Supplemental Material

CBE—Life Sciences Education

Harris *et al.*

Supplemental Materials

Contents

Appendix 1: Mindset intervention

Summary

Under the assumption that a gender gap in students' beliefs about the malleability of intelligence underlies the historical gender achievement gap, we initially set our sights on mindset. Specifically, we hypothesized that a mindset intervention that aims to instill a growth mindset would help close a gender gap, as previously seen in junior high school and high school STEM classrooms. The intervention was taken directly from Paunesku *et al.* (2015). Contrary to our expectations, mindset entering the course was not associated with gender or eventual course performance for students (Figure S1; Table S1). Thus, we found no evidence that students with more growth-oriented mindsets outperformed peers with more fixed mindsets. The intervention did alter student mindset to be more growth-oriented (Table S2), but this shift did not lead to improved course performance (Figure S2), nor did it contribute to closing a gender gap. Males outperformed females on exam points but not on non-exam points.

Methods

The mindset intervention was implemented in the 2015 autumn quarter of a large introductory biology course at a large research intensive university in the Northwestern United States. There were 1129 students. The course was divided into two sections that met back-to-back and took identical exams. The courses were co-taught by two male instructors. The courses met four times per week, were 10 weeks long, and included weekly lab sections and intensive use of active learning strategies (Freeman *et al.,* 2011). As described in the main manuscript, points earned throughout the course can be delineated as either high-stakes (exam) or low-stakes (non-exam) points. The interventions and data collection were performed following a review by the University of Washington Human Subjects Division, application 50071.

We exposed students to a mindset intervention in an effort to reduce some of the maladaptive perceptions about ability that might be contributing to the gender gap in science courses. Prior to the intervention, students in both treatments responded to two 6-point Likert items measuring their growth mindset taken from Paunesku *et al*. (2015). Following this assessment, lab sections were randomly assigned to either the intervention condition (16 labs), the control condition (16 labs), or to a randomized condition where half of the students in the lab were assigned to control and the other half to intervention (16 labs). These conditions were administered online through the course's online management system. The growth mindset and control intervention took place at the end of the first week, in the form of a 15-minute online assignment completed over the weekend. The intervention was taken directly from Paunesku *et al.* (2015), and students were awarded a small number of course points for completing the task.

Students in the treatment condition were asked to read a short passage that discussed how neurons change in the brain during the learning process and respond to two writing prompts that asked them to reflect on 1) the connection between cognitive challenges and neural changes, and 2) an instance in their own life where they had to learn something to overcome an obstacle. Students in the control condition read a similar-length passage about the gross anatomy of the brain and then responded to writing prompts that asked them to 1) reflect on how different areas of the brain might be active during their work in the course, and 2) explain the importance of the brain's structure and function to a friend. In a reading quiz administered during the last week of the quarter, all students were asked to respond to the same two Likert scale items about how they view intelligence. Thus, we gathered pre- and post- data to assess whether the intervention increased growth mindset. The Likert items about intelligence, treatment and control interventions, and the mindset-assessment questions are provided at the end of this Appendix. Students were not told that an intervention was taking place.

Data sources

Course performance data were collected from instructional staff and merged with demographic data from the Office of the Registrar. We calculated a pre-intervention mindset score and a post-intervention mindset score for each student by taking an average of the two Likert items. These scores ranged from 1 to 6 (fixed to growth mindsets, respectively), with 3.5 representing a neutral view. Cronbach's alphas for the pre-intervention mindset survey and the post-intervention survey were 0.85 and 0.87, respectively.

Statistical analyses

After the mindset intervention was underway, we learned that our freshmen students had participated in a 30-minute, small-group exercise focused on training a growth mindset during their orientation week the previous summer. Because this prior mindset activity potentially threatened the validity of any findings, we excluded all freshmen students from the analysis.

Filtering thresholds for analyses were the same as used in the test anxiety intervention. Because our goal was to address the gender-based underperformance documented previously in this introductory course series (Eddy *et al.,* 2014), we needed a measure of student preparedness. Here, we used a combined SAT score (math + verbal) and college GPA. For students who did not have SAT scores but did have ACT scores, concordant SAT scores were imputed based on the spring 2016 College Board recommendations. College GPA is a better predictor of performance in this introductory biology course ($R^2 = 0.43$) than SAT scores ($R^2 = 0.17$).

We ran *t*-tests and chi-squared models to test whether students in the randomly assigned treatment and control groups were similar in gender composition, preparedness, and mindset entering the course, and to assess any differences between males and females in GPA or SAT coming into the course. Our main interest was whether the treatment group would show a smaller gender achievement gap relative to the control group. However, testing the impact of the treatment requires several assumptions to be met. First, we used a *t*-test to test whether women reported more of a fixed mindset than males entering the course (Hypothesis 1).

We next tested whether mindset entering the course was associated with performance on either high-stakes exam points or low-stakes non-exam points (Hypothesis 2). Our goal was to explore whether students who started the course with growth mindsets would respond more adaptively to the cognitive demands of a rigorous course. We tested this in the control group because these students did not undergo the intervention intended to manipulate mindset. We ran linear regression models with total exam points and total non-exam points earned as dependent variables, and mindset entering the course as the main independent variable of interest.

The intervention was intended to change student beliefs about the malleability of intelligence to be more growth oriented (Hypothesis 3), and ultimately close the gender gap on course performance. We tested whether the intervention altered student mindsets through a regression model with the post-course mindset score as the dependent variable, condition (treatment or control) as the independent variable of interest, and pre-course mindset as a control.

We hypothesized that the intervention would close a gender gap, which implies that a gender gap should persist in the control condition (Hypothesis 4) and be smaller or non-existent in the treatment condition (Hypothesis 5). To test these two hypotheses, we used a model selection approach designed to understand which variables best predict high-stakes exam points, as well as low-stakes non-exam points. We started with a full model:

$$\textit{Exam points} \sim \textit{preparation} + \textit{gender} + \textit{treatment} + \textit{gender*treatment}$$

Similar to that described in the stress and anxiety intervention, we conducted stepwise backwards model selection to find the reduced model that best fit our data. We repeated these analyses using non-exam points with the expectation that the intervention would not alter performance on these low-stakes questions. Models for non-exam points used a squared transformation of low-stakes points to improve the linearity of the model.

Results

A total of 909 students completed all four exams and had GPA, SAT scores, or ACT scores available. Of these students, 162 freshmen were removed from the analysis. Our final dataset consisted of 612 upper-division students who completed the mindset intervention and pre- and post- mindset surveys. Among these 612 students, there was no bias by treatment condition: 319 completed the control intervention and 293 completed the treatment intervention. Students assigned to the treatment relative to control condition were not significantly different in pre-intervention mindset ($t(602.4)$, $p = 0.96$), preparedness ($t(609.85)$, $p = 0.10$), or gender ($X^2 <0.001$, $p = 0.99$) (Table S3).

Gender was not significantly associated with SAT scores ($t(407.62) = 1.544$, $p = 0.123$) or GPA ($t(401.2) = -1.302$, $p = 0.194$). We report our main findings below.

Finding 1: Mindset entering the course did not differ between males and females

Average mindset at the start of the course was on the growth-oriented end of the spectrum ($M = 4.25$, $SD = 1.12$; Figure S1). Contrary to our hypothesis, there was no significant association between gender and student mindset prior to the intervention (males: $M = 4.26$, $SD = 1.13$; females: $M = 4.24$, $SD = 1.11$).

Finding 2: Mindset entering the course was not associated with course performance.

Mindset entering the course was not significantly associated with accumulated high-stakes exam points or low-stakes non-exam points in the control group (Table S1). Thus, there is no evidence that students with more growth-oriented mindsets outperformed peers with more fixed mindsets in either kind of course performance.

