Learning about how people learn

Page 1: Why is it important to understand how learning works?

Your brain and body: how they both work for you

We are developing a new program for students—and we would like to invite you to help improve it.

The goal of this program is to provide you with scientific knowledge about how human learning works, along with some strategies to tackle new or especially demanding classes and assignments.

For example, did you know that:

- The college years are a time when experiences of difficulty, struggle, and frustration are actually important ways for your brain to learn and grow stronger.
- When you are learning new, hard things in college, it is common to feel confused, frustrated, anxious, and/or stressed — and this is actually a good thing.
- These feelings signal that you are both doing difficult things and learning how to do difficult things. The physical discomfort that comes with those experiences is actually just a sign that your body is preparing to support your learning.
- It is important to gain a deeper understanding of how the brain changes when you learn and how the body mobilizes resources to support your learning. This understanding can better prepare you to use your experiences of frustration and difficulty – and come to see them as a part–and even a valuable part – of learning the most challenging concepts and skills.

If we can learn from your experiences, we can teach these powerful ideas to more students more effectively in the future.

Why did we create this program?

This program was developed by scientists at Stanford University and the University of Texas at Austin, building on the work of many other researchers. We developed this program because many students say they're excited about learning new things in college, but they're also stressed because there are a lot of difficulties. Students are taking much more challenging classes, entering so many new environments, and meeting many people for the first time. They are probably also thinking about what they want to do in life and who they want to be.

The goal of this program is to empower students to harness the stress of being in college to grow and develop powerful new skills, rather than letting stress overwhelm them. Doing so provides a strong foundation to learn from challenges, accomplish the things they want in life, and over time contribute to the world around them.

But the program needs more real-life examples from Stanford students. After all, we're not the experts on what it's like to be in college. You are. That's why the program needs your input.

In the activity below, we invite you to share an experience from your own life, which we hope to learn from to improve this program next year.

Think of a time when you were working on something extremely important and felt stressed and confused because it was not always clear exactly what you were supposed to do.

It might have felt like you were "stuck" or "on your own," and perhaps maybe even the only one

around you who was feeling this way.

Try to choose a time you care about because we will come back to this example later. This might have been when you had to complete a particularly challenging writing assignment, problem set, or course project.

Please explain what thoughts you were having or what your body was doing that made you realize you were stressed and confused (write 3 to 5 sentences):

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student responds in text box here
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Let's get started

Thank you for your input!

Next, we will share information with you about how the brain learns in the face of challenges and how this relates to your time in school.

Page 2: What have scientists discovered about how learning works?

Where does success come from?

Have you ever noticed that the way people talk about success and achievement can make it seem like it just comes naturally to some people?

This is a problem because it makes it seem like success and achievement only come from some "natural ability" that a person is either born with or not. But there is mounting scientific evidence that this is not the case.

The problem with believing that achievement is supposed to come easily is that it can make people miss an important insight about how you can achieve the things that matter to you: *Experiences of struggle, frustration, and difficulty can be your friend, not only your enemy.*

Neuroscientists study how struggle and success go

hand in hand

Neuroscience is the scientific study of how the brain works. And some neuroscientists study what happens in the brain when people struggle or have otherwise frustrating or difficult experiences.

