APRIL 2024 *Seeking Science* VOL 33

SEEKING SCIENCE

by STEM Action Teen Institution

A MONTHLY
STEM NEWSLETTER

HAIR PERMS

DECISION MAKING

REWARD DESIGN

and more...

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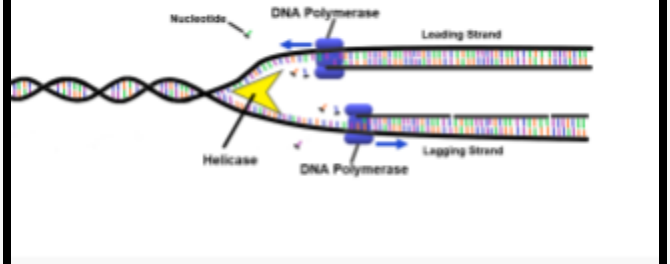
Meselson and Stahl's Experiments on DNA

Arthur Liang

Up until the middle of the 20th century, scientists and geneticists had no idea how DNA replicated itself. They knew that DNA was the molecule that passed down genetic information through cells and through to one's offspring, thanks to the experiments a few years earlier of Hershey-Chase. However, there were still 3 different theories on DNA replication, and no one knew which one was accurate. That was, until the work of Meselson and Stahl, who were able to determine the answer to this important question once and for all.

The 3 theories initially created for DNA replication were the dispersive, semi-conservative, and conservative models of DNA replication. The dispersive model stated that after DNA replication, the parent and daughter DNA helices were made up of fragments of both new and old DNA. The semi-conservative model stated that each parent and daughter helix had one strand of old and one strand of new DNA. Finally, the conservative model stated that the parent helix was all old DNA and the daughter helix was all new DNA.



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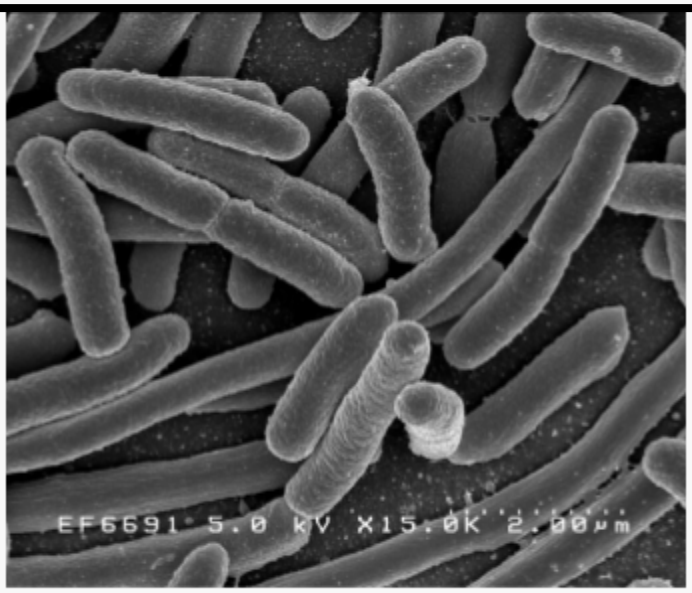
Meselson and Stahl experimented on E. coli bacteria, and they made use of 2 isotopes of nitrogen, N-14 and N-15. They used nitrogen since it is used to make up the nitrogen bases in DNA. First off, they grew E. coli bacteria in a solution of N-15, which led

to their DNA being made up of N-15 nitrogen. Then, they moved the E. coli to a N-14 environment and waited for the DNA to replicate. Afterward, they used a centrifuge to separate the E. coli and determine what was in the DNA. If the DNA had N-15, it would be heavier, and the bacteria would collect near the bottom of the centrifuge. N-14 would collect at the top, while a mix between the two would be in the middle. Meselson and Stahl discovered that after a few generations of replication, the DNA in the centrifuge agreed with the semi-conservative model of DNA replication, where there was one strand each of old and new DNA. Meselson and Stahl's experiments were monumental in their success in discovering the pattern of DNA replication, which would help advance genetic technology and understanding into the far future.



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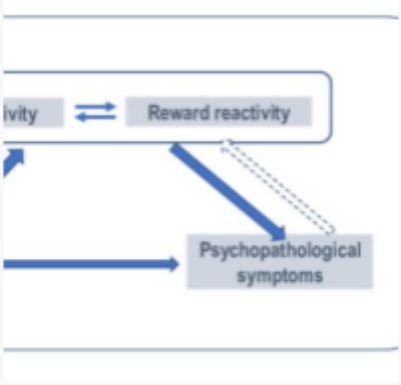
Unlocking Player Satisfaction: The Art of Reward Design in Games

Brian Wang

What hooks an audience to video games? Many may believe factors such as gameplay, the community, and rewards, all affect player retention. These are the very factors that make up the reward system in video game design. Video game designers focus on this aspect of creation to keep the loyalty of players. Often, we find ourselves becoming bored with a video game, sometimes after a few minutes, other times after many months or years. How are some games successful, while others are not?

Foremost, the reward system on which all video game designers base a game's foundation is intrinsic and extrinsic rewards. Intrinsic rewards come from within the player, such as gaining a sense of accomplishment from completing a task or enjoying gameplay within a vast land of traversal - common in adventure games. On the other hand, extrinsic rewards are those that give players satisfaction from factors that may not be directly linked to the gameplay, such as a daily login, rewards for playing a game for a certain amount of time, finding hidden chests around the map, finding an easter egg, etc. As clearly shown, both intrinsic and extrinsic rewards give players a sense of euphoria - something that makes them happy - that may not come from elsewhere. Video game designing's most important factor is player retention, which



The (Neuro)-Science Behind Resilience: A Focus on Stress and Reward by Chantal Martin-Soelch from ResearchGate
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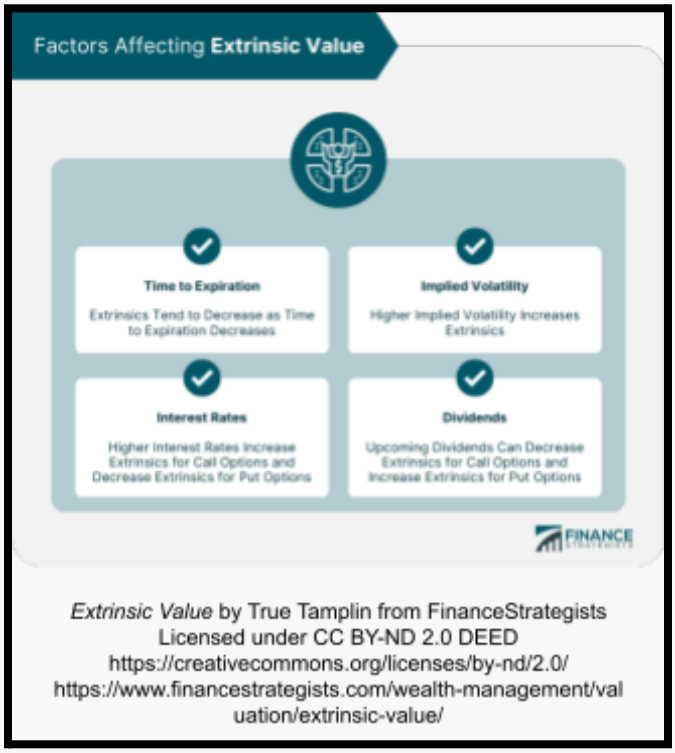
https://www.researchgate.net/figure/Simplified-Schematic-Model-of-the-Stress-Reward-Interaction-as-Mediator-of-the_fig1_369687130

is directly based on the reward system, and therefore places the balancing of both types of rewards on a high pedestal.

The general guideline for placing these rewards scattered throughout a game is not to hoard them within one section of the gameplay. Players must achieve something to gain these rewards, whether it be easy or hard, to give them a sense of input and output. However, video game designers also recommend placing rewards evenly spaced based on time. Players may gain a new item from playing for a short time, while a long-term quest may be awarded after long hours of gameplay - which should begin its hours very early on. In this way, players have long-term and short-term goals, both of which should be reachable, giving players satisfaction simply from playing for a long time. This is the art of a reward system, it is something that keeps a player engaged despite difficulties or inherent “boringness” within a video game.



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Therefore, it is best if, those who are aspiring to be video game designers, focus on the reward system as a major player retention factor. Evenly-spaced rewards provide player loyalty, player engagement, and player interest, all due to a streak of euphoria that crosses the mind - which is mainly based on psychology.