Finding 3: The treatment resulted in an altered mindset at the end of the course
Controlling for pre-intervention mindset, students in the treatment group reported, on average, significantly more growth-oriented mindset compared to those in the control condition at the end of the course ($\beta = 0.274$, $p < 0.001$) (Table S2). This result provides evidence that the treatment condition impacted student beliefs about the malleability of intelligence as intended.

Findings 4 and 5: The treatment did not increase exam or non-exam scores, and a gender gap persisted in exam scores
None of the best-fit models for exam scores or non-exam points included the treatment condition or the gender-by-treatment interaction (Table S4). Thus, our results indicate no impact of treatment, or differential impact of treatment by gender regardless of course performance metric (Table S5). The mindset intervention did not significantly improve student performance in the course (Figure S2), despite successfully altering student mindset as described above.

Instead, preparation (GPA and SAT) was a significant predictor for both high-stakes exam scores and low-stakes non-exam points. Gender was a significant predictor of high-stakes points with males having higher scores on average than females ($\beta = -6.052$, $p < 0.001$). However, gender was not a significant predictor of low-stakes non-exam points (squared) (Table S5).

Tables and Figures

Table S1. Regression model results for students (n = 319) in the control group of the mindset intervention. No association was seen between mindset entering the course and course performance.

Dependent Variable	**Intercept**	**Pre-course mindset**
Exam points	286.538 (18.235)***	-1.724 (1.901)
Squared non-exam points	85702.5 (2316.8)***	569.7 (528.1)

Table S2. Regression model results for mindset at end of course for all students (n = 587). Students in the treatment reported significantly more growth oriented mindsets at the end of the course compared to those in the control condition.

	Estimate
Intercept	1.792 (0.150) ***
Pre-course mindset	0.588 (0.033) ***
Treatment	0.274 (0.074) ***

Standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table S3. Numbers and relative frequencies of students in the control and treatment conditions by gender in the mindset treatment.

	Control	Treatment
Male	110 (34.5%)	102 (34.8%)
Female	209 (65.5%)	191 (65.2%)

Table S4. Model selection results from the mindset intervention. Bolded models are the final models reported in the manuscript.

Model	Rank	df	AICc	delta
Exam pts ~ SAT + gpa + gender	**1**	**5**	**5525.61**	**0**
exam ~ SAT + gpa + gender + treatment	2	6	5527.5	1.85
exam ~ SAT + gpa + gender + treatment + gender*treatment	3	7	5529.5	3.98
Non-exam pts ~ gpa	**1**	**3**	**12517.79**	**0**
Non-exam pts^2 ~ gpa + treatment	2	4	**12518.59**	0.80
Non-exam pts^2 ~ gpa + treatment + gender	3	5	**12520.44**	2.65
Non-exam pts^2 ~ gpa + treatment + gender + treatment*gender	4	6	**12521.95**	4.15
Non-exam pts^2 ~ gpa + treatment + gender + gender*treatment + SAT	5	7	**12523.97**	6.18

Table S5. Mindset intervention: best-fit models according to backward model selection for exam scores and non-exam points. Coefficients are reported for variables that were kept in the best fitting model with standard errors in parentheses.

		Preparation					
Dependent Variable	**Intercept**	**GPA**	**SAT**	**Gender**	**Treatment**	**Gender * Treatment**	**AICc**
Exam points	28.978 (11.348) *	42.375 (3.043) ***	0.091 (0.008) ***	-6.052 (2.211) ***	-	-	5525.61
Non-Exam points (out of 332) (Squared)	44894 (3445) ***	13081 (1034) ***	-	-	-	-	12517.79

Standard errors in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$
- means this variable was not kept in the best fit model

Table S6. SAT scores are biased by gender in mindset treatment.

	n	Mean (SD)
Male	212	1277 (146)
Female	400	1258 (147)

Figure S1. The distribution of mindset scores of students before the intervention. A score of 1.0 corresponds with a more fixed mindset, and 6.0 a more growth mindset. Students entering this course tended toward a growth mindset.

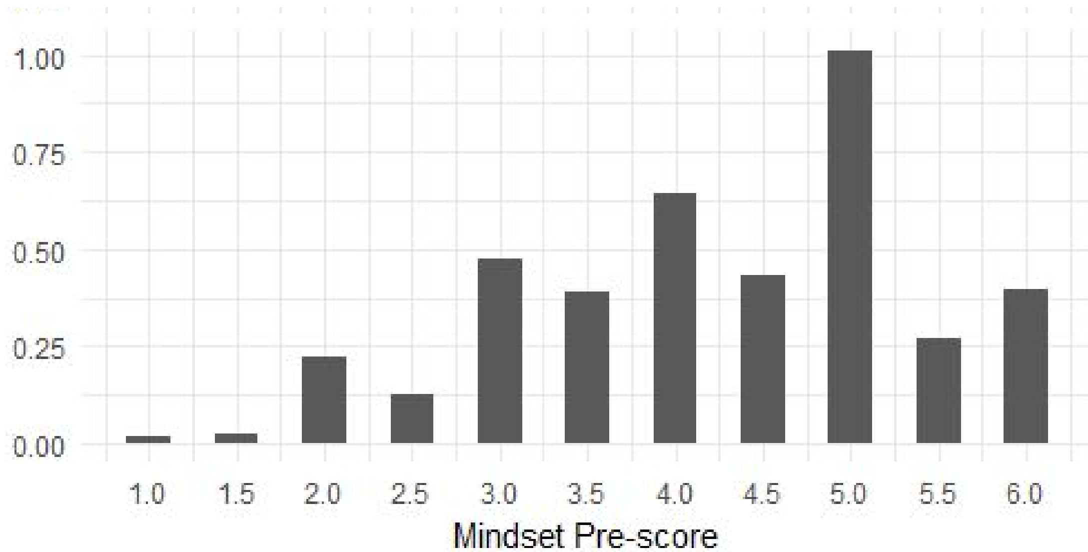
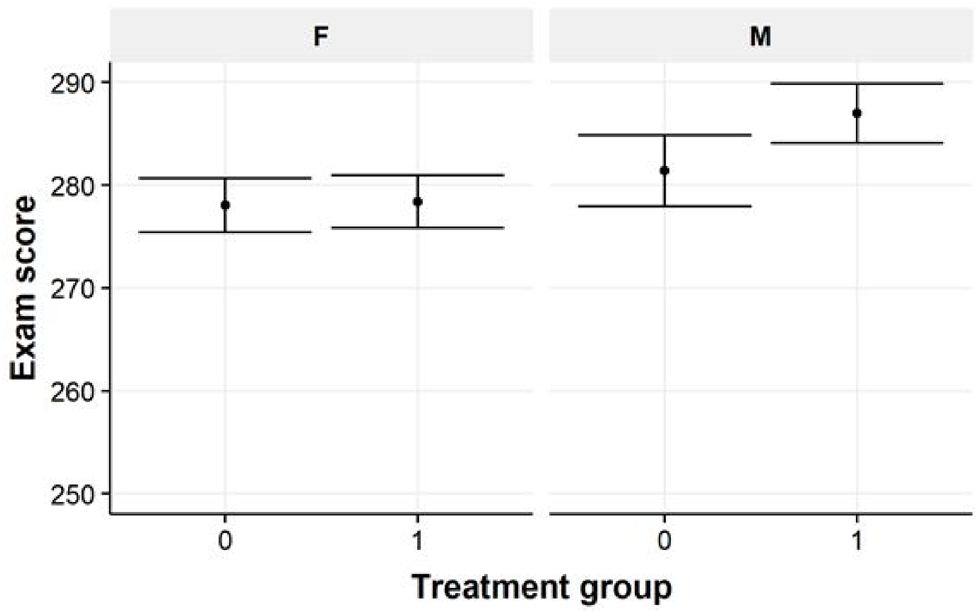


Figure S2. Mean and standard error of exam scores of male and female students in the control (0) and the mindset intervention (1) treatment.