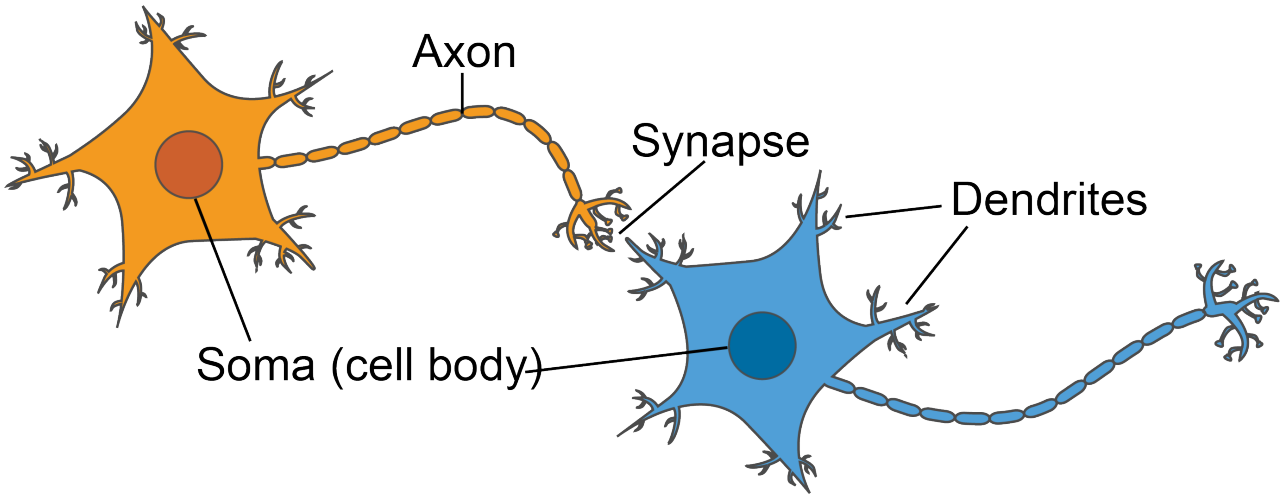
What these scientists have discovered is that when you are faced with difficult challenges and you keep trying until you get better, your brain grows and becomes better at taking on new challenges in the future.

Even for things that are initially very difficult, as you practice more and more, they can start to feel easier. And when you encounter new challenges later, your brain can learn how to respond more effectively to those, too.

This phenomenon might remind you of the way that physical exercise makes your muscles really sore at first, but with training, your muscles not only get stronger, they also recover more quickly when you do push them to their limit.

Zooming in on your brain

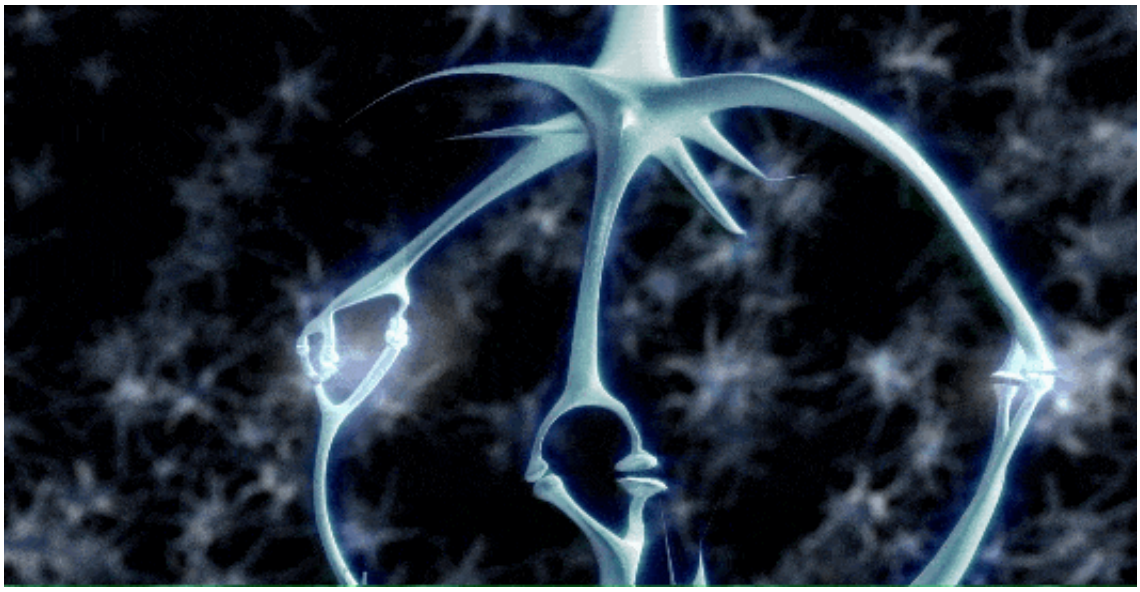
Your brain has billions of tiny cells called neurons. A neuron has a cell body (soma), a long branch (axon), and tiny branches (dendrites). Signals are transmitted from the axon from one neuron to the dendrites of another neuron across a small gap (synapse).



