hippocampus and other areas of the brain.

- Peter Aspinall and his colleagues had participants hike around Edinburgh while wearing a portable electroencephalograph and GPS system. The device monitored patterns of brain activity over the course of the walk. The researchers found that when participants were in green spaces, they exhibited patterns of brain activity associated with happiness. Frustration levels fell. Patterns of brain activity associated with meditation increased. When participants were in more urban spaces, these patterns were reversed.

- Colin Capaldi and his colleagues conducted a meta-analysis of these types of studies. They identified 30 different experiments—including 8,523 participants—that had explored the relation between natural surroundings and happiness. When they analyzed these studies together, the average effect on happiness was impressively large. Perhaps most remarkable was that the effect was consistent across a wide range of different types of studies.

Look Outside

- Cognitive research suggests that you don't have to change your activities, you can just take your current activities outside. In fact, you don't even need to go outside. Simply viewing natural settings can affect patterns of neural activation.

- A study by Roger Ulrich and his colleagues was based on hospital records at a facility in suburban Pennsylvania. Some of the hospital rooms had windows that looked out on the surrounding countryside; other rooms were windowless. Patients in both types of rooms received the same quality of care. They were served by the same staff with the same medications and protocols.

- Based on a review of hospital records, Ulrich found that the people assigned to window rooms recovered from surgeries more quickly and with fewer complications. Window-room participants checked out of the hospital, on average, about a day sooner than those in the windowless rooms. For the windowless patients, nurses' notes contained nearly four times more negative assessments than they did for the window patients.

Value Your Time

- Another strategy to boost happiness is to value your time highly. A recent study by Ashley Whillans and her colleagues assessed the trade-offs between time and money to determine how much monetary value people place on their time. The authors found that individuals tend to place a fairly consistent value on their own time. In addition, the researchers determined that people who place a greater value on their time tend to be happier.

- Cassie Molginer published a set of experiments exploring how time, social behavior, and happiness interact. In several of her experiments, participants started by completing a word-scramble puzzle. Participants had to unscramble the letters as quickly as possible and then come up with sentences that included the words.

- After completing this puzzle task, the study participants completed a questionnaire containing a list of daily activities, such as socializing, working, and commuting. The participants were asked to rate how much time they were likely to spend on each activity during the next day. They were also asked to rate how happy they expected to be while doing those tasks.

- The key manipulation in the study was the content of the word puzzle. For some participants, the words were related to time; for other participants, the words were related to money. A control group unscrambled neutral words.

- Cognitive scientists think of the word-scramble puzzle as a priming task. While you are doing the puzzle, you're inherently thinking about the related concepts, such as money or time. Once you finish the puzzle and go on to the survey, your conscious mind probably doesn't focus on money or time. However, there is strong evidence that the unconscious neural networks that are used to process information related to the priming task remain active for at least several minutes.

- Results of the experiment demonstrated that if you prime people to think about money, they indicate that they will spend more of their next 24 hours working. If you prime the concept of time, people unconsciously shift their plans to include more time in social activities. What's more, the time participants also anticipated being happier than the money participants.

Increased Work Production

- A wide range of studies find that happier people produce more work and superior work. Productive work, of course, is itself a source of satisfaction; however, a number of studies have found that when you experimentally boost people's happiness, they tend to improve in their work as well.

- To test the relationship between happiness and work, Andrew Oswald and his colleagues recruited about 300 students and randomly assigned them to either a control condition or a happiness-induction condition. To induce happiness, participants watched a funny movie clip or were provided free drinks and snacks. As simple as these happiness-induction steps were, they increased the happiness level of these participants. Participants assigned to the control conditions had about the same level of happiness as when they started.

- Oswald then asked these participants to perform some work, such as solving math puzzles. Across several studies using different types of happiness-induction procedures, the results were the same: Happy workers are more productive. When your brain is happy, it produces superior work. Happy people are less distractible, less irritable, and seem to have enhanced memory performance.

Enhanced Immune Function

- As we learned from Richard Davidson's research, happy brains have greater patterns of activity in the left frontal cortex, as opposed to the right frontal cortex and amygdala areas. As part of the Davidson study, researchers collected blood samples from participants who had recently received flu shots. Davidson's group found that the number of influenza antibodies in the bloodstream of the happy people was significantly greater than those in the bloodstream of the unhappy people.

- It may be that when you are unhappy, even if you aren't experiencing the surge of adrenaline that we associate with a strong activation of the sympathetic nervous system, perhaps there are milder activations that suppress processes such as digestion and immune function. If so, then being happy will result in more resources being devoted to immune function.

- If you are happier, studies have shown that you will tend to be more energetic and productive. The influenza antibody result suggests a

Happy people have better immune function and therefore fewer illnesses—and fewer sick days out of work.

very direct mechanism for that observed effect. Happy people have better immune function and therefore fewer illnesses—and fewer sick days out of work.

Practice Optimism

- A successful strategy for promoting happiness is to practice being optimistic. By intentionally practicing optimism, there is strong evidence that you will become more optimistic, which will lead directly to higher levels of happiness.

- A theory often associated with Rick Hanson and his colleagues is that humans are born pessimists. While this is debatable, there is evidence that we tend to be more affected by negative events than positive ones. A number of brain mechanisms may be responsible for this tendency. For example, the amygdala—an area greatly activated by negative experiences—has strong connections to the hippocampus, which is responsible for encoding information into long-term memory. Thus, a negative memory will likely be encoded more strongly than a positive one.