Mindset intervention pre/post questions, treatment exercise, and control exercise

A. Pre/Post Questions

Likert scale questions: Disagree strongly; Disagree; Somewhat disagree; Somewhat agree; Agree; Agree strongly

How much do you agree or disagree with each of the statements below?
There are no right or wrong answers. We would just like to know your perspective.

- You can learn new things, but you can't really change your basic intelligence.
- Your intelligence is something about you that you can't change very much.

B. Intervention exercise

As you read the article on the next page, please try to think about the ways in which the article relates to your own life.
Please read each page slowly and carefully
When you are done reading it, we will ask you to remember what you read. So please pay close attention.

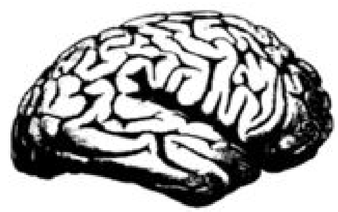
B. Intervention exercise (continued)

You Can Grow Your Brain

New Research Shows the Brain Can Be Developed Like a Muscle

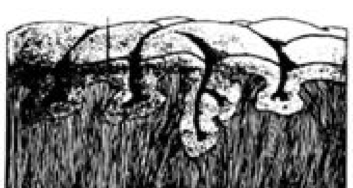
Many people think of the brain as a mystery. We don't often think about what intelligence is or how it works. And when you do think about what intelligence is, you might think that a person is born either smart, average, or dumb—either "good at school" or not—and stays that way for life.

But new research shows that the brain is more like a muscle—it changes and gets stronger when you use it. Scientists have been able to show just how the brain grows and gets stronger when you learn.



Everyone knows that when you lift weights, your muscles get bigger and you get stronger. A person who can't lift 20 pounds when they start exercising can get strong enough to lift 100 pounds after working out for a long time. That's because muscles become larger and stronger with exercise. And when you stop exercising, the muscles shrink and you get weaker. That's why people say "Use it or lose it!"

But most people don't know that when they practice and learn new things, parts of their brain change and get larger, a lot like the muscles do. This is true even for adults or older teenagers. So it's not true that some people are stuck being "not smart." You can improve your abilities a lot, as long as you practice.



A Section of the Cerebrum nerve fibers (white matter)

Inside the outside layer of the brain—called the cortex—are billions of tiny nerve cells, called neurons. The nerve cells have branches connecting them to other cells in a complicated network. Communication between these brain cells is what allows us to think and solve problems.

When you learn new things, these tiny connections in the brain actually multiply and get stronger. The more you challenge your mind to learn, the more your brain cells grow.

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B. Intervention exercise (continued)

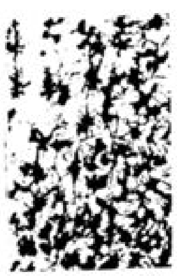
A Typical Nerve cell

Then, things that you once found very hard or even impossible to do—like doing science experiments or being a good writer—become easier. The result is a stronger, smarter brain.

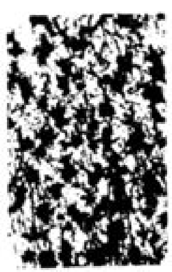
How Do We Know That The Brain Can Grow Stronger?

Scientists started thinking the human brain could develop and change when they studied adult animals' brains. They found that animals who lived in a challenging environment, with other animals and toys to play with, were different from animals who lived alone in bare cages.

While the animals who lived alone just ate and slept all the time, the ones who lived with different toys and other animals were always active. They spent a lot of time figuring out how to use the toys and how to get along with other animals.



Nerves in brain of animal living in bare cage.



Brain of animal living with other animals and toys.

These animals had more connections between the nerve cells in their brains. The connections were bigger and stronger, too. In fact, their whole brains were about 10% heavier than the brains of the animals who lived alone without toys.

The adult animals who were exercising their brains by playing with toys and each other were also "smarter" –they were better at solving problems and learning new things.

The same thing happens to human brains. When our brains are exposed to challenging environments, we form new connections between the neurons in our brains and we get smarter.

To help illustrate this, think about what happens to children's brains when they learn to speak. During the first few years of life, babies hear people talking to them and around them all the time. As they are exposed to new words and phrases, they form new connections in the language parts of their brain. Once their brains form enough connections they can begin to

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B. Intervention exercise (continued)

understand words and even talk back. Over time, as their brains continue to form new connections, they begin to understand and speak full sentences.

And once children learn a language, they never forget it. That's because when they learned to speak, permanent changes occurred in the language areas of their brains.

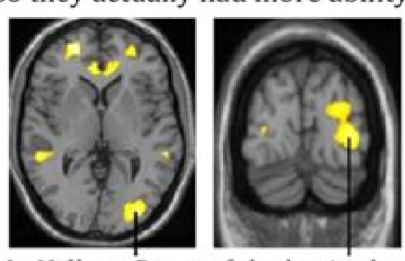
The same thing happens when children learn to read. At first, all they see when they look at a book is a bunch of letters on pages. But as their brains form new connections, they start to recognize basic words, and eventually they begin to read sentences. You might not realize it, but it's because of the connections you formed in the reading parts of your brain when you were a child that you are able to read this article today.

Can Adults Grow Their Brains?

Scientists have recently shown that adults can grow the parts of their brains that control their abilities—like the ability to write or even to juggle.

In one study, scientists found a group of adults who were not jugglers. They taught half how to practice juggling in the right way. These people practiced for a long time and got much better at juggling. The other half didn't practice, and didn't get better.

Next, the scientists used a neuroimaging device to compare the brains of the two groups of people. They found that the people who learned how to juggle actually grew the parts of their brains that control juggling skills—the visual and motor areas. Their brains had changed, so they actually had more ability.



In Yellow: Parts of the brain that grew when adults learned to juggle

doi:10.1371/journal.pone.0002669.g001

This was surprising because these people said before the study that they couldn't juggle—just like some people say they're "not good writers" or "not smart at school." But when they learned good strategies for practicing and kept trying, they actually learned and grew their brains.

This can happen because learning causes permanent changes in the brain. The

B. Intervention exercise (continued)

jugglers' brain cells get larger and grow new connections between them. These new, stronger connections make the juggler's brain stronger and smarter, just like a weightlifter's toned muscles.

And juggling isn't the only skill your brain can become better at. Your brain can form new connections that help you get better at many different things, like writing, reading, or even playing a musical instrument.

One place where people form new connections all the time is school. Think about it – people are exposed to new information and challenge their brains almost every day when they are in school. That means that each day they are forming connections between the neurons in their brains and getting smarter. So next time you are studying for a test or reading a chapter in your textbook, remember that you aren't just memorizing new facts that will help you get a better grade, you're actually exercising your brain and getting smarter.

Even when we struggling with difficult concepts and we don't feel very smart, our brains are forming new connections. For example, many people struggle to write essays in school. Often, they think that they just aren't good at writing. They might not realize that even while they are struggling to write their essays, their brains are forming new connections that will help them become better writers in the future.

The Truth About "Smart" and "Dumb"

People aren't "smart" or "dumb" in school. At first, no one can read or write essays. But with practice, they can learn to do it. And the more a person learns, the easier it gets to learn new things—because the brain muscles have gotten stronger.

This is true for everyone, even adults or college students. Dr. Wittenberg, a scientist from Wake Forest University, said "We used to think adults can't form new brain connections, but now we know that isn't true… The adult brain is like a muscle, and we need to exercise it."

People who don't know this can miss out on the chance to grow a stronger brain. It does take work to learn, just like becoming stronger physically or becoming a better juggler does. Sometimes it even hurts. But when people feel themselves get stronger, they realize that all the work is worth it.