Chemical Curling: Exploring the Science of Hair Perms

Cody Duan

A hair perm is one of today's most intriguing and popular fashion trends. It utilizes special chemicals that interact with the hair, allowing it to retain a new, wavy form. A hair perm is a molecular-level system in which hair molecules are broken down, restructured, and locked back into place.

Perming relies on the structure of a hair. A protein, keratin, makes up about 95% of a strand of hair, and this protein makes perming possible. Keratin contains the amino acid cysteine, and when these combine, it creates disulfide bonds that hold the hair together. Although strong, the bonds are still weaker than the keratin, and a reducing agent can break these bonds apart.

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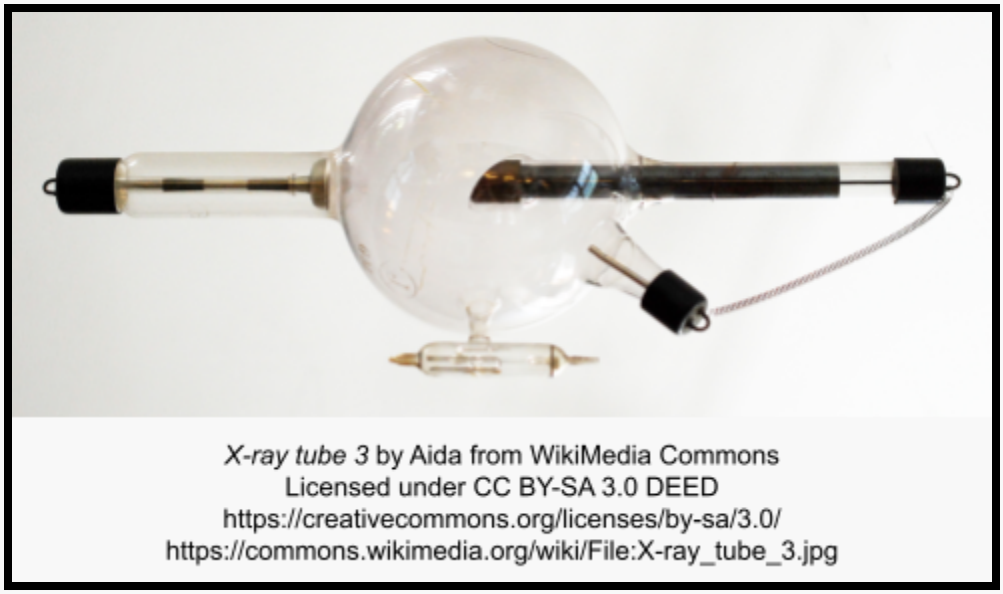
The chemical in a standard perm is ammonium thioglycolate. It acts as the reducing agent, breaking down the hair molecules. The hair is rolled into separate sections, and a neutralizer is added to reverse the reducing agent, effectively “locking in” the hair.

Although a perm may look good, it has some downsides. The use of chemicals can strip hair of its natural oils, leading to dry and frizzy hair, and improper use may give burns that cause hair loss. It can cause the follicle to swell, breaking it off and preventing hair from growing back.

Scanning the Body: Radio Tech

Edward Huang

How do medical experts examine the inside of your body? The answer is radiology. By performing different kinds of scans, doctors can observe and understand different parts of your body, such as your bones, brain, and blood flow. The underlying technology behind these scanning methods is based on the emission of photons that interact with various parts of your body, which are then captured by machines to produce an image of your internal organs. Let's look into a few examples to see how this happens.



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You are most likely familiar with the X-Ray. When doctors take a scan of your body with an X-ray, they are directing beams of X-ray energy through your body, which are absorbed by your various tissues and organs. This is done by heating a cathode (a negatively charged conductor), which releases electrons. These electrons then collide with the electrons of a "target material" such as tungsten. During these interactions, electrons will be knocked out of the tungsten atom's shell, and once another electron moves in to replace this vacant spot, energy is released in the form of X-ray photons. This energy is directed through your body towards an anode (a positively charged conductor),

and the rays are absorbed by a film. Different parts of your body absorb these X-rays before they reach the film, and the contrast between low-absorbing and high-absorbing materials in your body can be seen in the resulting image. For example, the calcium in your bones absorbs X-rays easily compared to the surrounding tissue, allowing for their contours to be seen in the final image.

While X-rays are effective in producing scans of your body, some situations may require more detail that X-rays cannot produce. In some cases, a CT scan (also known as a CAT scan) is preferred. CT Scans involve rotating the source of the X-ray in a circle around your body, allowing for more detailed scans from all directions. This can be used to produce both 2D and 3D images. Additionally, some CT scans are performed with *contrast*, which is a substance administered through your mouth or directly into your bloodstream. This contrast material is essentially a dye that can block X-rays, which can be used to make certain parts of your body – like your blood vessels – appear brighter in the resulting image.

A similar type of scan to the CT Scan is the PET Scan. Typically used to scan the brain or heart, the PET scan can be used to detect cancer or other health problems before they show up on CT Scans. In a PET Scan, small radioactive atoms are strategically attached to the chemicals used by the organ of interest, creating a *radiotracer*. For example, a PET Scan of the brain would attach radionuclides to glucose, which is then administered to the patient and allowed to accumulate in the brain. The radiotracer releases positrons as it undergoes radioactive decay, and these positrons release photons after colliding with electrons. The resulting photons are captured, producing an image of the blood flow of your brain, where abnormalities can then be detected and analyzed. For instance, tumors will use more glucose than the surrounding tissue, which will become visible in the PET Scan image. Additionally, radiotracers vary depending on what part of your body is being analyzed. For example, a radiotracer may involve oxygen instead of glucose to measure blood flow.

One more type of scan you may be familiar with is the MRI Scan. They operate by using a strong magnetic force to pull protons in your body out of their normal equilibrium position and rotation, essentially aligning them to the new magnetic field – similar to when a magnet rotates to point towards another magnet. After the magnetic force is disabled, the protons return to their original position, but the time it takes for this to happen and the amount of energy released varies around your body. Since different tissues in your body are made of different substances, each part of your body reacts differently to the magnetic force. After capturing the photons, an image of your tissues can be created. MRI Scans are not as harmful as the other scans since they don't involve the use of harmful radiation, and they are particularly good at differentiating between soft tissues.

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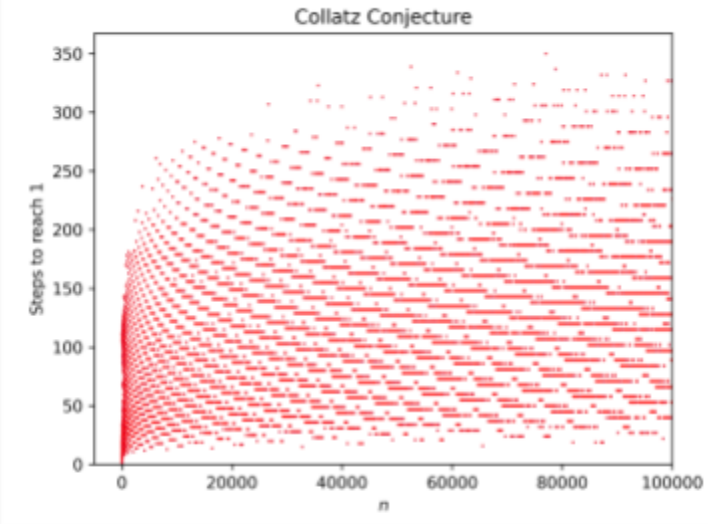
Our understanding of tiny particles in our bodies and the world around us has led to technology that allows us to see what happens in our bodies without having to cut ourselves open. The next time you find yourself in your hospital's Radiology department, remember all of the precise interactions of particles and radiation happening in your body that make it all possible!

Exploring the Collatz Conjecture

Eddie Zhang

The Collatz Conjecture, sometimes known as the 3n+1 issue, is one of mathematics' most puzzling and exciting unsolved problems. Lothar Collatz, a German mathematician, proposed it in 1937, and it depicts a simple sequence of numbers that discloses important number theory concerns. Despite its simple formulation, the intriguing Collatz Conjecture has captivated the imagination of both mathematicians and enthusiasts. It has not been conclusively proven.

Lothar Collatz posed a fairly simple mathematical issue in Hamburg in 1937. The problem, now known as the Collatz Conjecture, necessitates iterating a certain sequence of numbers using a straightforward technique. If n is even, divide it by two; if it is odd, multiply it by three and add one. The series eventually converges to the number 1 by using this strategy again. Collatz proposed that regardless of the starting value of n, this series will always approach 1.