- This creates a problem for happiness. If humans are inherently somewhat pessimistic, then the brain is wired to resist when positive events happen. Even if you experience an equal number of positive and negative events, your brain will remember a greater proportion of those negatives.

- The best way to be more optimistic, however, is to practice. A system that David Fresco and his colleagues have explored in several studies simply involves keeping track of the times when you engage in a pessimistic-explanation strategy.

- When some event or uncertain situation arises, you can interpret it in either an optimistic way or a pessimistic way. If you make a note of those times and then intentionally try to be more optimistic, then optimism will become a habit. In as little as two weeks of using this intervention, participants' explanatory styles are altered significantly.

Human Connectome Project

- Our brains contain unconscious control systems, and we have tendencies to think and behave according to certain cognitive reflexes. All of us are embodiments of an ongoing battle between these reflexive, automatic tendencies and our conscious, intentional mind.

- Throughout this course, we've considered ways to outsmart these automatic brain systems. We have provided numerous tools that you can use in that battle, and now you know enough to seek out additional tools adapted even more specifically to your individual situation. If you are patient and persistent, you can outsmart many of those automatic processes and take control for yourself.

- What's more, cognitive neuroscientists aren't finished with their research on the brain. If anything, the rate of new discovery has accelerated in recent years. For example, the Human Connectome Project has developed new neuroimaging techniques that combine assessments of connectivity and myelination with correlations in activation. The underlying circuit diagram of the human brain has uncovered more than 100 newly identified processing systems. Right now, we don't know what many of these systems do. But we will.

- It may be that you have little or no conscious control over your moment-to-moment behaviors; there's good evidence for that from cognitive neuroscience research. Over longer periods of time, however, you do have the ability to consciously shape those unconscious systems. The battle can be a challenging one, but the outcomes can be tremendously rewarding. You can outsmart yourself.

Questions to Consider

1. Spending time in natural surroundings engaged with nature promotes happiness. Even simply looking out a window seems sufficient to promote happiness. Do you think nature-themed art or computer screen savers would have a similar effect? How could you test for this in your own life?
2. Simply mentioning the concept of time a few times seems to promote greater socialization. The concept of money seems to promote more work behavior. What other key concepts might modulate our behaviors in this fashion?

Suggested Readings

Diamond, Scheibel, and Elson, *The Human Brain Coloring Book*.

Satel and Lilienfeld, *Brainwashed.*

Verstynen and Voytek, *Do Zombies Dream of Undead Sheep?*

Happy Brains Are Smart Brains

Here's a simple way to make yourself happier right now, or as soon as you finish with this lecture. Go outside and visit a place that's rich in natural vegetation—a place with trees, grass, and bushes—a forest, some fields, a city park, even a desert landscape should suffice. The effects on your happiness can be surprisingly large. There are studies that suggest this visit to nature will have an effect on your brain that's on par with taking a dose of prescription anti-depressants. Even better, while you're there, get some exercise—a walk or a bike ride are good examples.

Clearly, physical exercise is good for your brain. Regular workouts—even moderate ones—are associated with increases in neuron production in the hippocampus and a few other areas of the brain. But several recent studies suggest that it's even better if you do that exercise in green, natural surroundings

One of the best examples of this is a study that was performed by Peter Aspinall and several collaborators in which participants hiked around Edinburgh while wearing a portable electroencephalograph and GPS systems. The devices monitored patterns of brain activity over the course of that walk.

The researchers found that when participants were in green space—things like parks with more natural surroundings—they exhibited patterns of brain activity associated with happiness. Frustration levels fell. Patterns of brain activity associated with meditation increased. When participants were in more urban spaces instead, these patterns were reversed.

Other studies have supported this finding. When people are exposed to natural surroundings, their brains show patterns of activation associated with relaxation and happiness. Don't get me wrong here; you can certainly be very happy in a house or some other building. What these results suggest is that spending time in natural surroundings seems to promote greater happiness.

Holli-Anne Passmore and her collaborators conducted a random assignment experiment, using exposure to nature as an intervention to promote happiness. A large group of participants filled out a questionnaire that assessed, among other things, their general level of everyday happiness. The experimenters then asked half of those participants—randomly assigned participants—to seek a greater engagement in activities that would bring them in close contact with nature.

In my tip here, I'm encouraging you to put yourself into natural settings and do things—maybe walking, maybe just looking out the window. It's up to you to how to spend that time. That's exactly how Passmore's experiment was conducted. It was left up to the participants to figure out the best way for them to spend their time engaged in a natural setting.

Two weeks later, all participants returned to the lab. Those participants who sought a greater engagement with nature did so in a wide variety of ways actually. They worked in their gardens. They played in their backyards with their dogs. They went for walks in the woods. There were almost as many different ways to engage with nature as there were participants in the study. While the experiences of those participants were very different, their effects on everyday happiness were very consistent. Spending more time engaged with natural environments produced significantly greater happiness.

Colin Capaldi and his collaborators conducted something called a meta-analysis of these types of studies. They identified 30 different experiment including 8,523 total participants, studies that had explored the relation between natural surroundings and happiness. When they analyzed these studies altogether, the average effect size—the effect on happiness—was impressively large. Perhaps most impressive about this is that the effect was consistent across such a wide range of different types of studies.

Even short-term experiences—as short as a few minutes—seemed to produce positive effects in these studies. Long-term experiences produced greater effects, but the positive effect of happiness isn't something you need to wait a long time to obtain.

If you're looking for an easy way to boost your emotional state, the tip here is really clear. Find a way to engage in activities in natural surroundings. The research suggests that you might not even have to change your activities at all. Just take the activities that you are performing already and move them into a setting where you can see, hear, and smell nature around you.