The connections between neurons can be weak or strong. When you work hard to learn something new (like how to solve a new type of math problem) or acquire a difficult skill (like how to write code to analyze data), these connections in your brain can change in lasting ways. For example, there can be changes in the strength and number of connections between lots of

different neurons.

Challenging experiences can play an important role in affecting how these connections change. For example, the more time you spend practicing a new skill (e.g., writing and debugging R code), the more these connections have an opportunity to change so that activities that initially felt very difficult become easier over time.



Doing challenging things can lead to lasting changes in your brain

When people don't realize that their brain is constantly changing in light of new experiences, they may tend to avoid frustration and difficulty by not doing things that feel challenging.

But by avoiding difficulty, they're missing out on the best opportunities to develop skills and strengths that will help them achieve the things that are important to them.

Experiencing challenges — and even failure from time to time — can trigger a cascade of beneficial changes in the brain, both helping you to achieve your goals and prepare to learn new things in the future. Furthermore, experiencing confusion while learning something new can promote deeper understanding and support future learning.

Learning from challenges and identifying areas for improvement is critical for achieving long-term success. The most accomplished people credit their success to having learned from numerous challenging experiences and having tried many different strategies.

For example, Michael Jordan, one of the greatest basketball players, reflected on the role of

setbacks: “I’ve missed more than 9,000 shots in my career. I’ve lost almost 300 games. Twenty-six times I’ve been trusted to take the game-winning shot and missed. I’ve failed over and over and over again in my life. And that is why I succeed.”

Similarly, Thomas Edison, the well-known inventor who held 1093 patents, reportedly tested over 2,500 electric lamps with different designs and materials. He famously said “I have not failed. I've just found 10,000 ways that won't work.” and “Many of life’s failures are people who did not realize how close they were to success when they gave up.” Edison wouldn’t have made it so far if he stopped experimenting with the electric lamp on the first failure.

Although stressful experiences feel unpleasant in the moment, everyone who ever became successful has had many of these experiences on the way to achieving success. It is important to recognize the important role that challenging experiences can play in your own academic and personal journey.