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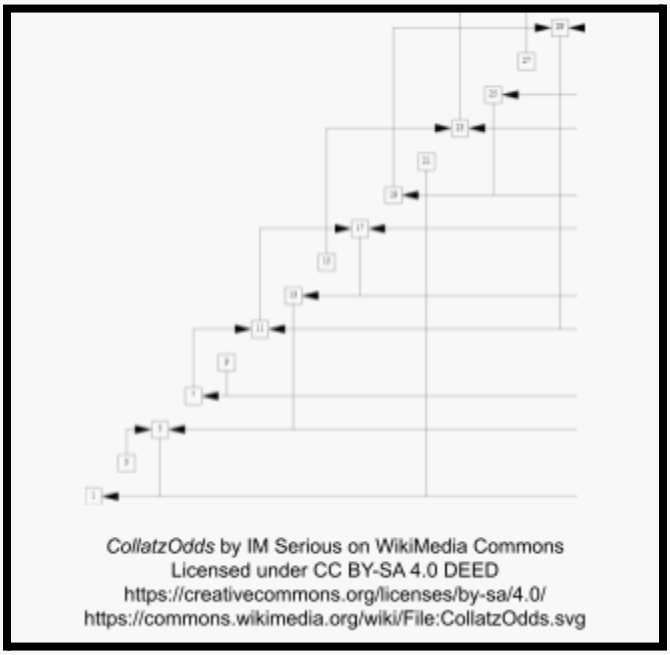
Numerous examples may be used to show the Collatz Conjecture. For example, beginning with n = 5, the sequence is as follows: 5, 16, 8, 4, 2, 1. Similarly, starting with n = 6 gives us: 6, 3, 10, 5, 16, 8, 4, 2, and 1.

Despite the simple rule governing the series, these numbers' behavior is incredibly complex and surprising.

Despite multiple attempts by mathematicians throughout the decades, a formal proof of the Collatz Conjecture still needs to be discovered. The intricacy stems from the sequence's unpredictable character, which shows chaotic behavior even with modest initial values of n. While computer simulations have confirmed the claim for many beginning values, a complete mathematical proof remains hard. The aim is to show that the sequence will always end up at 1 without encountering endless loops or diverging to infinity.



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Overall, the Collatz Conjecture embodies mathematics' long-standing enigma. Mathematicians are still perplexed by the elusiveness of this subject, despite its apparent simplicity. While extensive computer simulations and mathematical research have made significant progress, full proof remains difficult. But comprehending the Collatz hypothesis demonstrates the fundamentals of mathematical research and motivates us to solve the universe's riddles one hypothesis at a time.

AI in Healthcare

Yidian Wang

Modern artificial intelligence is revolutionizing the world of healthcare. Advanced AI technology detects various diseases and diagnoses patients with exceptional accuracy and precision. These phenomenal AI algorithms improve and help save the lives of millions of patients worldwide, and will continue to span and improve into the future.

AI in healthcare is primarily used to analyze the connections between clinical data and patient outcomes. These programs are applied to methods of diagnostics, treatment protocol development, drug development, personalized medicine, and patient monitoring and care (Wikipedia, Artificial Intelligence in Healthcare). Unlike traditional technologies in healthcare, AI can process and gather larger and more diverse data, and produce a near-perfect, well-defined output. An example of a practice of AI is the use of this tool to detect cancer cells. The technology scans images and identifies unusual patterns that might be missed by the human eye. AI can also analyze data from a patient's health record and various other data to recommend treatment plans. This algorithm is remarkably effective in complex diseases, where the AI can identify the most effective medications for individuals depending on their medical history and health data.

Other than examining data and prescribing diagnostics and treatments, AI is beneficial in other aspects of healthcare. Some examples include robot-assisted surgery, virtual health assistants, administrative tasks, and many more. Robot-assisted surgery algorithms allow robots to perform intricate procedures with precision and control

beyond a human's capability. These robots are also able to analyze past medical records ultimately minimizing the risks. Virtual health assistants provide constant support and monitoring for the patient, whilst also being able to offer medication and answer general health questions. Administrative AI schedules appointments, processes and stores patient data, and manages billing and other technical works. This reduces the workload of the medical staff allowing them to focus more on patient care.

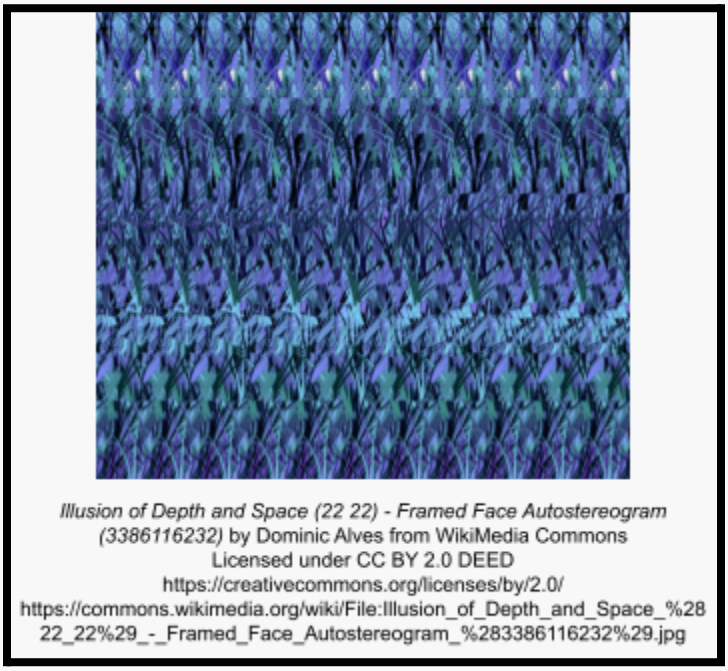
The Optimization of Early Disease Diagnosis: Blood and AI Could Be The Secret

Although these processes are extremely effective and useful to humans, we have to keep in mind that machine learning is relatively new, and research is still ongoing about its application in fields of medicine and treatments. There are several differences between AI and human traditions in health. Great consideration of the risks of this relatively new practice should be taken into account. Furthermore, AI can only understand what it is programmed to do and sometimes self-teach from the internet. This means AI is only capable of what humans programmed it to be. Even with the risks of this practice, artificial intelligence can–and will become extremely beneficial to the future world of technology and healthcare. AI is proficient in its skills and will continue to improve as discoveries and breakthroughs are brought to life.

A Fun Illusion: The Autostereogram

Richard Wang

Autostereograms are a fun and interesting optical illusion. It involves using one two-dimensional image which when looked at correctly, should produce a three-dimensional scene. Until the image is viewed properly, what shows up is an unrecognizable image. The viewer needs to use both eyes to look at the image because it is crucial to creating the optical illusion. The optical illusion is from depth perception and stereopsis, which is depth perception that comes from the different perspectives of each eye on a three-dimensional scene. Understanding Autostereograms should start from the historical development of them, the underlying principles, and the cognitive process that is needed to see them.



Illusion of Depth and Space (22 22) - Framed Face Autostereogram (3386116232) by Dominic Alves from WikiMedia Commons
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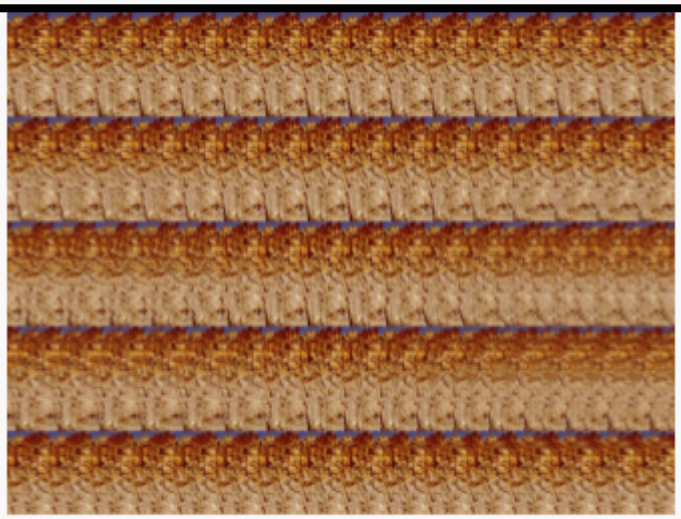
In 1838, Charles Wheatstone published his findings on stereopsis, asserting that depth perception arises from variances in the horizontal positioning of images between the two eyes. There are many different types of stereograms. In 1844, David Brewster discovered the wallpaper effect which enabled him to behold the wallpaper-style autostereogram. In 1939, Boris Kompaneysky published the first random-dot stereogram. Near the late '90s, autostereograms were found in several children's magazines. From that time on, several books were published such as The Magic Eye Beyond 3D: Improve

Your Vision book. With this publication, autostereograms became much more popular and were mainstream.