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B. Intervention exercise: Open response questions

In the article, you learned 4 scientific ideas:

- When you work hard and learn new things, your brain grows new connections and you get smarter.
- The more you challenge yourself, the smarter you will become.
- Smart people are the ones who have practiced and stretched themselves more—they have built up their brain's "muscles."
- Just "working hard" isn't enough; you also have to learn new strategies to grow the "know how" part of your brain.

In the box below, please write in your own words 3-5 sentences about how the brain grows with learning, and how the brain learns when you do something hard.

We are interested how students strengthen their intellectual abilities over time, especially by overcoming obstacles.
In order to learn more about how students have done this in the past, please answer the question below.

What is a time in your own life when you used to not know something and then you had to learn and get better at it? Try to choose an example where you had to grow to overcome an obstacle. Write 3-5 sentences in the box below.

C. Control exercise

As you read the article on the next page, please try to think about the ways in which the article relates to your own life. When you are done reading it, we will ask you to help us explain these ideas to another student.

The Specialties of the Brain Revealed

New Research Shows That Different Areas of the Brain Have Different Specialties

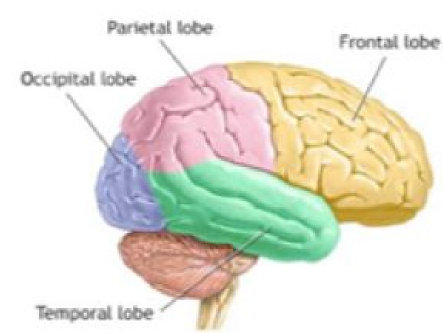
The human brain has done some important things. Brains have designed big buildings. They've created beautiful music throughout the world, and they've written books and texts throughout recorded history. As humans, we have an important tool between our ears, but most of us don't know much about how it works.

Many people think the brain is a mystery. They don't know much about what it's made of, how it works, or what its different parts do. Research shows that the brain has many different parts or areas. Furthermore, many brain areas have different jobs from each other.

The brain is broken up into three main parts: the hindbrain, the midbrain, and the forebrain. Scientists have spent the most time studying the forebrain because it does some of the most interesting things and it's the easiest to study.

The forebrain

The forebrain – the largest part of the brain – is broken up into four different *lobes* or parts. These different parts do very different things from each other. Going from the front of the brain towards the back, the lobes are called the *frontal lobe, temporal lobe, parietal lobe,* and *occipital lobe.* Take a look at the picture below to see the four lobes. Each lobe is broken up into even more parts, and these parts do different tasks.

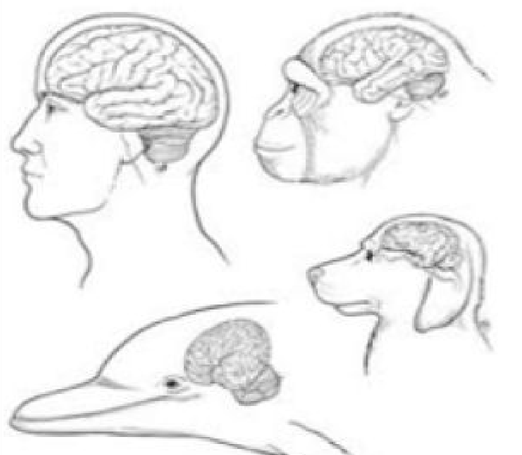


Humans' brains are bigger than the brains of almost all other animals. Some animals, like elephants or whales, do have bigger brains. But those animals also weigh a lot more. So

C. Control exercise (continued)

compared to their total body weight, their brain is smaller. Interestingly, when you look at how big brains are as a part of total body weight, humans have bigger brains than most other animals.

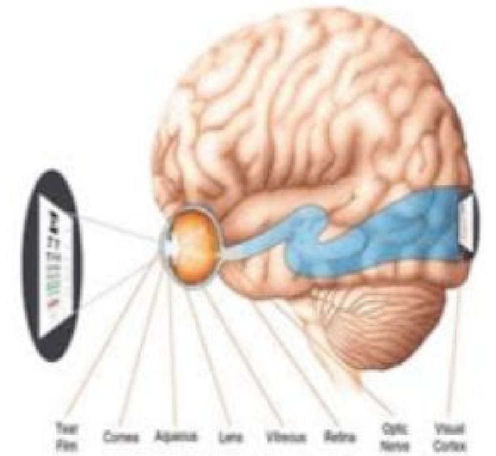
Even though their brains are smaller, the brains of other mammals have the same four lobes of the forebrain as we do. And they are arranged in the same general way.



What do the different lobes do?

The *occipital lobe* is the one on the left side of the picture on the previous page. It is in the very back of your head. Its main job is vision. That's where the brain understands the things you see.

When information comes from our eyes to our brain, it's not organized very well. What our eyes see is actually very blurry.



When we look at something, we can only see it clearly because the occipital lobe is amazingly good at making sense of the information our eyes send it.

The information coming in from our eyes is so confusing that there are special areas in the occipital lobe that specialize in detecting horizontal lines and other areas that specialize in detecting vertical lines. Once those areas figure out where the lines are and how they are shaped, they pass that information onto the next areas. These later areas figure out the full shape of whatever you're looking at and where it is

C. Control exercise (continued)

compared to other things you can see.

The visual areas in the occipital lobe are like the best computer software for editing photographs. They're like a super-charged Photoshop! And we don't even have to think about using it. But it's very important. If someone's occipital lobe is damaged, they can go blind even if their eyes work perfectly!

The *parietal lobe* is where the brain interprets the sense of touch. When we touch a feather, an electrical current—like that in a battery—is sent from our finger up through our spinal cord and into our parietal lobe. This is where the brain translates this touch sensation and identifies the object we touched as soft. In the same way, it helps us understand temperature and pain. It's what lets us know when it is hot outside or that we have a toothache. Think about how dangerous it would be if you couldn't feel pain—you could injure yourself without realizing it!

The *temporal lobe* is responsible for hearing and for producing language. When a person calls you, your ear catches the sound, which is then converted into an electrical signal. That signal is then passed to the temporal lobe. When you talk with your friends, the temporal lobe is what allows you to understand what they are saying. It also helps you think of the right words to refer to different things. People with injured temporal lobes can't speak properly because they can't find the right word for what they're trying to say.

The temporal lobe is also involved in memory. Some of the areas in and around the temporal lobe learn new information and store it for later use. When students remember how to get around their school or what one of their friends looks like, it's because their temporal lobe and the areas around it store that information.

Finally, the *frontal lobe* is the brain's mastermind. It's in the very front of our head, and it's involved in making plans, making decisions, dealing with our emotions, and understanding other people.

Whenever people make a long-term plan or decide what they're going to do, they're doing it with the frontal lobe.

So now you know that different lobes are specialized for different tasks and that their parts are broken up into *areas* that have specific functions. But how do

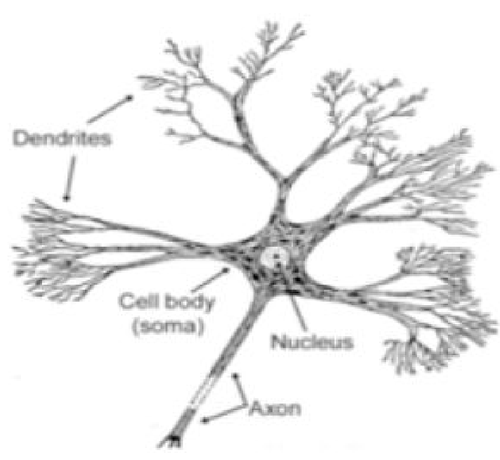
C. Control exercise (continued)

they talk to each other? And what are they made of?

How does the brain work?

The brain is made up of 100 billion tiny cells called neurons. These cells are special because they can communicate with one another very quickly using a combination of electricity and chemicals.

Take a look at the picture below. Each neuron has a cell body, or *soma*. It also has little arms called dendrites coming off to the sides. The dendrites receive information from other neurons. They are called dendrites because they look like branches. Dendrite is the Greek word for branch. Last but not least, most neurons also have an axon that they use to send messages to other neurons.