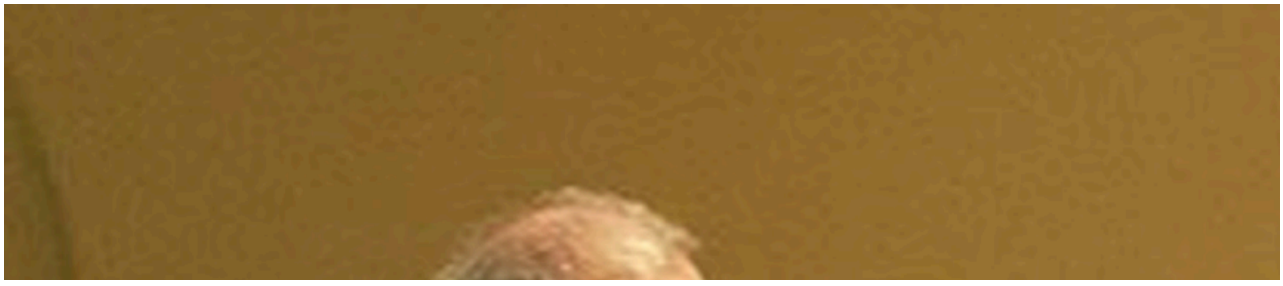
Expanding your limits

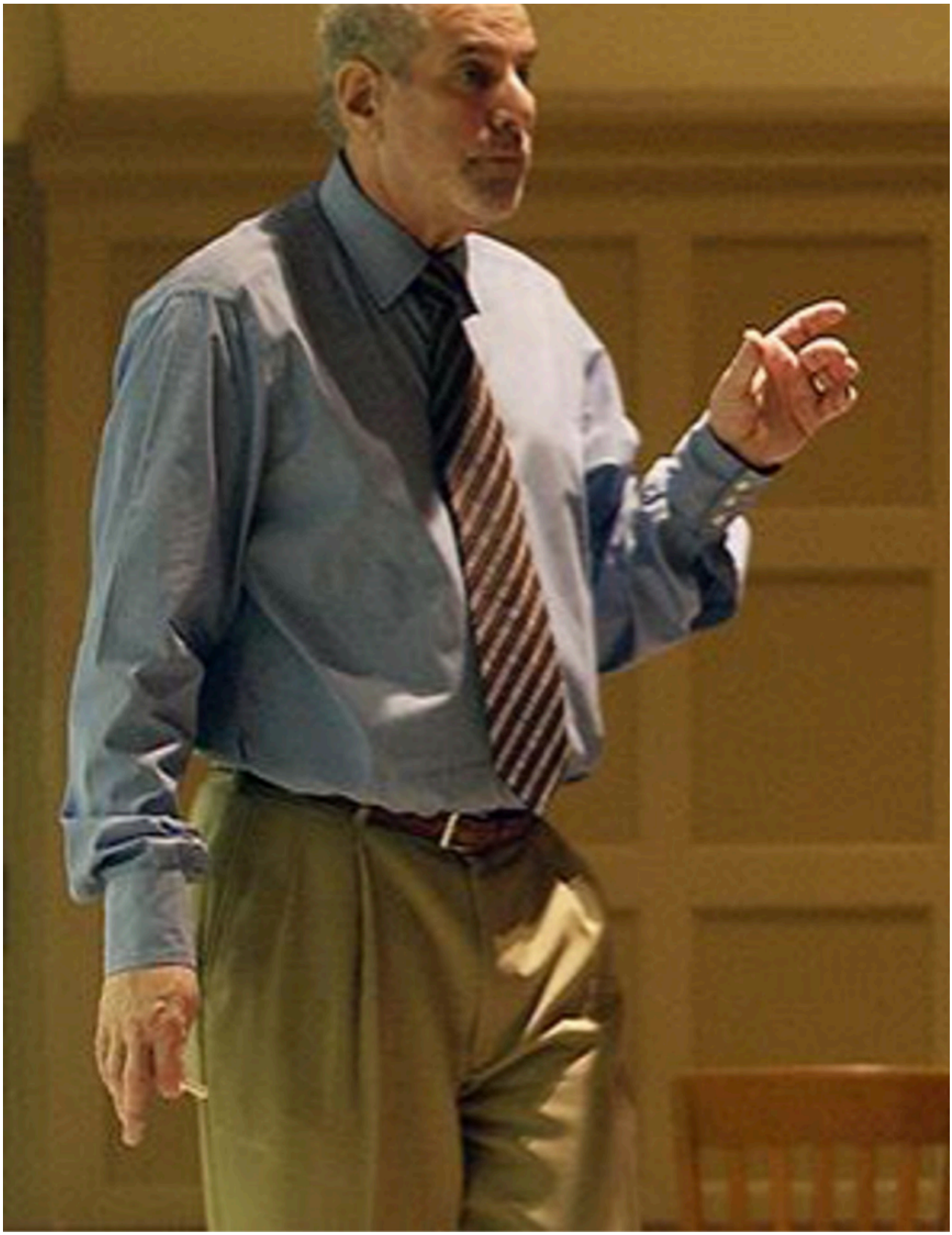
However, only you know how much challenge and difficulty is right for you. The point is that you have the power to choose your challenges and the strategies to overcome them—**you are not confined by what you can do right now.**

In sum, difficulty, struggle, and frustration are very common when you’re learning challenging new skills and should not be understood as signs that you’re not good at this or you’ve reached your limits. Rather, these are signs that you’re *expanding* your limits. And you can learn to *use* the difficulty and confusion that accompany these challenging experiences to learn and grow.

Renowned math professor and leading education expert Uri Treisman puts it this way when students walk into his course for the first time:

> “Everybody in this class will struggle. No matter who you are, questions are going to be flying at you that you can’t answer. And when that happens, you’re going to experience stress. And if you don’t understand that stress, you’ll think it means, ‘Oh no, I don’t belong here.’ But in fact, that stress is an indicator that your understanding is deepening. It’s not a sign that you’re **not** learning. It’s a sign that you **are** learning.”