Seeing the 3D image may take little effort for some but for others, it may take some time as they need to train their eyes to decouple eye convergence from lens focusing. What this means is that people need to train themselves to separate the process of directing the eyes to a specific point from the adjustment of the person's lens to focus. In other cases, people may have visual impairments that prevent them from seeing the illusion. Even visual impairments in one eye render the ability to see the autostereograms useless. Those with a dominant eye and a lazy eye have amblyopia which also makes it impossible for them to see stereograms. Those who have two healthy eyes with no neurological impairments can make the process easier by having intense lighting. This constricts the pupil so that the eyes depend less on focusing. It is important to defocus the eyes to see the image.



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Voice Assistants

Aidan Hong

Phones have evolved in various ways over the last few years. One key way phones have changed is through the introduction of voice assistant. Voice assistants offer convenience to users, allowing them to access information without having to open an app. However, the technology behind them is often complicated.

Voice assistants often require a keyword to be activated. This could come in the form of “Hey Siri” or “Hey Google.” This prevents the phone from listening to unwanted conversations, as most people do not say the keyword unless they need to use the voice assistant. Once the keyword is said, the phone then listens to the user, parsing the request and finding keywords that can identify the user’s need. Then, the voice assistant develops a response to the question. This response can consist of various actions, for example, sending a text, opening a webpage, and many more. Neural networks and artificial intelligence are often needed for these interactions, hence the reason why they require the internet.

Siri by Bernard Goldbach from Flickr
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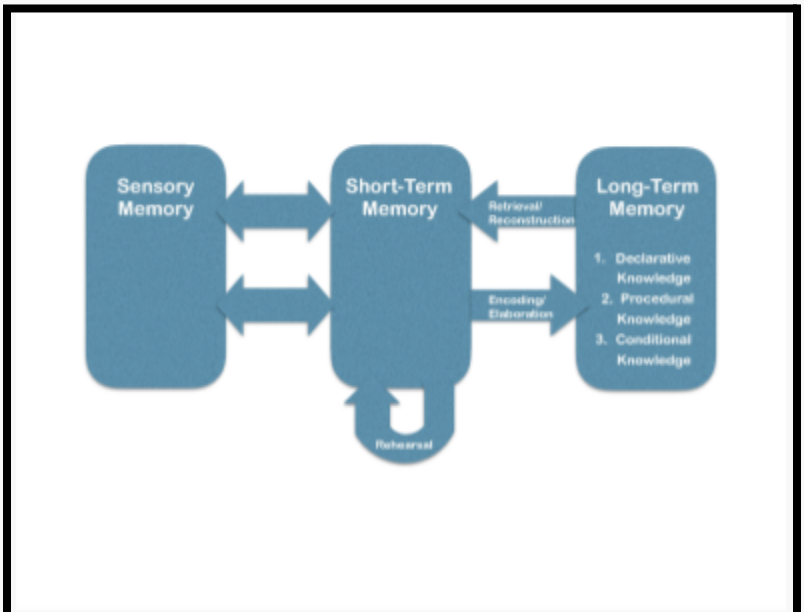
Voice assistants are a key feature that smartphones possess. There are many different voice assistants, for example, Siri, Google Assistant, Bixby, Alexa, and Cortana. However, each voice assistant employs the same steps to assist the user’s task. This includes receiving the query, parsing through it, and returning an answer. Voice assistants will continue to get better, as they become faster and more intelligent, answering each question efficiently and effectively.

Editing Human Memory

Kenny Wu

New methods to control and modify human memory have been made possible by recent developments in neuroscience and technology. Along with evaluating proper memory of correct serial location, one key topic of research is the use of editing distance to increase memory space performance (Gonthier, 2022). This approach allows for more comprehensive information on memory performance and offers insight into the underlying processes by taking into account the similarity between loaded objects and their real placement.



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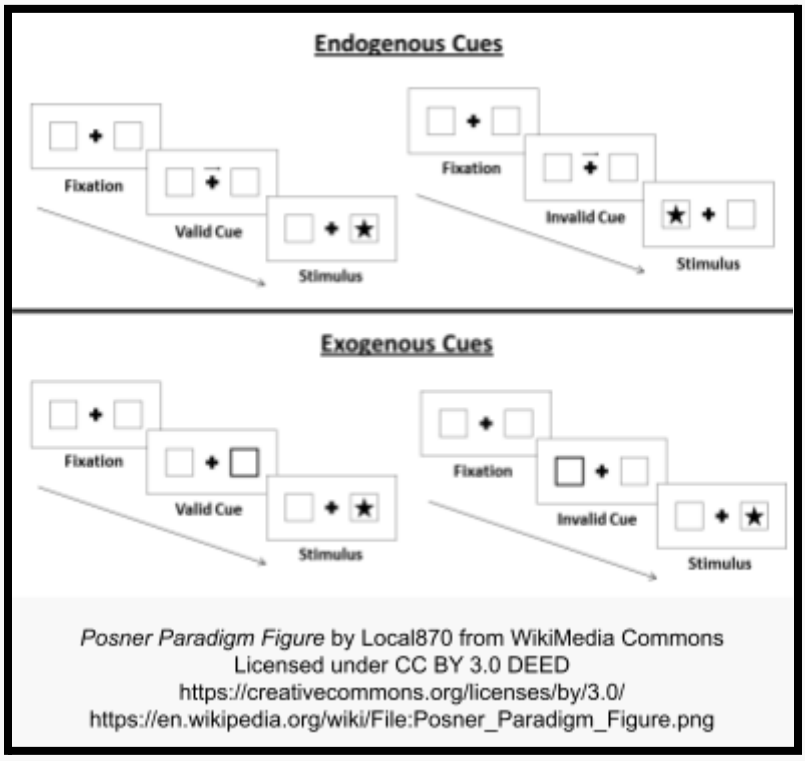
Furthermore, the impact of short-term memory updating was reexamined by empirical and computational research that clarified the functioning of the human memory system (Gonthier, 2022). Researchers have learned a great deal about memory systems and control processes, which advocate new memory processing methods.

In addition, dual-task paradigms have proven to be an effective method for studying central methods. control in human memory (Della Sala et al., 1995). By combining such approaches with cutting-edge technologies such as brain-computer interfaces or neurostimulation devices, scientists are now able not only to understand but also precisely change human memories.



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All in all, human memory altering presents significant ethical issues related to personal experiences and views of an individual. The authenticity and integrity of memories are threatened by the capacity to control memory through cutting-edge technology like brain-computer interfaces. People may lose significant facets of their identity and the emotional ties that mold their lives when they alter or erase memories. The idea of editing human memory is still considered immoral to most and likely wouldn't be accepted for another century, however, its potential remains neglectable and gives humanity an excitement awaits in the distant future.

Exploring the Psychology Behind Decision-Making and Rationality

Brandon Wang

The psychology of decision-making and rationality delves into the intricate processing of the fundamental basics of human choices and the magnitude to which these decisions align with logical reasoning. Decision-making involves assessing the situation and selecting the best course of action based on the available information, personal preferences, and situational context. However, many cognitive biases and different perspectives can influence this process, causing individuals to make irrational or flawed choices.

One basal aspect of decision-making psychology is acknowledging biases. For example, confirmation bias is when an individual is inclined to find information that confirms their speculations while ignoring the antithetical evidence. Similarly, anchoring bias occurs when individuals depend too heavily on initial information, even when it is irrelevant to the imminent decision. These biases emphasize the human propensity to take mental shortcuts, even if it costs rationality.