Through its dendrites and axon, each neuron is connected to many other neurons in a network. These networks are connected to each other in an even bigger network—kind of like computers connected to each other on the Internet.

How does the brain send messages?

When one neuron wants to send a message to another neuron, it sends a message down its axon using an electrical signal called an action potential. Once the signal gets to the edge where the two neurons meet—where the axon of the first neuron touches the dendrite of the second neuron—the axon releases chemicals called neurotransmitters. These are special chemicals that tell the dendrite what kind of message it is.

When neurons form networks with each other, important stuff happens—like the ability to read this!

Of course, there's a lot more to the brain than we can explain here. The brain does many other things that we did not have space to mention. It's a complicated organ, but important.

C. Control exercise: Open response questions

In this article you learned that

- Different areas of the brain control things like how we see and hear
- Your brain helps you do normal things like pick up a phone or do your favorite dance
- Damage to the brain can cause many problems such as blindness or lack of hearing

Think about all the things different parts of your brain will help you do in Bio180. For example, your occipital lobe may help you read the textbook, and your frontal lobe may help to decide where to study. Explain how each of the different lobes in your brain (the occipital, frontal, parietal, and temporal) will help you do what you want to do during the upcoming week.

Imagine a friend of yours thinks the brain is a total mystery that people don't know anything about. Write a letter to your friend explaining that scientists do know a lot about the brain -- tell your friend what you just learned and why the brain is really useful.
For example, you can tell them

1. how they use their brain to do many tasks,
2. how different parts of their brain control different functions,
3. how life can be hard when different parts of the brain are damaged.

You can include any other facts that can help your friend understand the importance of the brain. (Don't worry about spelling or grammar. We just want to know how you would convey this information to another student.)

Appendix 2: Test anxiety intervention

Summary

This appendix reports supplemental data and the intervention materials from the test anxiety experiment.

Tables & Figures

Table S7. Numbers and relative frequencies of students in the control and treatment conditions by gender and class in the test anxiety intervention.

	Control	Treatment
Male	177 (45.5%)	213 (42.1%)
Female	265 (54.6%)	365 (57.9%)
Freshmen	129 (53.5%)	112 (46.5%)
Upper-division	313 (40.2%)	466 (59.8%)

Table S8. SAT scores are biased by gender.

	n	Mean (SD)
Male	379	1300 (141)
Female	614	1263 (145)

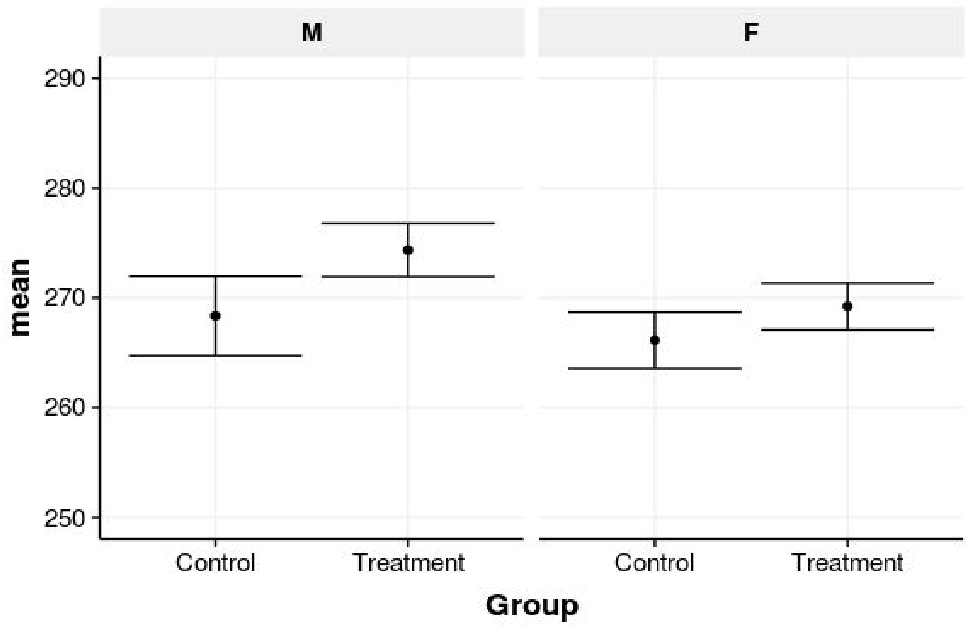
Table S9. Linear regression models used for hypotheses 1-4 tested in the test anxiety intervention.

Hypothesis	Dataset	Model(s)
1	Control & treatment	Pre-course anxiety ~ gender
2	Control	Exam points ~ pre-course anxiety + GPA
		Non exam points ~ pre-course anxiety + GPA
3	Control & treatment	Post-course test anxiety ~ pre-course test anxiety + gender + trt + trt*gender
4	Control	Exam points ~ gender + GPA
		Non exam points ~ gender + GPA

Table S10. Model selection results. The final models reported in the manuscript are in bold.

Model #	Model	Rank	df	AICc	delta
5a	exam ~ gpa + anxiety + trt + gender+ anxiety*gender	1	7	7411.1	0
6a	exam ~ gpa + anxiety + trt + gender	2	6	7411.19	0.09
4a	exam ~ gpa + anxiety + trt + gender+ trt*gender + anxiety*gender	3	8	7411.35	0.25
7a	**exam ~ gpa + anxiety + trt**	**4**	**5**	**7411.46**	**0.36**
2a	exam ~ gpa + anxiety + trt + gender + trt*anxiety + trt*gender + anxiety*gender + anxiety*trt*gender	5	10	7411.52	0.42
1a (Full)	exam ~ gpa + anxiety + trt + gender + gender*gpa + trt*anxiety + trt*gender + anxiety*gender + anxiety*trt*gender	6	11	7412.35	1.25
3a	exam ~ gpa + anxiety + trt + gender + trt*anxiety + trt*gender + anxiety*gender	7	9	7412.79	1.69
4b	non-exam ~ gpa + anxiety + trt + gender + gender*gpa + trt*gender	1	8	6574.7	0
6b	non-exam ~ gpa + anxiety + gender + gender*gpa	2	6	6574.77	0.07
7b	**non-exam ~ gpa + anxiety + gender**	**3**	**5**	**6576.33**	**1.56**
3b	non-exam ~ gpa + anxiety + trt + gender + gender*gpa + trt*gender + anxiety*gender	4	9	6578.18	1.85
5b	non-exam ~ gpa + anxiety + trt + gender + gender*gpa	5	7	6580.18	2
8b	non-exam ~ gpa + anxiety	6	4	6582.49	2.31
2b	non-exam ~ gpa + anxiety + trt + gender + gender*gpa + trt*anxiety + trt*gender + anxiety*gender	7	10	6586.26	3.77
1b (Full)	non-exam ~ gpa + anxiety + trt + gender + gender*gpa + trt*anxiety + trt*gender + anxiety*gender + anxiety*trt*gender	8	11	6591.88	5.62

Figure S3. Distribution of exam scores of male vs. female students in the control or the test anxiety treatment



. Test anxiety interventions

Expressive writing Intervention

A. Pre-question Prompts

Section A: Intervention

Exam 1,2,3,4 (same prompt for all)

You are going to begin by completing a timed exercise—do not start the rest of the exam until we prompt you. We've made the exam significantly shorter than normal to give you enough time to complete this timed exercise.

Instructions for Exercise: Please take the next 3 minutes to write as openly as possible about your thoughts and feelings regarding the test you are about to take.

In your writing, really let yourself go and explore your emotions and thoughts as you are getting ready to take your test. You might relate your current thoughts to the way you have felt during other similar situations at school or in other situations in your life. Please try to be as open as possible as you write about your thoughts at this time.

Use the back of the exam's last page—the surface facing you now.