What are some challenging and/or stressful situations you are facing at school related to your academic goals? How do you think you might grow and learn as a consequence?

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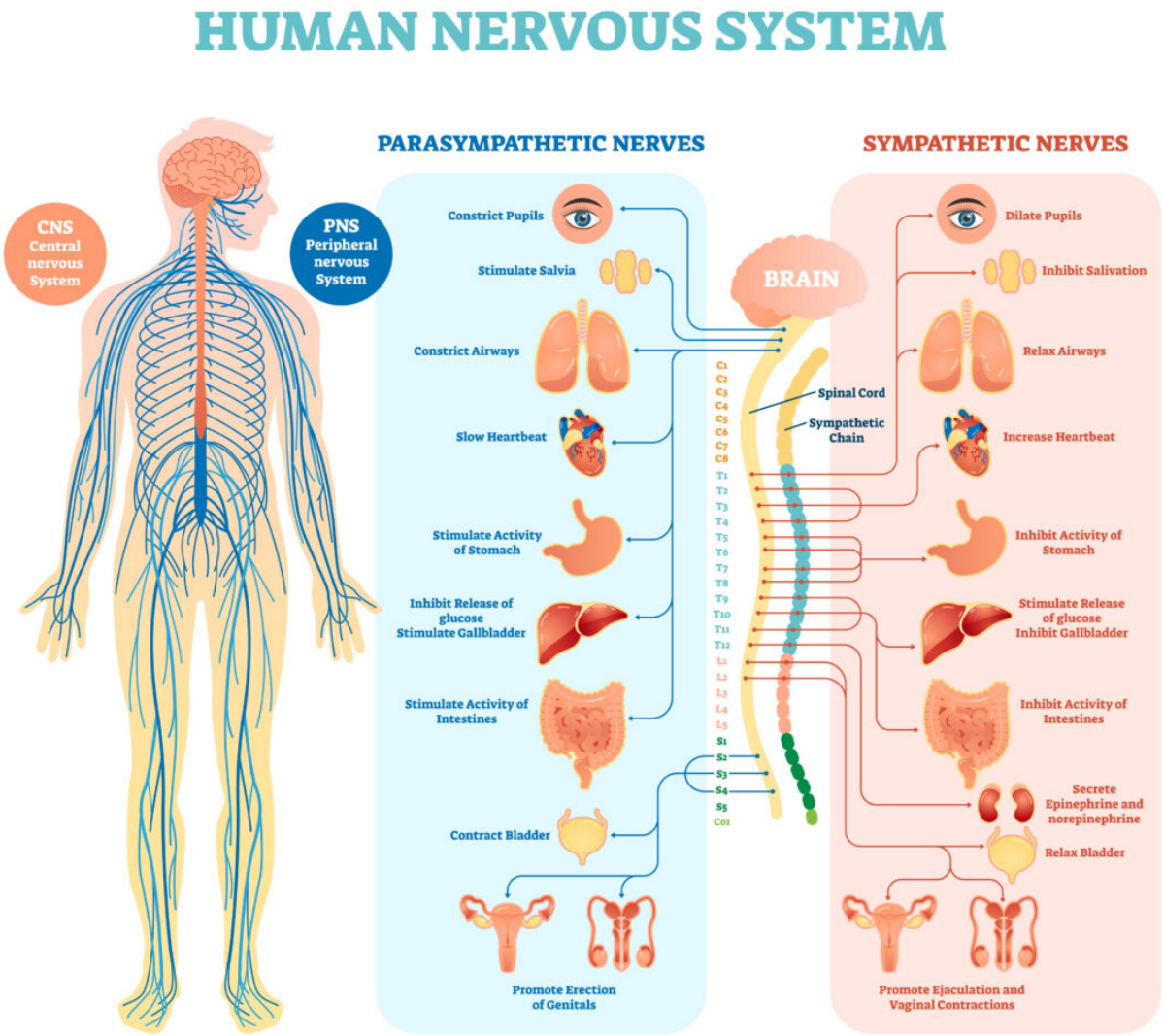
Page 3: What have scientists discovered about how the brain and body are connected in challenging situations?