It might be that you don't even need to go outside. When people merely view natural settings, it can affect their patterns of neural activation. There's a lot of data on the immediate effects of this viewing activity. One of my favorite studies suggests that there are health benefits as well.

A clever study was performed by Roger Ulrich and his collaborators, based on hospital records at a facility in suburban Pennsylvania. This is a big hospital with lots of different rooms. Some of those rooms have windows that look out on the surrounding countryside. Other rooms don't have windows. Now, the patients in these different rooms get the same quality of care. They're served by the same staff, the same medications, and the same protocols. But the people in the non-window room, they only get only a view of a brick wall.

Based on a review of records from this hospital, Ulrich found that the people assigned to window rooms recovered from their surgeries more quickly with fewer complications. Window room participants checked out of the hospital, on average, about a day sooner than those in non-window rooms.

Now, this study didn't record patterns of brain activity in these patients, but nurses typically make notes about how patients say they're feeling. The records thus often include nurse's notes such as "needs encouragement" or "upset and crying." Those brick wall patients? Their records contained almost four times as many negative notes as the window patients. Nature—just being able to look at nature—is good for your health and happiness.

Another tip to boost happiness is to highly value your time. Dozens of the decisions that we make in our lives, on a very regular basis, require us to consider the trade-off between time and money. The simple decision about how many hours we want to work in a given year is a time versus money decision. The more you work, the more money you'll likely have, but obviously the less time you'll have left to do other things.

Our decisions about where to live also involve a time-money tradeoff in many cases. Most people work near population centers. Housing that's close to those areas tends to be more expensive. All things being equal, houses that are close to a commuter rail line are also generally priced higher. Less commute time, more money.

A recent study published by Ashley Whillans and her colleagues assessed this time versus money tradeoff that people tend to make by presenting them with a series of scenarios to consider. For instance, if you need to fill your car's 18-gallon gas tank, how much farther would you be willing to drive to get to a more distant gas station that has a lower price per gallon? For 10 cents a gallon, how far would you go? How about 20 cents a gallon? How much would you pay someone to mow your lawn if it takes about an hour to do so? A participant's answers to these kinds of questions enable a calculation—how much monetary value do people place on their time?

Firstly, the authors found that individuals tend to place a fairly consistent value on their own time. That is to say, if you test someone with one set of scenarios and then test them again, say, three months later with another set of novel scenarios, they tend to produce very similar results. This Resource Orientation Measure, referred to with the acronym ROM, can be considered a validated psychological assessment.

Second, they assessed people's general level of happiness. They asked questions such as, "Taking all things together, how happy would you say you are on a scale from

0, which is not at all happy, to 10, extremely happy? They found that people who place a greater value on their time tend to be happier.

Your time is important. I don't want to suggest that you shouldn't mow your own lawn if that's how you do things, but give that decision at least a bit of thought before you fire up the mower. Is there some other way you'd rather get some exercise? Is there something else that you'd rather do around the house with your time?

Now so far, this evidence that I've presented that you should focus on time more than money is correlational. It would be better if we had a good experiment with random assignments and a good controlled design. Cassie Molginer recently published just such a set of experiments, experiments that cleverly explored how time, social behavior, and happiness interact with one another.

In several of her experiments, participants started by completing a word scramble puzzle. Letters for several words were presented in a scrambled order. Participants had to unscramble the letters as quickly as possible. They then had to come up with as many sentences as they could that included those words within a few minutes.

After completing this puzzle task, the study participants completed a questionnaire. It contained a list of daily activities—things like socializing, working, and commuting. For each one, the participants were asked to rate how much time they were likely to spend on each activity during the next day. They were also asked to rate how happy they expected to be while doing those tasks.

The key manipulation in the study was the content of the word "scramble." For some participants, all of those words were related to time—things like minutes, second, week. For other participants, the words were related to money—dollar, finance, bills. A control group unscrambled neutral words that weren't closely related to time or money.

Participants didn't know that the puzzle was related to the questionnaire. It was presented as a cognitive challenge before the survey. Cognitive scientists think of the word "scramble task" here as a priming task. While you're doing the word scramble puzzle, you're inherently thinking about the related concepts—in this case, money, time, or neither. Once you finish that puzzle and go on to the survey task, your conscious mind probably doesn't focus on money or time.

But there's good evidence that the unconscious neural networks that are used to process information related to the priming task remain active for at least several minutes.

So how does priming of money or time concepts influence the participants' survey responses? If you prime people to think about money, they indicate that they'll spend more of their next 24 hours working. If you prime the concept of time, people unconsciously shift their plans to include more time spent in social activities—everything from general conversation to sex. The time condition participants also anticipated being happier than the money participants. Focusing on time, even unconsciously, seems to increase happiness.

Based on this study, I can be more specific with a tip to outsmart yourself. You don't have to explicitly increase the value you place on your time. You don't have to walk around with a calculator keeping track of your hourly rate. This study suggests that you might not have to engage in much effort at all. If you just think about time for a few minutes, that alone seems to be enough to shift unconscious decision-making systems and to generate more happiness.

This is all fine, but—to be blunt-—when data are completely based on a survey, I'm often a little skeptical. People say that they will spend more time in their social activities and be happier, but saying you'll do something and actually doing it are two distinct things. Fortunately, Molginer had this same concern. She ran a delightful second study in a cafe.