DO NOT WRITE YOUR NAME ON THIS SHEET. You are doing this anonymously—just for yourself. No one will ever be able to link your writing to you.

If everyone makes a good-faith effort on this exercise, everyone will get +3 points on the exam. Please do not talk to your neighbor at this time.

Section B: Control

Exam 1

You are going to begin by completing a timed exercise—do not start the rest of the exam until we prompt you. We've made the exam significantly shorter than normal to give you enough time to complete this timed exercise.

Imagine someone came to you for advice on how to look for an undergraduate research position. What two key things would you tell them to do in order to look for an undergraduate research position? We want to know specific actions or strategies you would give them , and why you expect these strategies or approaches to be helpful in finding a position.

Use the back of the exam's last page—the surface facing you now. DO NOT WRITE YOUR NAME ON THIS SHEET.

If you make a good-faith effort on this question, you will get +3 points on the exam. Please do not talk to your neighbor at this time.

Exam 2
You are going to begin by completing a timed exercise—do not start the rest of the exam until we prompt you. We've made the exam significantly shorter than normal to give you enough time to complete this timed exercise.

In many fields, scientists are becoming increasingly specialized in terms of their expertise. But at the same time, more and more scientific research is being done by collaborative teams, made up of people with complementary skills. The same is now true for almost all aspects of engineering and clinical practice.

The collaborative work you do in this class—with your lab group, study group, and discussion partners in class—is intended to prepare you for the collaborative work you'll be doing as a professional, in the future (as well as helping you learn more). State whether the group work in this class has been helpful in building your collaborative skills, and explain why or why not.

Use the back of the exam's last page—the surface facing you now. DO NOT WRITE YOUR NAME ON THIS SHEET.

If you make a good-faith effort on this question, you will get +3 points on the exam. Please do not talk to your neighbor at this time.

Exam 3
You are going to begin by completing a timed exercise—do not start the rest of the exam until we prompt you. We've made the exam shorter to give you time to complete this timed exercise.

In planning your career, it can be extremely powerful to be good at two things—for example, being a good health care provider AND speaking a second language, or AND having management or financial skills, or AND being able to do informatics/coding, or AND being a good researcher or teacher.

Question: State your number one career choice right now. State an AND—a "second skill"—that could make you more effective in that career. Explain a) why it would make you a better professional, and b) what you will do, as a Dawg, to cultivate this skill.

Use the back of the exam's last page—the surface facing you now. DO NOT WRITE YOUR NAME ON THIS SHEET.

If you make a good-faith effort on this question, you will get +3 points on the exam. Please do not talk to your neighbor at this time.

Exam 4
You are going to begin by completing a timed exercise—do not start the rest of the exam until we prompt you.

The head of hiring at Google says that in addition to technical ability, he is looking for three traits in prospective employees:
- Ability to think on the fly and pull together disparate bits of information;
- Emergent leadership—stepping forward or back as appropriate;
- Intellectual humility—ability to learn from failure.

Question: Evaluate your current strengths and weaknesses with respect to one of the three traits. State how you will practice this skill (and thus improve) during your undergraduate career.

Use the back of the exam's last page—the surface facing you now. DO NOT WRITE YOUR NAME ON THIS SHEET.

If you make a good-faith effort on this question, you will get +3 points on the exam. Please do not talk to your neighbor at this time.

B. Reappraisal

Exam 1
Intervention
Quiz Instructions: Please do careful work on this exercise--you will get full credit (3 points) for a good-faith effort.
There are many situations (e.g. a music recital, athletic contest, course exam, or job interview) for which people experience a physiological stress response.

This stress response is required for heightened alertness and responsiveness. Humans can respond with a peak performance in stressful situations because they are in a state of physiological arousal, which puts our bodies in an alert state, ready for action.

When our bodies experience a stress response, our minds also produce an emotional response. In this way, the body and mind work together. But the emotional response we have depends in large part on the way we choose to interpret stress and arousal. If we interpret the physiological arousal state as negative, then we experience negative emotions like fear and threat. But if we choose to interpret physiological arousal as positive, then we experience positive emotions like excitement and anticipation.

People who respond really well to stressful situations are those who choose to interpret their body's physiological arousal in a positive manner—they get excited about their body being ready for peak performance during a test, game, or presentation.

Explain why the following three statements are true. In each case, your explanation should be 1-2 sentences.

1. The body's stress response is an adaptation—it leads to increased fitness.
2. The mind's interpretation of the body's stress response is a choice. As such, it can be considered an acclimation and is not heritable.
3. In humans, peak performance usually occurs when a positive emotional state co-occurs with an aroused physiological state.

Control
Quiz Instructions: Please do careful work on this exercise--you will get full credit (3 points) for a good-faith effort.
Most Bio180 students want to have an undergraduate research experience during their time at UW. Many professional schools, graduate schools, and life sciences employers view research participation as an extremely positive or even required experience. In addition, research has shown that students who have undergraduate research experiences are more likely to stay in science than similar students who don't do research, in part because students who do research have an increased feeling of belonging to the scientific community.

Here are the steps we'd advise for you to follow, when looking for a position:

1. Identify a topic or question that interests you.
2. Identify labs where you might like to work by searching lab websites, looking at notices on bulletin boards on campus, talking to students who are already working in labs, or checking the UW's Undergraduate Research Program website.
3. Read papers that have recently been published by people in the lab you are interested in. You will be able to download these papers from the lab's website.
4. Write to the head of the lab—the Principal Investigator or PI. In this email, do the following: Introduce yourself by giving some background on your year in school and your interests, make an observation or pose a question about the work going on in the lab (inspired by the papers you read!), and ask about the possibility of interviewing for a position. You will need to decide whether you need to get paid (as work-study or straight hourly), can volunteer, or want to get course credit.
5. If you don't get a response, don't take it as a rejection. PIs are *extremely* busy. Instead, follow-up with an email to one of the post-docs or grad students in the lab (they will be listed in the lab's website), saying that the PI hasn't had a chance to respond, so you wanted to know if they (the post-doc or grad student) are looking for an undergrad helper. Grad students have a bachelor's degree and are working on a PhD. Post-doctoral fellows have completed a PhD and are doing grant-supported research, usually for 2-5 years, before getting a longer-term faculty or research or teaching job. Most grad students and post-docs love to work with interested, curious, responsible undergrads who are easy to get along with.
6. BE PERSISTENT! Some students have to contact 30 or more labs before finding a position. Be a Dawg!

Finally, be prepared to work on the project at least 10 hours a week, and be aware that most labs want students who are early in their undergraduate career, so they can keep working in the lab for several quarters or years. The gold standard in undergraduate research is that you make enough of a contribution to the work to warrant co-authorship on a paper.

Please answer the following three questions. In each case, your explanation should be 1-2 sentences.

1. Are you most interested in applying to health professional school, grad school, or a job in industry? Why do you think that undergrad research experience is considered so important for your application?
2. It is not advisable to start your query letter to PI's with a statement like, "I want to work in your lab because I need research experience to get into medical school." Why?
3. A lot of day-to-day tasks in science are tedious grunt work—running the same assay over and over, washing glassware, cleaning mouse cages. Why does our advice include the phrases "a question that interests you" and "easy to get along with"?

Exam 2
Intervention: Arousal reappraisal
Quiz Instructions: Please do careful work on this exercise--you will get full credit (3 points) for a good-faith effort.
Recall from an earlier assignment that people experience a physiological stress response in many situations, including public speaking, taking a course exam, or being interviewed for a job. That assignment also claimed that this stress response is required for heightened alertness and responsiveness.

To explore this claim in more detail, consider three specific aspects of the human stress response:
- Heart rate (blood pumping) increases;
- Breathing rate (oxygen intake) increases; and
- Glycogen stored in the liver and muscle is broken down to glucose (a sugar that supplies energy), which enters the bloodstream.