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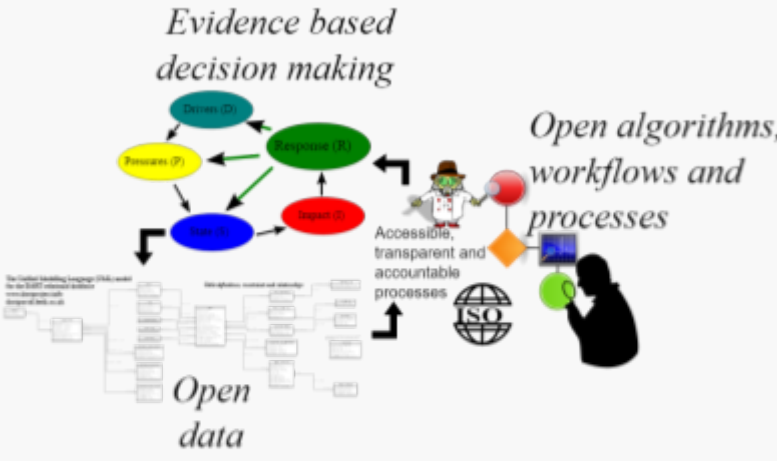
Emotions also play an impactful role in decision-making because they influence the discernment of risk and reward. Moreover, studies display that

emotional responses outweigh logical reasoning, causing individuals to make decisions based on short-term fulfillment rather than long-term benefits. This can be shown in different contexts such as impulsive buying and perilous behaviors driven by adrenaline.

All things considered, comprehending the psychology of decision-making and rationality is crucial for individuals who pursue improvement in their decision-making processes, but can also assist legislators, businessmen, and professionals in various fields. By revealing the implicit procedures of human choice, it can develop strategies to foster rational decision-making and reduce the impact of cognitive biases in various contexts.



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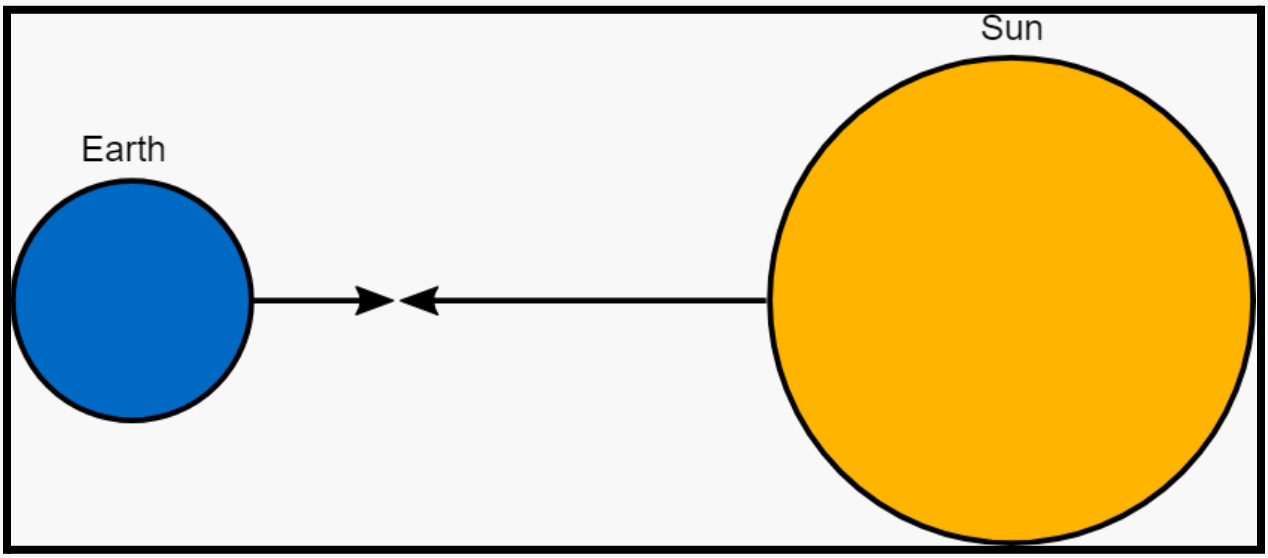
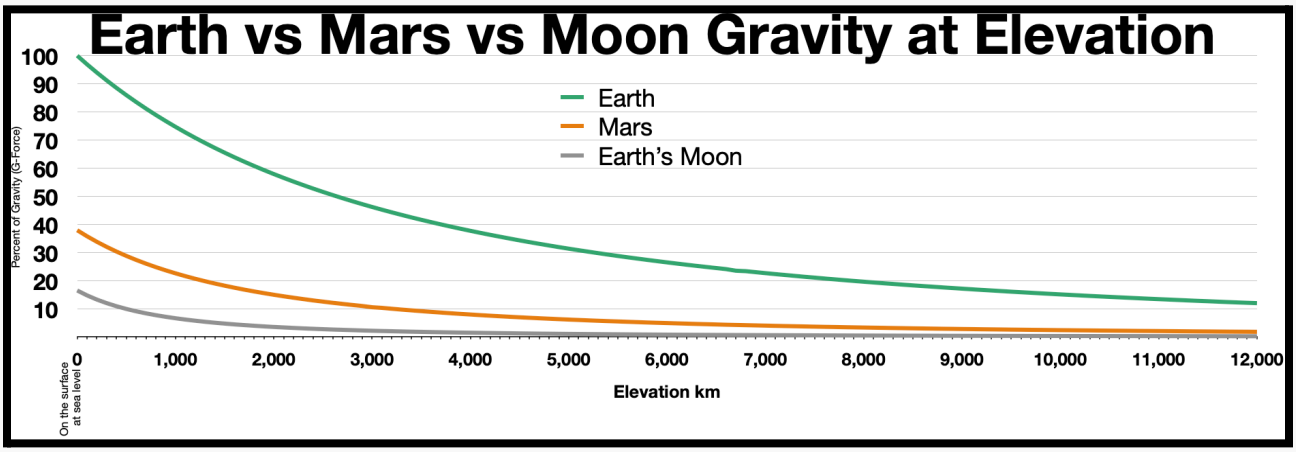
Gravity: The Force That Keeps Us On The Ground

Brandon Pian

If you haven't noticed when you jump you fall back down towards the ground. Not up or start floating. You fall back towards the ground. Gravity is the force that keeps us on Earth, moons orbiting planets, planets in the solar system, solar systems in galaxies, and more.



The power of gravity is determined by the mass and the distance. Anything with mass has gravity, from the tallest buildings to the smallest insects. The reason why you don't see people start to float toward skyscrapers is because the mass is so little it does nothing, but something like the Earth with a mass of kilograms making its gravity strong enough to keep us on the planet. Your weight differs from planet to planet because weight is determined by the gravity of the planet so if you weigh 100 pounds on Earth you would weigh 38 pounds because Mars has a weaker gravitational pull.



The ocean has tides that come and recede. Those tides are caused by gravity. The moon's gravity on Earth causes the tides. Gravity also created the stars and planets. Stars are created when nebulas collapse under their weight because of gravity. Then a rotating sphere of gas and dust was formed, and under intense heat and pressure, it exploded creating our sun. Gravity not only pulls on mass but also on light, an example of this is a black hole. Black holes are small for the amount of the mass they have is enough to keep light from escaping.

Gravity has a major effect on Earth. It is the reason we are here and it keeps our planet in orbit with our sun just enough for life to flourish. The gravity created by the moon gives us the tides and gravity-bending light. Our life wouldn't be like this without gravity

Ways of Storing Energy

Ben Liang

Energy is a big part of our lives. It is important in so many devices and electronics that it has a big demand. Using so much electricity makes it hard for companies to keep up with the demand when demand is high. Having a way to store energy is needed and what are the ways of storing energy?

First, There are many reasons for storing energy. Many places like England have a lot of wind but very little sun. Having very little sun also means that they can't use solar energy and can only rely on wind energy. Places with high population density places like London need a lot of energy, but people are usually up during the day and use a lot of energy. Most energy from wind energy is during nighttime. When there is a gap between when energy is produced and when it is used, batteries are needed to even out the gap.

Second, there are many ways of storing energy. There are some of the obvious ones such as lithium-ion batteries, uranium, elastic deformation, and gasoline but there are some of the exotic ones such as running water down a lake, compressed air, and falling weight. Running water down a lake works like hydro power but water is pumped to a higher lake from a lower lake. Then, a generator is put in the middle of the path and is converted back into energy when demand is high. Compressed air works by pumping air into a container and is released to spin a generator when needed. Falling weight works by raising an object in the air and when energy is needed, the object will fall and convert it into energy.

A History of Sharks

Arick Hong

Sharks have a long and complex history. Some sharks like the frilled shark have been around for hundreds of millions of years, while other sharks have just started to show up. However, how did sharks get to where they are today? How many species have died off to create new ones? Why did we lose the megalodon?

Some scientists believe that early sharks were toothless, as fossils show cartilaginous skin, but no teeth. Scientists are still debating whether these were sharks or shark-like animals. Nevertheless, Cladoselache, one of the first recognizable sharks, emerged around 380 million years ago, longer before many of the dinosaurs appeared. It ended up going extinct, but it ultimately laid the framework for many of the sharks today.