Participants were invited to participate when they arrived at the cafe. Many people said no, but 88 eventually said yes. Participants started completed that word scramble task, and then went ahead with their cafe visit. The experimenter would quietly, surreptitiously, watch what the person did during their time at the cafe.

The experimenters coded how much time a given participant spent socializing, talking with other people, and talking on the phone. They also timed how long the participants spent working—reading, doing homework, or typing on a laptop.

Remember that all that the participants actually thought they were doing for the study was completing a word scramble task. In the minds of the participants, the study procedure was finished at that point. To make sure that experimenter bias didn't influence the coding, one experimenter would administer the word scramble task. A second experimenter—someone who didn't know whether the participant had completed the money, time, or neutral word scramble—that person would record what happened during the rest of the visit to the cafe. This was a really carefully done experiment.

If the word scramble contained money words, the participants spent about 40 percent of their time at the cafe working and about 25% on social activities. If the word scramble contained time words, they spent 60% of their visit engaged in social activities, and only about 5 percent of their time was spent on actual work.

There are at least two really notable tips for outsmarting yourself here. The first isn't about happiness at all, but about working away from the office. If you head to the local cafe to get some work done, it's clear you should think a lot about money as you do—maybe stare at a dollar bill, or think about when your next paycheck is scheduled to arrive. Do think about money. Don't think about time. Maybe leave your watch at home. Having a watch or a clock around isn't the same thing as being primed to think about time, but when you look at it, you'll be thinking about time.

The second tip seems likely to boost your happiness levels. Whether you're headed for a café or not, think about time. This study indicates that you don't have to think about it very much. Just a few minutes thinking about how much time you have available in a given day or a given week. Think about the notion that we all have an inherently finite amount of time available. Maybe think about how many seconds are in an hour. Get those time-related semantic networks working, then think about what you want to do with your next few hours and days. It's quite likely that you'll include more social activities in those plans, and that when you are done implementing those plans, you'll feel happier.

Increasing happiness is a worthy goal, I think, all by itself. But it's not the only product of pursuing strategies that might make you happier. It's great to feel happy, but I think many of us feel—in a Puritan way, maybe—that happiness isn't the only important goal in life.

If I have to sacrifice some of my happiness in order to improve the lives of my family, my community, and the world, maybe I should do that. If I spend my time chatting with friends and socializing, I might feel better, but the data also indicate that I'll spend a lot less time working. If my work benefits other people, then am I sacrificing their happiness for my own gain? I want to take a few minutes here to argue that happier is better, not just for the happier people, but for the other people around them.

The first argument in support of this comes from studies relating happiness ratings to the quantity and quality of work that individuals produce. A wide range of studies have found that happier people produce more work and better work. Productive work, of course, is itself a source of satisfaction, so maybe it's being productive that makes for happy people as well not just that happiness causes the productivity. But a number of studies have found that when you experimentally boost people's happiness, they tend to improve in terms of their work as well.

Andrew Oswald and his colleagues performed one such test of this. They recruited about 300 students and randomly assigned them to either a control condition or a happiness induction condition. Some of the happiness induction methods were somewhat arbitrary. For instance, in one of the experiments, the participants simply watched a funny movie clip. In some more realistic conditions, the participants were provided with free drinks and snacks. As simple as these happiness induction steps were, they worked. When the happiness level of the participants was assessed, they tended to indicate that they felt generally happier in those conditions. The participants assigned to the control conditions, of course, had about the same level of happiness as when they started.

Oswald then asked these participants to perform some work. In some cases, it was solving puzzles. In other cases, it was to perform certain types of simple calculations at a rapid pace. In all cases, the participants were paid a small amount of money for every correct answer that they obtained. Across several studies and several types of happiness induction procedures, the results are the same. Happy workers—happy people—are more productive.

A range of similar experimental studies have supported this conclusion. Better decision-making, more accurate proofreading, better solving of anagrams, all of these improve after a happy mood is induced. When your brain is happy, it just works better across a very wide range of task behaviors. Happy people are less distractible, less irritable, and seem to have better memory performance.

If you think about money as you sit down to work, then maybe in the short-term, you'll spend more time working. But in the long-term, over the course of many weeks rather than just a single visit to a cafe, you're likely to spend more time productively working if you are happy.

Ironically, most people think of happiness as something that will emerge from good work. If you work hard and achieve success, then you'll be happy. The irony is that a wide range of good, experimental studies suggest that the opposite is true. When you're happy, then you tend to do better work. Happiness may thus not usually arise from success. Success seems to arise from happiness.

Remember Richard Davidson's work on the pattern of activity in happy brains? He found a greater ratio of activity in the left frontal cortex relative to the right frontal cortex and amygdala activation. Well, as part of that same study, they also collected blood samples from many of the participants. A group of those participants had received a flu shot—an influenza vaccination—about a week before that blood draw part of the study. Davidson's group found that the number of influenza antibodies in the bloodstreams of the happier people was significantly greater than for those in the bloodstream of the unhappy people.

The mechanisms that relate happiness to immune function are not completely understood.

We know that the fight or flight response associated with activation of the amygdala suppresses functions of the body that are not related to immediate survival of that fight or flight situation, whatever it is. For the same reason that digestion is delayed if you are faced with a potentially deadly threat, immune function is as well. Energy is diverted from that immune function to the heart, lungs, and other muscles for the purposes of producing a fight or flight action.

It may be that, when you're unhappy, that there are milder activations of this fight or flight system—activations that occur on a regular basis. Even if you aren't experiencing the surge of adrenaline that we associate with a strong sympathetic nervous system activation, perhaps there are milder activations of it that suppress things like digestion and immune function.