Note also that even though the brain is only about 2% of human body weight, it receives almost 20% of the total blood supply. It is also the organ with the highest demands for oxygen (it uses 25% of the body's total) and for energy in the form of glucose (it uses 20% of the body's total).

Explain why the following event supports the claim that the stress response leads to heightened alertness and responsiveness. Your explanation should be 1-2 sentences and focus on the underlying physiology.

1. Increased heart rate:
2. Faster breathing:
3. Glycogen breakdown:

Control
Quiz Instructions: Please do careful work on this exercise--you will get full credit (3 points) for a good-faith effort.
As part of your professional development, it will be important for you to understand some key aspects of how science works.

Funding
Most scientific research in the U.S. is funded by grants from the federal government, with a smaller proportion supported by grants or contracts from private companies or foundations. The University of Washington, for example, regularly attracts over $1billion per year in federal research support—highest among all public universities in the U.S. Much of this funding comes from the National Institutes of Health (NIH), which funds biomedical research, and the National Science Foundation (NSF), which funds basic research in all of the sciences and engineering fields. Grants are difficult to obtain—many NIH and NSF programs fund 10% or less of the proposals they receive.

Peer review

The head of a research lab is called the Principal Investigator, or PI. When a PI submits a grant to fund a research project, the proposal is reviewed by a panel of experts who are recruited by the granting agency. If the work is funded and the research succeeds in discovering an interesting result, the PI will collaborate with other members of the research team to publish a paper in a scientific journal. Most journals publish only peer-reviewed papers, meaning that an editor at the journal recruits experts in the field to analyze the paper and confirm that the methods and data are of high quality. Many papers are rejected for publication and have to be revised extensively, submitted to a different journal, or abandoned.

Science is considered self-policing because other research groups may try to replicate the published results. If they cannot, they will publish data that conflict with the original results. Or if they find flaws in the methods or data analysis, they can publish their criticisms in the journal where the work was originally published. When this happens, the original authors are invited to respond. But if the original result holds up to scrutiny, other researchers will start projects that build upon the data and ideas and extend them.

The Mentoring Ladder

In addition to a PI, most labs have post-doctoral fellows (individuals who have completed a PhD and are working on a grant-supported research project), graduate students (individuals working toward the PhD degree), and undergraduates. Some may also have a lab manager or technician who takes care of ordering, training, and other administrative tasks. There is a "mentoring ladder" in science because the PI supervises the post-docs who work with graduate students who supervise undergraduates. Science is also an increasingly collaborative exercise. Almost no papers have a single author, and in some fields it's not uncommon for a paper to have dozens or even hundreds of authors.

Please write 2-3 sentences explaining the following observation: In some respects, science is a competitive enterprise; in other respects, it is intensely collaborative.

Exam 3

Intervention

Quiz Instructions: Please do careful work on this exercise--you will get full credit (3 points) for a good-faith effort.

Recall from earlier assignments that situations like public speaking, taking a course exam, or being interviewed for a job trigger a physiological stress response. Those assignments also maintained that:

- the stress response is adaptive because it results in heightened alertness and responsiveness, and
- people can choose to interpret the physiological symptoms in a positive or negative way—leading to either excitement and anticipation or fear.

To explore these ideas in more detail, consider another aspect of the human stress response: redirection of blood flow. During the stress response, blood is re-routed in two ways:

- away from the periphery of the body—especially the hands and feet—and toward the body core; and
- away from the digestive tract and toward the muscles and the brain.

Question 1

In 2-3 sentences, explain why people experiencing the stress response often get

a) cold hands or feet, and

b) the "butterflies" (or even nausea!).

Question 2

Analyze how redirection of blood flow during the stress response, resulting in increased blood volume reaching the brain, impacts alertness, responsiveness, and the ability to think quickly. (1-2 sentences)

Control

Quiz Instructions: Please do careful work on this exercise--you will get full credit (3 points) for a good-faith effort.

As part of your professional development, we want to encourage you to think about the array of career options available to individuals with a degree in the life sciences.

When we survey Biology 180 students about their preferred career options, 85-90% of people will list one of the five following jobs: physician, biomedical researcher, dentist, pharmacist, or public/global health professional.

These can certainly be fantastic careers, but you should also be aware that when we analyzed what UW Biology majors actually do once they are out of school, we came up with a list of 126 jobs. Go Dawgs!

In addition, consider the job postings published by Life Sciences Washington--a trade group representing about 600 companies in Washington state whose products and services relate to biology. They send out a "Job Flash" twice a month, each time listing 60-80 vacancies. The President of the group once said, "My companies are desperate to find skilled employees."

Suppose the career that is currently your number one choice doesn't work out. What is your plan B, and your plan C? For each career option, state:
a) What it is;
b) Why it's attractive to you; and
c) What you will do to prepare for it during your undergraduate career.

Exam 4

Intervention

Quiz Instructions: Please do careful work on this exercise--you will get full credit (3 points) for a good-faith effort.

This is the last of four online exercises focused on situations like public speaking, taking a course exam, or being interviewed for a job. The previous exercises noted that situations like this trigger a physiological stress response. This acclimation response is normal and adaptive and includes:

- Faster heart rate that increases blood flow to the brain;
- Higher breathing rate that increases blood oxygen levels in the brain;
- Release of energy-rich glucose from storage areas into the bloodstream;
- Redirection of blood flow away from the gut and periphery of the body to the brain.

All of these responses increase the body’s capacity for heightened alertness and performance.

As an earlier exercise noted, however, Neuroscience research has shown that there is a critically important connection between the mind and body during the stress response. There is a continuum of how people can choose to interpret the stress response, ranging from fear and threat (“There must be something wrong with me”) on one end to eagerness and excitement on the other (“I’m pumped up and ready to go. Let’s do this!”). There is a mountain of scientific evidence showing that those who choose to interpret the stress response as fear usually perform worse than those who choose to interpret the stress response as excitement.

Question

Suppose a close friend is about to interview for an important job, and you notice that he seems a little stressed.

1. What message would you tell him?
2. How will this message help him move toward eagerness and excitement?

Control

Quiz Instructions: Please do careful work on this exercise--you will get full credit (3 points) for a good-faith effort.

Many or most Biology 180 studies plan to eventually attend a graduate or professional school. To prepare for this, it is important to think carefully about what admissions (and hiring) committees are looking for. Here are the top four traits that professional and graduate schools ask recommendation writers to comment on (these are also traits that Google and other top companies are looking for):

· Strengths/unique characteristics (in some cases, recommenders are asked to specifically

evaluate problem-solving ability, curiosity, and/or creativity);
· Ability to get along with people (sometimes the prompt refers to collaboration or working with others);
· Ability to handle stressful or disappointing situations (this prompt may also refer to emotional maturity, emotional intelligence, or self-management);
· Oral and written communication skills.

It’s also interesting to think about the types of interview questions you might get. Kanter (2012; *Academic Medicine* 87:387) considers these to be the three most-revealing interview questions for applicants to health professional schools:

1. What are you going to do to change the world?
2. Tell me about a book you have read recently. How has it changed you?
3. Do you enjoy your own mind? And if so, how?

Question 1

Pick one of the top four “what they’re looking for” traits.

a. Answer it as though you were recommending yourself (do a self-evaluation). In doing so, you MUST back up any claim that you are making about yourself with convincing evidence.

b. Describe what you will do, during your undergraduate career, to improve with respect to this trait.

Question 2

Pick one of Kanter’s three most-revealing questions, and answer it.

Appendix 3: Focus groups

Summary

We ran focus groups with students to learn more about potential psychological barriers that exist in our local context—specifically how they responded to exam and to opportunities to participate in class. Our goal was to explore possible causes for the gender-based differences in exam scores and class participation documented in Eddy et al. (2014).