Post Cladoselache, sharks began to become more complex. Stethacanthus and Helicoprion were some of the weird and wacky sharks that existed back then. Sthethacanthus had a table with spikes on its head, while Helicoprion had a whorl of teeth on the bottom of its mouth. Hybodus also had spikes at the front of its fins. These sharks died out over 250 million years ago, long before the dinosaurs.

Diorama of Mississippian fossil fish - Stethacanthus by James St. John from Flickr
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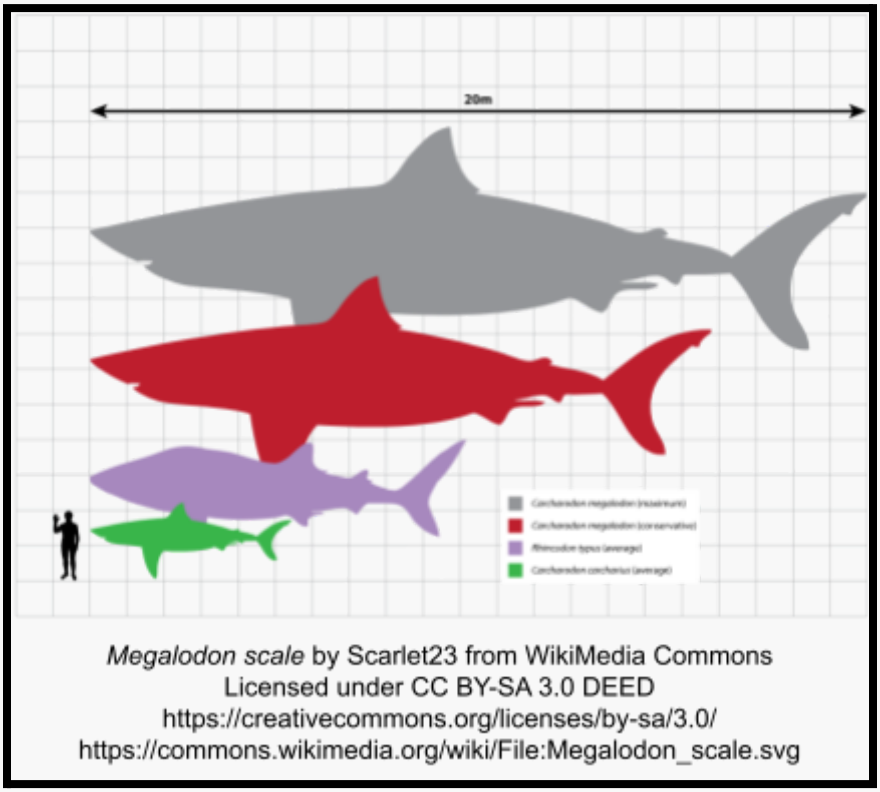
Modern sharks began appearing around 3-6 million years ago, but some sharks have been around longer. The Frilled Shark first appeared a shocking 150 million years ago, and the Goblin shark at 125 million years ago. These sharks live in deep water and are found very rarely. Marine life evolved with the sharks too, and the first whales appeared around 50 million years ago. The large Megalodon preyed on these whales for food.

Tiger Sharks appeared a good 5 million years ago, while Great Whites appeared 25 million years ago, which is earlier than the Megalodon.

Multiple theories exist for why the Megalodon went extinct. A very popular one emerged on Shark Week in 2022. Teeth comparisons with the Megalodon and Great White showed that they hunted similar prey. After a large mass extinction of whales, Megalodon had to turn to the seals that Great Whites often hunted. However, since the Great White was better at hunting their usual seal prey, the Megalodon lost the battle and starved into extinction.



Megalodon scale by Scarlet23 from WikiMedia Commons
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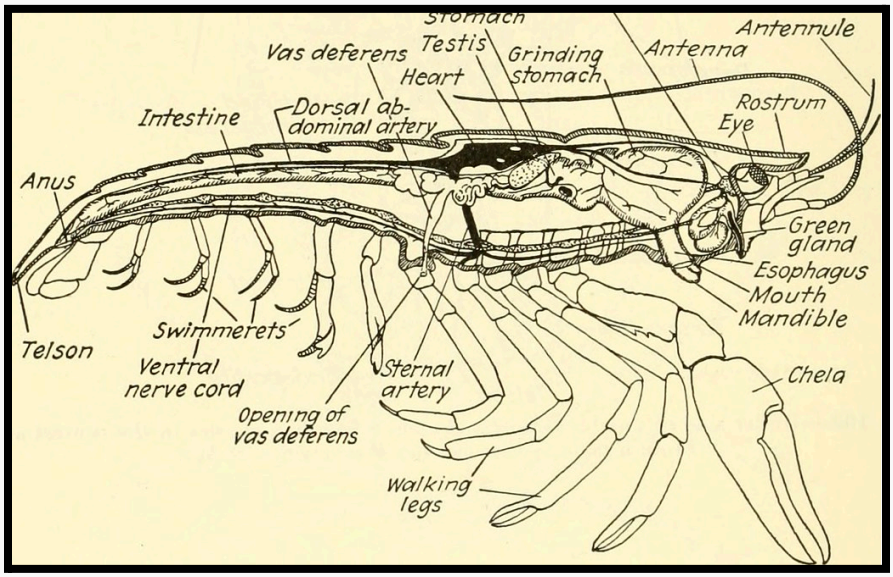
After the Megalodon died off, we began to see all the modern sharks we do today. Some of them resemble the ones that have died off in the past, while others are the start of a new generation of sharks. Next time you see a shark, try to wonder where it might have come from.

The Anatomy of Shrimps

Denise Lee

Shrimps are known for being small, delicious sea creatures, but did you know that shrimps have interesting body structures that make them different from other animals? Their heart is located near their head, and their stomach is right below their eye. A surprising fact about shrimps is that they don't have brains.

They have a central nerve cord, which is similar to a brain. It helps them move and react to their surroundings. Besides their body parts, shrimps have special features that help them sense things around them. They have long antennae that can detect chemicals in the water, feel movement, and find food. Shrimps also have a tough outer covering called an exoskeleton made of a material called chitin. This shell protects them and gives them support.



Shrimps use molting, which is when they need to shed their old exoskeleton to grow bigger or replace damaged parts. When it comes to getting around, shrimps are quite agile. They have strong muscles in their tail, which they use to swim backward quickly. This skill helps them escape predators and catch their pin in the ocean. Shrimps

are important for keeping the ocean ecosystem healthy. They eat algae and other tiny organisms, helping to keep the ocean clean.

In conclusion, shrimps have fascinating bodies that help them survive in the ocean. Their unique features, like their heart placement and sensory abilities, make them special creatures worth learning about and celebrating. In learning about the anatomy and importance of shrimps, we gain a deeper appreciation for the wonders of marine life and the delicate balance of our oceans.

Heterocarpus Hayashii Minoebi 2 by Totti on WikiMedia Commons
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Pi (Math)

Emily Ma

Pi, also known as π, is a mathematical constant that has fascinated mathematicians for centuries. It is defined as the ratio of the circumference of a circle to its diameter, and it is approximately equal to 3.14159. Pi is an irrational number, which means that it cannot be expressed as a finite decimal or fraction. It is a never-ending and never-repeating decimal, making it a unique and intriguing mathematical concept.

The number Pi has numerous applications in mathematics, physics, and engineering. It is used to calculate the area and volume of circles, spheres, and cylinders and to solve complex mathematical equations. Pi is also a fundamental constant in trigonometry, helping us understand the relationships between angles and sides in triangles. In addition, Pi is used in many modern technologies, such as satellite navigation systems, computer graphics, and cryptography.

Pi plate by Piledhigheranddeeper at English Wikipedia from WikiMedia Commons
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The history of Pi can be traced back to ancient civilizations, such as the Egyptians, Babylonians, and Greeks. The earliest known calculation of Pi dates back to around 1900 BC in ancient Egypt. However, it was in the 17th century that Pi was accurately calculated to many decimal places. Today, with the help of modern computers, Pi has been calculated to billions of decimal places, and mathematicians continue to search for patterns and discoveries within its digits.

Frill-Necked Lizards

Mary Liang

Living primarily in the northern regions of Australia, frill-necked lizards are known for their frilled necks, hence their name. They are a lizard species in the family Agamidae and the only member of the genus Chlamydosarous. Native to northern Australia and southern New Guinea, these Australian dragons can run up to 30 mph and spend most of their time in trees in dry seasons. In the cycle of reproduction, frill-necked lizards bury up to 23 eggs. Like many other reptiles, the eggs are left alone by the female lizard to hatch 12 weeks later to protect themselves.