If so, then being happy will, by definition, result in more resources being devoted to things like immune function.

If you're happier, studies have shown that you will tend to be more energetic and productive. The influenza antibody result here suggests a very direct mechanism for that observed effect. Happy people have better immune function. Better immune function means fewer illnesses, and thus fewer sick days out of work. It also means that fewer mild infections will be experienced as well. Happier people, even if they're at work, can spend a smaller portion of their body's energy fighting off illness.

I have one last tip for promoting happiness: practice being optimistic. We've discussed how you can break bad habits by simply keeping track of when you do them. Just carry a notebook with you and write down times when you're aware that you're focusing on a negative possible outcome of a situation. By intentionally practicing optimism, there's good evidence that you will become more optimistic. This will lead quite directly to higher levels of happiness.

There's a theory, often associated with Rick Hanson and his collaborators that humans are born pessimists. I don't know if I'm in complete agreement here, but there's evidence that we tend to be more affected by negative events than positive events. Humans are better at remembering negative life events than positive ones. There's just something about how the brain is wired up that it processes negative information as being more salient than positive information.

A number of brain mechanisms have been suggested as responsible for this tendency. For instance, the amygdala—an area that is greatly activated by negative experiences—has strong connections to the hippocampus, which is responsible for encoding information into our long-term memories. If you experience something positive, it's not that you won't encode it into long term memory, but if it's negative, it will likely be encoded better.

This creates a problem for happiness, of course. It seems that all humans—some would argue all mammals—are inherently somewhat pessimistic. If you are especially pessimistic, then your brain is wired to resist when positive things happen. Even if, say, half of the time, something positive happens and half of the time something negative occurs, your brain will remember a greater proportion of those negatives.

It might be that good things are happening to you almost all of the time. If you're sufficiently pessimistic, however, then you probably aren't aware of it. If you were more aware of it, then you would gain a boost in happiness, along with all of the positive things that come with it. So how can you be more optimistic? Practice.

A system that David Fresco and his collaborators have explored in several studies simply involves keeping track of the times when you engage in a pessimistic explanation strategy. When some event or uncertain situation arises, you can interpret it in many ways. Sometimes, you'll think of ways in which the situation might work out well, in an optimistic fashion. In other cases, you'll tend to interpret the event pessimistically. If you note those times and then intentionally try to be more optimistic, then optimism will become a habit.

In as little as two weeks of using this intervention, participants' explanatory styles are typically altered significantly. Happiness, it seems, can be a good habit. We just have to practice.

In this lecture, we've discussed several ways you can make yourself happier—for instance, thinking about the concept of time. That's a surprising result. There's nothing inherently happy about time, but thinking about time affects automatic, unconscious processes in your brain that lead your brain to greater happiness.

Throughout this course, we've considered ways to outsmart these automatic brain systems. Having these automatic systems, I should remind you, is a great thing. While my brain makes breakfast and gets me dressed each morning on autopilot, I can think about dozens of other things and even have conversations with my family. Life would be very hard without these automatic systems.

But the systems have predictable, problematic shortcomings. The many tips to outsmart yourself in this course provide tools for hacking into those systems and changing them. I started the course by arguing that many of your actions are controlled by systems over which you don't have control—not intentional, conscious control anyway. However, and this is a sort of master tip for the course, adaptable to almost any situation: If you're patient and persistent, you can outsmart many of these automatic processes and take that control back for yourself. This process can even work in some extreme circumstances.

When my son was about five years old, he developed something called transient tic disorder. It's the epitome of control by unconscious processes. He would periodically blink his eyes hard and repeatedly for several minutes. At other times he would clear his throat over and over again.

For weeks at a time, one of those tics would go away, but then be replaced by another. For a while, it was periodic grunting noises. That wasn't that big deal, to be honest, but there were times when I would worry. I would ask him if he was okay. He would say yes, but keep repeating those behaviors. There were times, like during a quiet church service, when I would ask him if he could stop. He would try but eventually say no. He couldn't. His automatic, unconscious motor system was causing these actions so automatically that he couldn't stop.

My wife and I worried about him a lot. When he was learning to write in cursive, his arm started having the tics. It would jerk at the worst moments and mess up his work. We could always tell when he was about to get a cold or a fever. For about a day before those symptoms arrived, the tics would become especially frequent. Something about the immune response seems to make this problem worse.

Transient tics are, it turns out, not that uncommon in young children. About 10 percent of school-age kids exhibit at least one bout of these symptoms. Most just grow out of it. For some, it's the precursor to Tourette's syndrome—a disorder characterized by severe, long-lasting, often verbal tics. We worried a lot about that possibility. In my son's case, his conscious mind eventually figured out a way to beat it with a piano.

He started piano lessons when he was about five. We usually had to push him to practice. It was a chore for him, but after lots of reminders and urging, he was sometimes willing to do it for 15 minutes or so. When he was about eight years old, we suddenly found ourselves not pushing him to practice, but occasionally actually asking him to please stop, just for a few minutes. He would feel a periodic compulsion to practice piano. He really got into it, and we haven't seen a tick since.

Now, my son is just one person. He might have just been outgrowing the problem at the same time he got interested in music. But there's a behavioral therapy for transient tic disorders that matches what he spontaneously did—habit reversal training. With this training, children work with a clinician to develop a sense of the precursors of their tic behaviors to sense when they're about to start and to recognize the external things that sometimes trigger them.

The children are then taught to introduce a competing response—to learn to perform some alternate behavior in place of the tic, something that is incompatible with performing the unwanted behavior. Because the motor cortex is intentionally occupied with this alternate behavior, that brain region is no longer available for the unconsciously inspired tic behaviors.