Methods

We chose focus groups over one-on-one interviews because we hoped to encourage interaction based on shared experiences and concerns, and to reduce students' apprehension. The focus groups involved students who had taken the course during the Mindset experiment (see Appendix 1) and met early in the subsequent term (Winter quarter 2016). There was an approximately three-week interval between the end of the course and the focus group sessions.

Sampling and format

Participants were recruited via an email to the entire course-list; the text presented the focus group as a way for students to share their thoughts about the course in a safe space with the intent of improving it. Respondents were divided into four groups: high-performing females, high-performing males, low-performing females, and low-performing males. High and low designations were relative to the median grade: high-performing students were defined as those who received a grade ≥ 3.0 on a 4.0 scale, and low-performing students were defined as those who received a grade < 3.0. Potential candidates for the focus groups were placed in one of the four binned groups. Students were then purposefully sampled based on gender and grade attained in the course to select three to six final participants for each focus group (with 19 participants total). All focus group participants received compensation in the form of a $25 gift card. A summary of focus group participants by class is available in Table S7.

At the beginning of each focus group session, participants signed a release form permitting the use of their responses for research purposes. To focus participants' thoughts, the students were asked to respond to a writing prompt. When this task was complete, participants were asked to share their written responses verbally. The remainder of the session, representing about 80% of the 60-minute schedule, was devoted to addressing a common set of questions about the students' experiences in introductory biology. The questions were designed to address the gender differences in the course documented by Eddy *et al.* (2014) and by the Mindset experiment summarized in Appendix 1. Questions were divided into two main themes: (1) the students' experiences taking exams (i.e. "Explain the feelings you experienced as you were taking Biology 180 exams?") and (2) their experiences with in-class participation (i.e. "How did you feel about answering questions in front of the entire class?"). Within each theme, the focus group facilitator pursued semi-structured follow-up questions. The writing prompt that started each session and a full listing of questions about exams and course participation are provided below. We focus on the first theme in the following analyses.

Qualitative Data Analysis

We used an explanatory mixed-method design to pursue our goal of using qualitative data to explain or provide enhanced meaning to our quantitative data (Creswell and Clark, 2011). Specifically, we employed a content analysis to provide meaning to the gender differences observed in this course. A content analysis seeks to describe a particular phenomenon by representing segments of text through coding (Hsieh and Shannon, 2005). We chose to analyze the interview data by coding students' comments related to their emotional experience during exams—all of which were negative. An emotional comment could be something explicit, where they relate being angry or anxious, or it could be more implicit where their tone or word choice alludes to a particular emotion. We also analyzed students' statements dealing with other academic experiences such as studying, coping with grades, homework, and in-class activities, because these situations can mediate their exam experiences.

Initial coding began by making thorough readings of the transcripts, identifying quotations relating to students' explicit or implicit discussion of their emotions, asking questions of the data, and making notes about the identified quotations. Next, each quotation was re-evaluated and assigned a code. Finally, two independent researchers used that suite of codes to qualify all of the identified quotations. The resulting code lists were used to calculate a Cohen's kappa of 0.87, which is considered a strong degree of interrater reliability (McHugh, 2012). We focused on codes related to negative statements about the course, as we

Results

Six codes emerged from the data regarding the emotional experience of exam-taking (Table S8). The first five codes were emotions experienced by students, including test anxiety, low self-efficacy, academic frustration, student anxiety, and disconnect. The sixth code was an explicit avoidance of emotion, which we refer to as dismissive. We converted the total numbers of coded statements to percentages to normalize the data across participant groups.

Low-performing male participants had the lowest total percentage of coded statements related to academic emotions (54%), followed by high-performing men (69%). Low-performing women (94%) and high-performing female participants made the most statements relating to academic emotions (96%). Students in all groups made statements about test anxiety.

Summary of findings

Our data agree with literature indicating that women in STEM have reduced self-efficacy, have trouble feeling like they connect with the domain, and are vulnerable to experiencing academically related negative emotions (Schmader *et al.,* 2008). In a recent study, highly anxious students were more likely to bring up topics related to identity, low self-efficacy, and academic frustration (Pelch 2018). That work suggests that women are more susceptible than men to becoming trapped in a self-deprecating feedback loop of academic emotions that leads to low-performance (Pelch 2018).

Although both male and female students in our focus groups expressed a variety of negative academically related emotions about exams (i.e., frustration, anxiety, efficacy), negative feelings were much more prevalent among females. These negative emotions may, in turn, derail how well women perform relative to their preparation and ability.

Is this phenomenon general across STEM, or unique to this introductory biology course? Do the statements about negative emotions concerning exams corresponding to differences in state anxiety during exams, or is it more likely to impact exam preparation? If this gender-based asymmetry in negative emotions about exams is real, what is the root cause? Answering these questions will require research that goes far beyond the preliminary work reported here.

Tables & Figures

Table S11. Focus group demographics.

		High-performing females	High-performing males	Low-Performing females	Low-Performing males	Total
Freshman		0	2	2	0	4
	Soph	3	2	2	1	8
	Jr	2	1	1	2	6
Upper-division	Sr	0	0	1	0	1
Total		5	5	6	3	19

Table S12. Codes used in the qualitative portion of this study.

Code	Description	Example Quotation
Test Anxiety	Participants' statements about anxiety directly related to exams.	"I felt very kind of anxious and rushed in the exams…"
Student Anxiety	Participants' statements about anxiety relating to courses and classroom session but not directly related to exams.	"It was nerve-wracking. It felt like [*sic*] if you got it wrong it was like a public shame."
Academic Frustration	Participants' statements interpreted to be associated with some level of academic frustration or anger.	"...and it was kind of weird in what should I expect from the grade? What should I expect from the grader? Or how should I be going about doing this test?"
Low Self-Efficacy	Statements where participants' voiced some degree of doubt in their ability to do well in the course or in their capability to succeed academically.	"I just felt myself shutting down, like this was going to be what it was going to be. It was kind of dream-crushing."
Disconnect	Occurrences where participants' voiced a concern that their grades did not reflect what the "feel" that they learned or when their expectations of the course were not met.	"Like [*sic*] I guess my exam scores were lower than I thought reflected what I knew.."
Dismissive	Occurrences where participants' seemed aloof about their emotions, or avoided discussions about their academic emotions.	"...at the end I was sort of like [*sic*], I get what I get. Yeah, I was more indifferent about it."

Focus Group Questions

Exam Experience

Written prompt:
Explain the feelings you experienced as you were taking Biology 180 exams.

Oral questions:
1. Can you give a brief summary of what you wrote?
2. How does your described experience compare to how you feel during exams in other colleges courses, such as Chemistry?
3. Can you describe how you prepared for Biology exams?

Class Participation

Written prompt:
How did you feel about answering questions in front of the entire class?

Oral questions:
1. What would make you more or less likely to speak in front of a lecture class?
2. How did you feel when the instructor used the random call list?
3. In comparison to other classes you've taken at UW, how comfortable were you with speaking in front of the Biology 180 lecture class?

References

Creswell, J. W., & Clark, V. L. P. (2011). Designing and conducting mixed methods research. SAGE.

Eddy, S. L., Brownell, S. E., & Wenderoth, M. P. (2014). Gender gaps in achievement and participation in multiple introductory biology classrooms. *CBE Life Sciences Education, 13*(3), 478–92.

Freeman, S., Haak, D., & Wenderoth, M. P. (2011). Increased course structure improves performance in introductory biology. *CBE Life Sciences Education, 10*(2), 175–86.

Hsieh, H., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277–88.

McHugh, M. L. (2012). Interrater reliability: the kappa statistic. B*iochemia Medica, 22*(3), 276–82.

Pelch, M. (2018) Gendered differences in academic emotions and their implications for student success in STEM. *International Journal of STEM Education 5*:33.

Schmader, T., Johns, M., & Forbes, C. (2008). An integrated process model of stereotype threat effects on performance. *Psychological Reviews*, *115*(2):336-356.