The relationship between the body and the mind



Your body has two main nervous system components: the parasympathetic and sympathetic nervous systems. They work together to support your body systems to respond to challenges and opportunities.

The parasympathetic nervous system is in charge of maintaining your body's normal healthy functioning—normal heart rate, breathing, and sweat to keep you cool.

The sympathetic nervous system is in charge of your body's automatic responses to unexpected stimuli. During challenging or stressful situations, the sympathetic nervous system is activated and you experience faster heartbeats and become more alert.

Oxygen is the fuel for our brains. When your heart starts beating faster, it's delivering an extra liter of oxygenated blood to your brain and muscles every minute. This means our brains have enough fuel to work harder than normal.

Pumping all that extra blood into your brain and muscles means you need to breathe faster to keep your blood rich with oxygen. That's why you might find yourself out of breath or breathing harder when you're stressed and frustrated.

Noticing your body's stress response and reflecting on how you are thinking

As we've discussed, when we struggle to accomplish something we care about, whether it's a difficult math problem; a challenging athletic or technical skill; or an important personal goal, we might get frustrated. We think of that as a bad thing—a feeling that gets in the way of achieving our goals.

But that stress response means your body is kicking into high gear so you can engage with difficult challenges and learn from them. And you can learn to notice that response and harness it to help you succeed.

For instance, it could be a sign that it might be worth taking a step back from the current situation and asking yourself questions like: What can I do to help myself? How else can I approach this? Is there a way to do this even better?

Asking yourself these questions is known as strategic metacognition: reflecting on the way you are thinking about something. This kind of reflection is especially useful when you are stressed because it can give you the opportunity to break out of unproductive ways of thinking about the problem and instead look for new information, resources, or people who can help you.

Moreover, scientists have discovered that engaging in strategic metacognition is one of the most important skills that people develop when they become really good at something. For instance, highly experienced engineers facing a difficult problem will more readily adjust their problem-solving strategy on the fly than inexperienced engineers, who rely more heavily on rules and formulas they have memorized.

Harnessing your body's stress response to engage with challenging experiences

People often mistake their body's stress response for a sign that they're in a situation they can't handle. This is a mistake that can actually cause you to perform worse because if you think your stress response is a problem, you're more likely to be worried about it and get distracted from what you are doing. Regardless of the stage of life and situation, everyone encounters challenges and stress responses.

Instead, it can be more helpful to think of the body's stress response as a cue to reflect on your current approach to the situation. What other avenues might be worth exploring? Are there other resources that might be useful to consult?

You are now armed with the key information you need to harness your body's stress response to help you engage with challenging experiences with an open mind. This should help you to spend less time worrying when you feel anxious or frustrated so you can focus on what you are trying to learn and accomplish.

Feedback for the program: Please put a check in front of the things you've learned so far and leave the other choices unchecked.

- The brain changes with new experiences, which often affect the strength of connections between neurons.
- The brain stops developing and growing after puberty, and learning becomes increasingly difficult.
- The body's stress response is a sign that you are ready to learn and expand your limits, not that you have reached them.
- Michael Jordan attributes his success to never experiencing failure and sticking to the same strategies.

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student responds in text box here
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Page 4: Applying what you have learned

How could you use your body's stress response effectively?

Think back on the stressful situation at school that you wrote about at the beginning of this program—one where you wanted to do your best but felt stressed and confused. Or, if you want to, think of a new example of a time you felt anxious and stressed about a situation at school.

We're going to share three ways that you can use the information you learned in this program to help you in the future when you face other stressful situations like that in school.

How do you use your body's stress responses?

Below are three ways that people don't just survive but thrive during stressful situations like the one you wrote about. Which ones have you used before?

Please click all of the ones you've tried before, in some form, before. Then tell us what it would look like for you, personally, to do them again in the future with another challenging school situation. If you haven't tried them before, you can still tell us how you would use them in the future.