My son replaced his tic behaviors with playing music. Now he plays piano, guitar, bass, drums. He writes his own music. He sings. My family had dinner at a large, crowded restaurant recently where a guitar player was performing in the background. My son talked to him, and before we knew it, the guitar guy took a break and my son was performing. His music is one of the great joys of his life, and it all started because of those persistent, unconsciously generated behaviors and his battle to overcome them.

All of us have brains that contain unconscious control systems. We have tendencies to think and behave according to certain cognitive reflexes. Some of those reflexes are good. Others can be really problematic. In the case of some disorders, the reflexes can be really challenging.

All of us are embodiments of an ongoing battle between these reflexive, automatic tendencies and our conscious, intentional mind. This course has provided many tools that you can use in that battle, and now you know enough to seek out additional tools adapted even more specifically to whatever your individual situation happens to be.

And cognitive neuroscientists aren't finished. If anything, the rate of new discovery has accelerated in recent years. For instance, the human connectome project has developed new neuroimaging techniques that combine assessments of connectivity and myelination along with correlations in activation. The underlying circuit diagram of the entire human brain has uncovered over 100 newly identified processing systems. For many of them, we don't even know what they do yet, but we will.

It may be that you have little or no conscious control over your moment-to-moment behaviors; there's good evidence for that from cognitive neuroscience research. But over longer periods of time, you do have the ability to consciously shape those unconscious systems. The battle can be a hard one, but the outcomes can be tremendously rewarding. I wish you health and happiness, for your body and especially for your brain.

Bibliography

Allen, D. *Getting Things Done: The Art of Stress-Free Productivity*. New York: Penguin, 2015. This is a longtime best-selling business productivity book, but our understanding of how the brain implements goals, decisions, and even anxiety fits very closely with the wide range of practices recommended by the author.

Allen, J. S. *The Omnivorous Mind: Our Evolving Relationship with Food*. Cambridge, MA: Harvard University Press, 2012. This book provides a clearer understanding of how culture, history, and brain processes combine to produce our eating habits.

Ariely, D. *Predictably Irrational*. New York: HarperCollins, 2008. The author provides an entertaining and readable summary of modern thinking about human decision making, articulating both its strengths and weaknesses. A deeper understanding of the limitations of unconscious decision-making tendencies leads to better decision making in general.

Berns, G. *How Dogs Love Us: A Neuroscientist and His Adopted Dog Decode the Canine Brain*. New York: Houghton Mifflin Harcourt, 2013. *How Dogs Love Us* explores the nature of love—presenting research on human love and comparing and contrasting human love with the nature of animal love. This entertaining read considers a journey taken by a neuroscience researcher, his family, and his dog as they explore the neural underpinnings of this most precious of emotions.

Buss, D. M. *The Evolution of Desire: Strategies of Human Mating.* New York: Basic Books, 2003. The author is a pioneer in the field of evolutionary psychology, which considers how historical evolutionary pressures may have led to the modern characteristics of the human brain. In this book, Buss considers how human animals select mates and seek to produce offspring. The perspective of humans as members of the animal continuum can be disturbing at times, but the work remains a significant part of the cognitive-science canon.

Cabeza, R., L. Nyberg, and D. Park, eds. *Cognitive Neuroscience of Aging: Linking Cognitive and Cerebral Aging*. Oxford: Oxford University Press, 2004. This authoritative volume summarizes an enormous amount of research on how the brain and associated cognitive performance change as we age.

Chabris, C., and D. Simons. *The Invisible Gorilla: And Other Ways Our Intuitions Deceive Us*. New York: Harmony Books, 2011. This fascinating book describes surprising research on the limitations of our perception and action-control systems and presents compelling evidence on the problems of multitasking.

Cialdini, R. B. *Influence: Science and Practice.* Vol. 4. Boston: Pearson Education, 2009. Cialdini summarizes a wealth of discoveries, many his own, about how various techniques can greatly increase the likelihood of persuading someone to say yes. It's a good read if you want to learn to influence people—and also if you want to ensure that your own decisions are not unduly influenced by others.

Cialdini, R. *Pre-Suasion: A Revolutionary Way to Influence and Persuade*. New York: Simon & Schuster, 2016. This update of the author's classic work on persuasion considers the techniques to use in advance of a persuasive interaction to motivate people to say yes. The new techniques, described as "pre-suasion," provide a nice complement to the earlier work.

Csikszentmihalyi, M. *Flow and the Psychology of Discovery and Invention*. New York: HarperCollins, 1996. When our mind and body operate in synchronized, efficient harmony, we experience a nearly unconscious state of flow. This book considers the nature of flow from a variety of perspectives.

Cvetkovic, D., and I. Cosic, eds. *States of Consciousness: Experimental Insights into Meditation, Waking, Sleep and Dreams.* New York: Springer

Science+Business Media, 2011. This book explores what happens to the brain during sleep and sheds light on the nature of consciousness itself.

Davidson, R. J., and S. Begley. *The Emotional Life of Your Brain: How Its Unique Patterns Affect the Way You Think, Feel, and Live—and How You Can Change Them.* London: Hodder & Stoughton, 2012. Two pioneers in the exciting new field of affective neuroscience describe recent groundbreaking findings on the emotional life of the brain and present potential applications to real-life situations.

Diamond, M. C., A. B. Scheibel, and L. M. Elson. *The Human Brain Coloring Book*. New York: Barnes & Noble, 1985. This book reviews the structure of the human brain and invites the reader to color brain diagrams in various ways. It's fun, and this technique makes the knowledge stick uncannily well.