The frill on the lizard is a flap of skin that extends from the head and neck and takes the appearance of a disk that reaches four times the length of its torso in diameter whenever they feel threatened. They may stand up on their hind legs, make whistling noises, strike the ground with their tails, and even charge at their enemy to intimidate them. But those aren't the only uses for them, they can be used to regulate the lizard's body temperature.

Frill-necked Lizard (Chlamydosaurus kingii) by Matt from WikiMedia Commons
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The lizard's frills, although noticeable when extended, it is not the only important attribute to the lizard's survival. They have sharp teeth which could cause painful bites and scratches, and the ability to camouflage well to their surroundings. Frill-necked lizards live up to 15 years in the wild, but some individuals have reached up to 20 years.

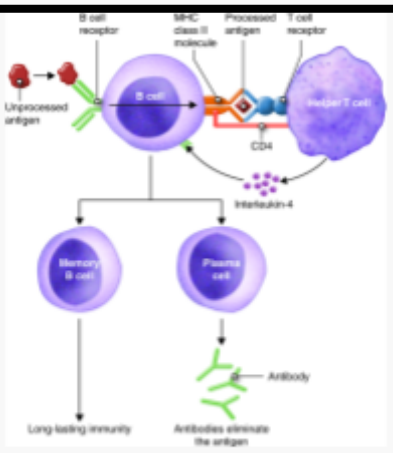
Understanding the Human Immune System

Natalie Dai

A complex web of cells, tissues, and organs forms the human immune system; its goal is to protect our bodies from harm. It does so by spotting and doing away with dangers like germs, bugs, and odd cells—such as those in cancer. Keeping us healthy is this key system's role.

At its heart lie white blood cells, or leukocytes, made in the bone marrow; these split into two groups: phagocytes and lymphocytes. The job of phagocytes is to eat up and break down germs; meanwhile, lymphocytes aim to spot and remember these threats for a quicker, more on-point reaction later.

Included in the immune setup are parts named after lymphoid function, for example, the thymus, spleen, and nodes that swell. They're spots where immune fighters hang out and meet; these places catch germs so they can be attacked and taken out by immune troops.



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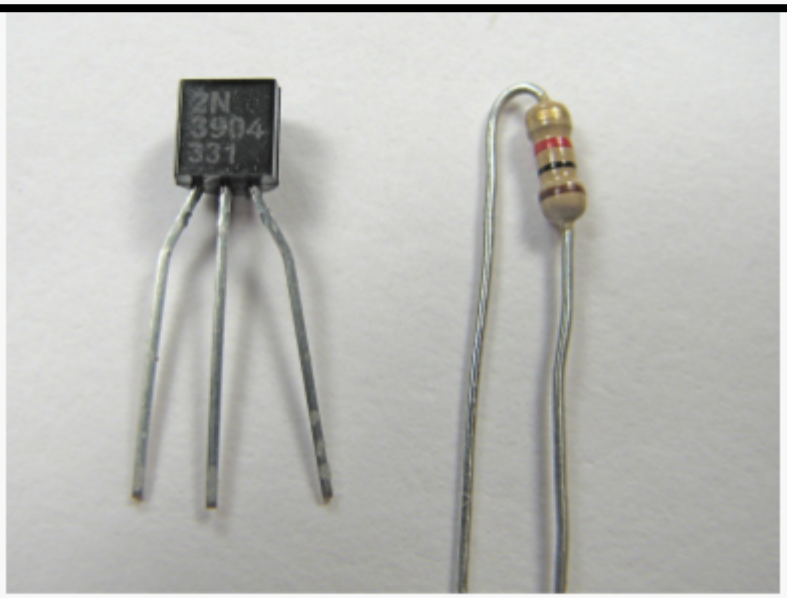
Among the stand-out traits of the immune function is its knack for knowing what belongs to us versus what doesn't, letting it target outside threats while leaving our cells alone. Yet, sometimes this skill misfires, leading to sickness where the body fights itself.

Demystifying Electronics

Riley Lee

At the heart of all electronics lies the fundamental concept of electricity. Electricity is the flow of electric charges which is usually carried by electrons through conductive materials such as metals. These conductive materials can be considered as circuits, but inside an electronic, there are around 6 different components. The power source, the conductor, the resistors, the capacitors, the inductors, and the transistors. The power source is the component that provides the energy that is needed to drive the circuit which can be batteries. Conductors are materials such as copper that allow or let electricity flow freely. Resistors are the components that stop the flow of electric current and they control the voltage. Capacitors are devices that can store and release electrical energy, but an inductor is a two-terminal component that stores energy in a magnetic field when the electric current flows through it. A transistor is a device that amplifies or switches electronic signals.



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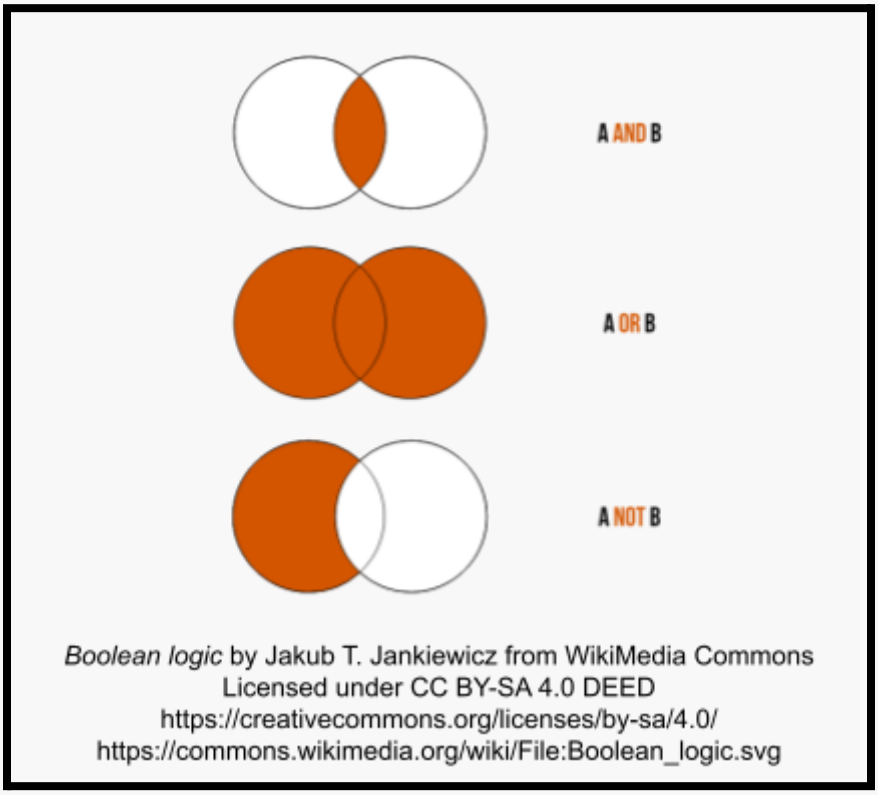
Electronics operate based on the manipulation of electric currents and voltages. Just by controlling the flow of electrons through multiple components, the electrical

device can do a lot of functions such as processing information, generating signals, and controlling other electronics. In electronics, information is shown in binary form, using the combinations of ones and zeros to create data. Electronic circuits called logic gates process the binary form by using operations called Boolean operations. Some Boolean operations are known as AND, OR, and NOT. All of the Boolean operations form the regular basis of digital computation.



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Understanding how electronics work helps us use their functions to their full potential. If anyone was designing new technologies, troubleshooting issues, or just simply appreciating the wonders of modern innovation, they have touched or felt how electronic functions and principles open doors to endless possibilities. All in all, as technology continues to evolve, our fascination will also evolve as electronic devices help shape our world.

Why Does Perpetual Motion Not Work?

Wilson Zhu

Perpetual motion machines have filled the imaginations of many inventors and engineers for many centuries. The idea of perpetual motion is that once a device is set in motion, it will continue forever without additional energy required to maintain it. The appeal of perpetual motion is wanted by many as it promises the ability to have free and limitless energy. However, perpetual motion machines cannot work as envisioned due to several fundamental reasons that prevent it from occurring.