A. Reminding yourself that the feelings of confusion and struggle when learning new skills (e.g. debugging code, modeling data) or doing difficult assignments won't last forever because as you work through those struggles, your brain is changing in lots of different ways to prepare you to face those challenges more effectively in the future.

B. Using strategic metacognition to come up with new ways to approach the challenge (e.g., asking yourself questions, getting help from teachers/friends or trying to study in a new way)

C. Remembering that your body's stress response is there to help you reach your peak performance level and retain lasting skills when you're facing difficult challenges.

"Reminding yourself that the feelings of confusion and struggle when doing difficult school work won't last forever because as you work through those struggles, your brain is changing in lots of different ways to prepare you to face those challenges more effectively in the future."

How could you use this kind of strategy in an upcoming stressful situation like the one you wrote about?

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student responds in text box here

I could use this strategy in an upcoming stressful situation by…
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"Using strategic metacognition come up with new ways to approach the challenge (e.g., asking yourself questions, getting help from teachers/friends or trying to study in a new way) "

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"Remembering that your body's stress response is there to help you reach your peak performance level and retain lasting skills when you're facing difficult challenges."

How could you use this kind of strategy in an upcoming stressful situation like the one you wrote about?

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student responds in text box here

I could use this strategy again for my upcoming challenge by...
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Page 5: Sharing what you have learned with others

Let's put what you have learned into practice

After going through this program, one of the TAs from your course says this about navigating school:

“I used to be the student who was constantly struggling. I remember that learning to code and debug in R was pretty frustrating and I always felt like giving up. Labs and projects felt intimidating because I didn’t know exactly what I was supposed to do. It really felt like everyone else just knew what to do and doing well came naturally to them. I didn’t want to ask for help because it didn’t seem like anyone else did.

Through this program, I learned that taking on challenges is exactly what I needed to do to learn as much as I did that quarter. I realized that stress and confusion was unavoidable and simply part of the experience of learning new and difficult concepts. Whenever I got stuck figuring out what was wrong with my code, I learned to step back, think of different approaches, and try again. I also began seeking support from office hours and classmates – I soon realized I definitely wasn't the only one who was confused and was seeking out guidance.

Now I'd say that I feel pretty comfortable with computer programming because I've thought about and worked through so many bugs using various approaches. I've now become a TA to help students navigate these same challenges."

If future students don't know what you now do about learning, they could feel bad or even give up when school is stressful and challenging. This could keep them from getting the most out of their time in college.

Here is where we really need your input to make the program better. Please write a personal message to a student who will be taking this class at Stanford next year.

Please write a message to a student who is taking this class next year.

1. First, **describe a few experiences or situations in school when you found coursework challenging or stressful.** Write 3 to 5 sentences.

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student responds in text box here
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1. Second, what could you say to help a Stanford student who might be experiencing something similar to understand how challenge and stress can be useful for learning? (i.e. our brain can adapt over time to handle situations more effectively and listening to your body signals can help you reflect and explore strategies for success.)

For instance, you can mention:

- That connections in the brain change when engaging with new experiences and challenges
- That the body's stress response system is there to support learning by helping you to stay alert and ready to learn new things
- Strategic metacognition is a potent tool to help you break out of unproductive ways of thinking about the problem and instead look for new information, resources, or people who can help you.

Write 1-2 paragraphs.

We may choose some of your statements to share with other students (anonymously) during

stressful times. Remember, the more powerful your message is, the more helpful it will be to other students. You don't have to worry about spelling or grammar– just focus on sharing your thoughts. If you want, you can sign your letter.

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student responds in text box here
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One final point: Not all stressful experiences are good

Thank you for your response.

Here's a final point. The lessons of this program apply to normal experiences in school, like the stress we feel when we are trying to learn or master a difficult concept or skill. That's "good stress," and you should trust that your body's responses are helping you perform and succeed.

But sometimes people experience trauma—stress that is outside their control and harmful. If you experience trauma, you might consider reaching out to a parent, teacher, counselor, or other adult who you trust for advice.

Do you have any other reflections or feedback that you'd like to share? Any questions you have about the information presented? If you'd like to share anything, please type it in the box below.

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student responds in text box here
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