Doidge, N. *The Brain That Changes Itself: Stories of Personal Triumph from the Frontiers of Brain Science*. New York: Penguin, 2007. This book contains a wide range of case studies of individuals who managed to rewire their brains to function better after discovering a deficit or suffering an injury. Their inspiring stories illustrate the remarkable flexibility of the human brain.

Duhigg, C. *The Power of Habit: Why We Do What We Do in Life and Business.* Vol. 34, no. 10. New York: Random House, 2012. This book considers a wide range of evidence that most of our behaviors are produced via habits. By mediating your own habit-forming system, you can more effectively control these largely automatic tendencies.

Eagleman, D. *Incognito: The Secret Lives of the Brain*. New York: Pantheon, 2011. Written by a highly acclaimed neuroscience researcher, this book provides an in-depth consideration of the brain systems involved in the unconscious control of different types of behaviors.

Ericsson, A., and R. Pool. *Peak: Secrets from the New Science of Expertise*. New York: Houghton Mifflin Harcourt, 2016. Two leaders in expertise research provide an excellent summary of the current understanding of expertise and how that understanding can be applied in specific circumstances.

Eriksson, P. S., E. Perfilieva, T. Björk-Eriksson, A. M. Alborn, C. Nordborg, D. A. Peterson, and F. H. Gage. "Neurogenesis in the Adult Human Hippocampus." *Nature Medicine* 4, no. 11 (1998): 1313–17. This paper describes the now-classic studies that demonstrated the creation of new neurons in the human adult brain.

Finke, R. A. *Principles of Mental Imagery*. Cambridge, MA: MIT Press, 1989. This book considers the principles that characterize and motivate the use of mental imagery for many purposes—including how we can use mental imagery to improve performance—and describes what the brain does when we imagine something or perform an action.

Gauthier, I., M. Tarr, and D. Bub. *Perceptual Expertise: Bridging Brain and Behavior.* Oxford: Oxford University Press, 2009. The researchers explore how the brain changes its processing as it acquires greater expertise through experience. The very processes we use to gather information from the world around us change as we become experts.

Gladwell, M. *Blink: The Power of Thinking without Thinking*. New York: Back Bay Books, 2007. Many of our decisions occur rapidly and outside our conscious awareness—that is, in the blink of an eye. The book describes many of the same decision-making processes influenced by the systems described in this course.

———. *Outliers: The Story of Success*. New York: Little, Brown, 2008. The author considers research on the cognitive science of creativity and presents a wealth of readable, entertaining stories about people who have achieved great success in creative endeavors.

Gottman, J. M., J. S. Gottman, and J. DeClaire. *Ten Lessons to Transform Your Marriage: America's Love Lab Experts Share Their Strategies for Strengthening Your Relationship*. New York: Harmony Books, 2007. This book provides a nonscientific study-based description of how to improve long-term romantic relationships.

Gottman, J., and N. Silver. *What Makes Love Last?: How to Build Trust and Avoid Betrayal*. New York: Simon & Schuster, 2012. Gottman and his collaborators became famous for their ability to predict accurately which married couples would remain married and which would divorce. These authors build on that research, describing the relationship characteristics associated with lasting love.

Horstman, J. *The "Scientific American" Healthy Aging Brain: The Neuroscience of Making the Most of Your Mature Mind*. Vol. 4. Hoboken, NJ: John Wiley & Sons, 2012. This book considers evidence-based practices that can be used to maximize your brain's potential as you age. As described in this course, these activities can improve cognitive performance at almost any age.

Kahneman, D. *Thinking, Fast and Slow*. New York: Macmillan, 2011. Kahneman, winner of the Nobel prize in economics and a thought leader in understanding human decision making, presents an updated theory contrasting quick emotional reasoning with slower deliberative processing.

Kessler, D. A. *The End of Overeating: Taking Control of the Insatiable American Appetite.* New York: Rodale, 2010. The author, former commissioner of the U.S. Food and Drug Administration, is credited with reducing the negative impacts of smoking on public health. This book considers how the food production industry influences human eating and health and how that influence might be rendered more positive.

Knaus, W. J. *The Cognitive Behavioral Workbook for Anxiety: A Step-by-Step Program.* Oakland, CA: New Harbinger, 2008. This workbook provides a detailed program for unlearning fear by altering how we process information.

Korb, A. *The Upward Spiral: Using Neuroscience to Reverse the Course of Depression, One Small Change at a Time.* Oakland, CA: New Harbinger,

2015. Depression is often considered a downward spiral in which the symptoms encourage behaviors that then worsen the symptoms. This book describes how our understanding of the brain and depression can be use to create an upward spiral to reduce—and ideally to eliminate—depression.

Kounios, J., and M. Beeman. *The Eureka Factor: Aha Moments, Creative Insight, and the Brain.* New York: Random House, 2015. Kounios and Beeman are highly acclaimed cognitive researchers who have made notable discoveries about the "eureka" factor—that is, how unexpected realizations happen in the human brain. The authors precisely describe the science and present ways to boost the reader's own creative thinking.

Lakoff, G., and M. Johnson. *Metaphors We Live By*. Chicago: University of Chicago Press, 2008. There is much evidence demonstrating that the way we think influences the way we talk and the way we talk influences the way we think. This book considers what many common phrases indicate about our underlying thought processes.