Perpetual motion wheels by Citron
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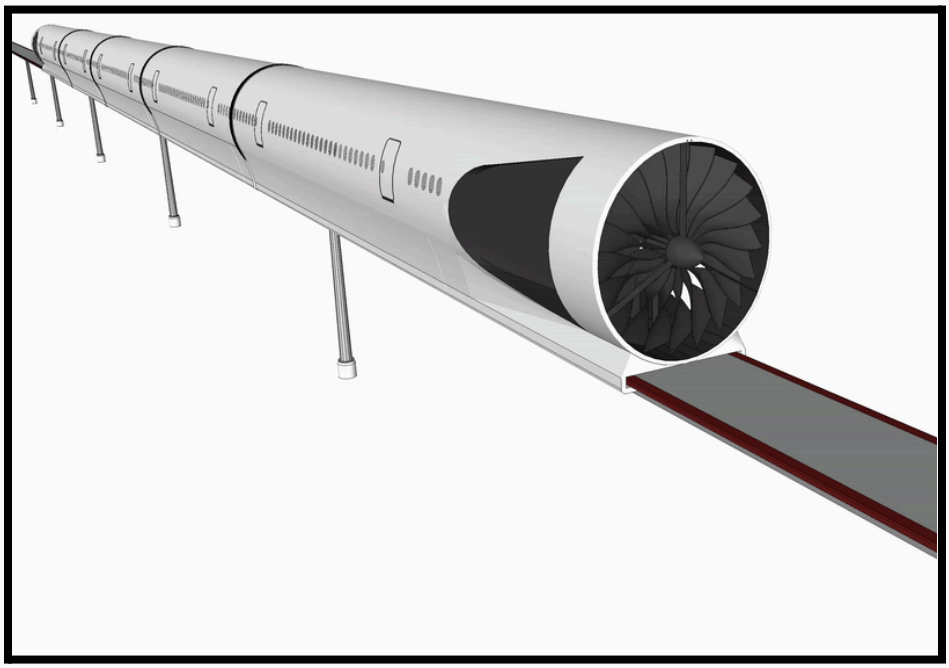
For instance, perpetual motion violates the fundamental laws of thermodynamics, the study of the relations between heat, work, temperature, and energy. The first law states that energy cannot be created or destroyed, only transformed from one form to another. The second law dictates that in any energy conversion process, some energy is lost as heat. Any perpetual motion machine would have to circumvent these laws, which

is impossible according to our current understanding of physics. Many proposed perpetual motion machines involve perpetual motion without an external energy source, which contradicts the basic principle that all energy ultimately comes from somewhere. Perpetual motion machines have to overcome friction and other sources of resistance indefinitely. However, in physical systems resistance is present e.g. friction, air resistance, or electrical resistance. Resistances can be decreased and would require additional energy which inhibits the production of perpetual motion machines. Superconductive metals have the removal of electrical resistance at very low temperatures; the energy to maintain the temperature exceeds that of the metals.



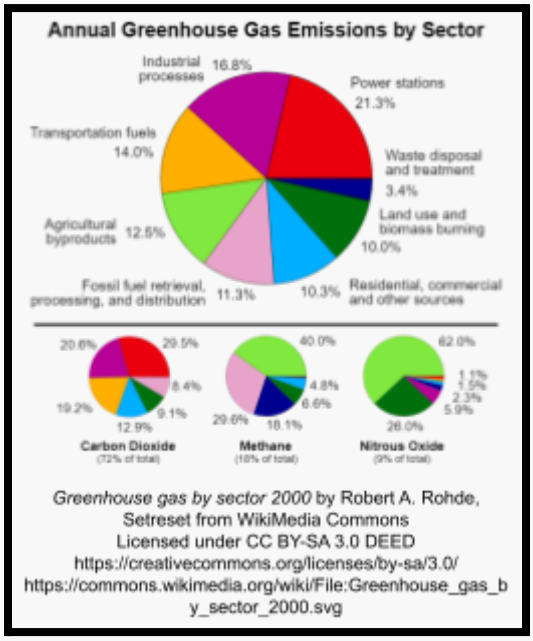
Thus, perpetual motion machines continue to be envisioned by inventors but are scientifically impossible. The laws of thermodynamics prevent the existence of perpetual motion and no ingenuity can circumvent these obstacles. It would be better to focus on other parts of scientific innovations rather than figuring out ways to create perpetual motion machines.

How Pollution Affects Pollination

Yifan Yang

It's been a longstanding fact that the work provided by pollinators gives society the abundance of natural produce it needs. Recently, it has come under notice that pollination is also being threatened by human contamination. Air pollution has been seen to lessen the scents of nighttime blooming flowers, putting pollination at risk.

Factories continuously pump out greenhouse gasses and chemicals like ozone, nitrogen oxide, and more into the atmosphere. During the day, ozone is susceptible to sunlight and is broken down, but at night, it accumulates, reacting with nitrogen oxide to create nitrate radicals. These molecules are strong oxidants that react with a wide range of many organic compounds, but most importantly with the fragrance of flowers. In a test, fragrances were released by researchers in a wind tunnel containing hawk moths, all of which were capable of tracking and flying toward the odor. Later, adding the pollutant mix of nitrogen dioxide and ozone to the scene caused the moths to search cluelessly for scents. The antennae of pollinators rely on the aromatic molecules to guide themselves to flowers, using two specific compounds called monoterpenes. These molecules are also subject to reacting with nitrate radicals, breaking into pieces and taking away the aroma of scented flowers.



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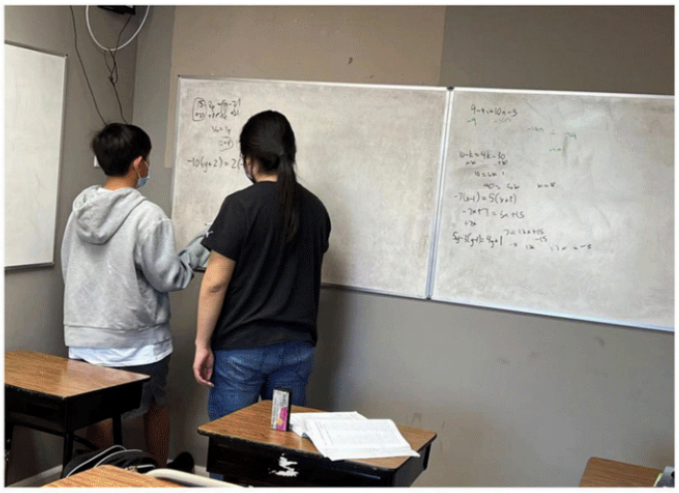
This is a major threat to agricultural production, as many plants rely on pollinators like bees and moths to spread their pollen and produce more seeds.



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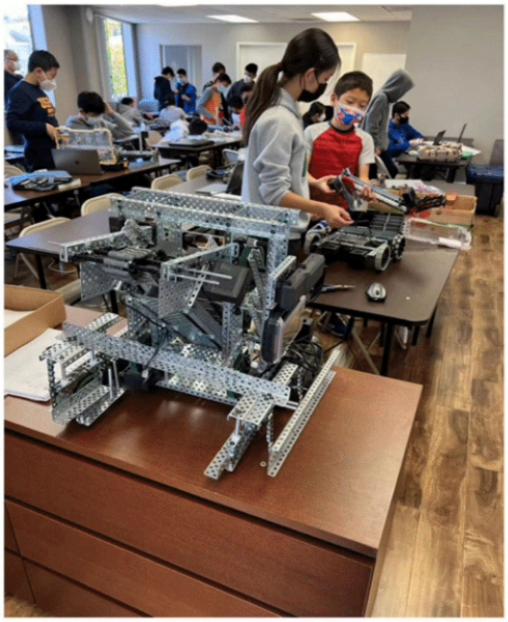

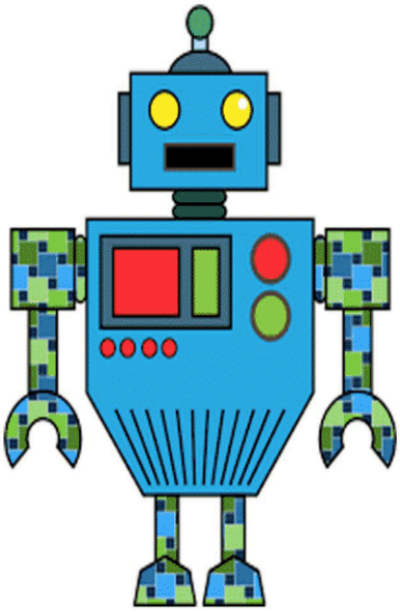

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