LeDoux, J. *The Emotional Brain: The Mysterious Underpinnings of Emotional Life.* New York: Simon & Schuster, 1998. A leading researcher on emotion and the brain provides a detailed summary of the large body of research on how (and to some extent why) the brain exhibits different emotional states.

Lindstrom, M. *Brandwashed: Tricks Companies Use to Manipulate Our Minds and Persuade Us to Buy*. New York: Crown Business, 2011. Marketers are professional persuaders who make use of many techniques to convince us to buy. Understanding how subtle cues influence our own decision making is fascinating and can help us improve our own reasoning processes.

Mlodinow, L. *Subliminal: How Your Unconscious Mind Rules Your Behavior*. New York: Vintage, 2013. This detailed book provides an entertaining and readable consideration of research about how unconscious processes influence human behaviors.

Pashler, H. E., and S. Sutherland. *The Psychology of Attention.* Vol. 15. Cambridge, MA: MIT Press, 1998. Pashler and his colleagues identified the bottleneck in the human brain that creates a problems for multitasking. This book explores the experimental and theoretical details of that work and its implications.

Pink, D. H. *Drive: The Surprising Truth about What Motivates Us*. New York: Penguin, 2011. Most people describe their goal in life as that of increasing happiness. In a compelling, relatable style, the author describes what really seems to motivate humans.

Sander, D., D. Grandjean, G. Pourtois, S. Schwartz, M. L. Seghier, K. R. Scherer, and P. Vuilleumier. "Emotion and Attention Interactions in Social Cognition: Brain Regions Involved in Processing Anger Prosody." *Neuroimage* 28, no. 4 (2005): 848–58. This study supports the conclusions outlined in this course: When you speak to someone in an angry tone of voice, particular brain circuits are activated; suppressing that tone of voice can reduce the anger inherent in any confrontation.

Satel, S., and S. O. Lilienfeld. *Brainwashed: The Seductive Appeal of Mindless Neuroscience.* New York: Basic Books, 2013. This course has often argued that understanding the patterns of brain activity associated with various types of mental and physical activity can lead to a better understanding of ourselves and better outcomes. This book questions those assumptions and will lead to a better understanding of the strengths and weaknesses of the cognitive neuroscience approach.

Schwartz, Barry. *The Paradox of Choice: Why More Is Less*. New York: Ecco, 2004. The notion that expanded choice and freedom of choice are always desirable is central to Western cultural identity. This book considers situations in which too much freedom of choice leads to negative outcomes; examines what these negative outcomes reveal about the nature of human decision making; and presents strategies to minimize the problems created by too much choice.

Skinner, B. F. *Beyond Freedom and Dignity*. New York: Bantam Books, 1972. This enormously influential work provides a fascinating firsthand account of the behaviorist approach to understanding and controlling the behaviors of humans and other animals. Much has been discovered since this book was published, but this work remains fundamental to many modern theories of behavioral science.

Soeter, M., and M. Kindt. "An Abrupt Transformation of Phobic Behavior after a Post-Retrieval Amnesic Agent." *Biological Psychiatry* 78, no. 12 (2015): 880–86. This paper provides a detailed summary of a potentially transformative study of memory re-consolidation and fear.

Spivey, M. *The Continuity of Mind*. Oxford: Oxford University Press, 2008. At the heart of embodied-cognition theory is the idea that the body and mind are integrated into a single dynamic system. This book maintains that we should change our conceptions of the brain and mind if we are to understand completely the nature of human thought and behavior.

Stickgold, R., and M. P. Walker, eds. *The Neuroscience of Sleep*. London: Academic Press, 2010. The authors provide a detailed, authoritative account of what the brain does during different types of sleep.

Tang, Y. Y., B. K. Hölzel, and M. I. Posner. "The Neuroscience of Mindfulness Meditation." *Nature Reviews Neuroscience* 16, no. 4 (2015): 213–25. This journal article provides a detailed and technical review of what happens in the brain during different types of meditative practice.

Thaler, R. H. *Misbehaving: The Making of Behavioral Economics.* New York: W. W. Norton, 2015. Behavioral economists describe the mythical creature "homo economicus" as one whose behavior conforms to the economic principles of maximizing benefits and minimizing costs. In fact, however, decisions about how to increase happiness are driven by a variety of principles characterized by behavioral economics.

Tracy, B. *Eat That Frog!: 21 Great Ways to Stop Procrastinating and Get More Done in Less Time*. San Francisco: Berrett-Koehler, 2007. This book takes its title from a famous quote attributed to Mark Twain. If you start each day by eating a live frog, you can go through the rest of the day comfortable in the notion that nothing else will be worse. This course argues that you should first tackle the hardest thing you have on your to-do list. This book suggests this as well and presents many other tips for overcoming procrastination.

Verstynen, T., and B. Voytek. *Do Zombies Dream of Undead Sheep?: A Neuroscientific View of the Zombie Brain.* Princeton, NJ: Princeton University Press, 2014. One of the best ways to consider human thought processes and human behavior is to ponder how other creatures might think and behave. This highly engaging book considers how our understanding of human cognitive neuroscience might explain why zombies behave as they do. While not scientifically testable, the book is both entertaining and educational.

Wansink, B. *Slim by Design: Mindless Eating Solutions for Everyday Life*. New York: Hay House, 2016. This outstanding book describes research on human eating behaviors and outlines how those results can be used to improve our physical health and well-being.

Wenk, G. L. *Your Brain on Food: How Chemicals Control Your Thoughts and Feelings*. Oxford: Oxford University Press, 2014. The lectures in this course consider how to regulate your eating. This book explores a related topic: how your eating regulates you.

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