

**How Can We Instill Productive Mindsets at Scale?
A Review of the Evidence and an Initial R&D Agenda**

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Executive Summary

Research has increasingly shown that there is more to student success than cognitive ability, curriculum and instruction. Students' *mindsets*—their beliefs about themselves and the school setting—can powerfully affect whether students learn and grow in school. For example, when students have a *fixed mindset*, they believe that their intelligence is something that is finite and unchangeable. This makes them doubt their intelligence when they experience difficulty and it undermines resilience and learning. However, when students have more of a *growth mindset*, they believe that intelligence can be developed. In this mindset, students respond more resiliently to challenges and show greater learning and achievement in the face of difficulty. Randomized experimental studies find that even brief interventions that convey a growth mindset can have important, lasting effects on student learning and performance. For instance:

- In an experiment with over 250,000 students learning math concepts on the Khan Academy website, growth mindset encouragement presented at the top of the screen (e.g., “*When you learn a new kind of math problem, you grow your math brain!*”) increased the rate at which students successfully solved math problems even months after students no longer saw the message, compared to controls who did not see this message.
- In an experiment conducted with over 1500 students at 13 high schools across the country, learning the growth mindset for one classroom session over the Internet reduced the percent of courses failed by low-achieving students by nearly 7 percentage points, compared to control group students.
- In an experiment with over 7,500 students at a state university with high dropout rates, a web-based growth mindset intervention completed the summer before freshman year increased the percentage of students earning 12+ credits in the first term by 3-4 percentage points (vs. controls), an effect that was larger for African American students (10 percentage points). Earning 12+ credits strongly predicts on-time graduation.

How can we deploy research on students' mindsets to help more students succeed in school? While it can be helpful to redirect students' mindsets using brief interventions, it may also be helpful to create everyday experiences that reinforce productive mindsets. Doing so is not always straightforward, as there are many ways the essential psychological message can be lost at scale. Scaling responsibly will require dedicated R&D efforts in three areas:

- *Principles*: Understanding how to maximize the effects of mindset interventions.
- *Practices*: Expanding the “toolkit” of day-to-day practices that instill adaptive mindsets.
- *Assessments*: Developing measures that allow for more rapid learning from practice.

With significant investments in these areas, researchers and practitioners can more confidently apply research on mindsets to effect large-scale changes in education—to make educational outcomes more equitable by reducing achievement gaps, to make school more enjoyable by placing the focus on learning and improving rather than on demonstrating raw intelligence, and to make school more efficient by allowing students to take better advantage of learning resources already available to them.

How Can We Instill Productive Mindsets at Scale? A Review of the Evidence and an Initial R&D Agenda

Why do some students shrink from challenges and wilt in the face of difficulty while others thrive on challenges, achieve, and fulfill their potential? Imagine a low-income student who is not learning in school, even with a well-trained teacher using appropriate content and pedagogy. When the student is given hard tasks and critical feedback, the student shuts down, does not ask for help, and hides misunderstandings. Why? In recent years, a growing body of experimental research has begun to answer this question.

This research shows that there is more to student success than cognitive ability or the quality of the classroom curriculum. Students' *mindsets*—their beliefs about themselves and their school environments—can powerfully affect whether students engage and learn in school or do not.¹ Students who conclude “I’m dumb at this” or “People like me don’t belong here” may not exhibit the tenacity needed to persist in school, regardless of their cognitive ability or the quality of the instruction they receive. Yet when educators are armed with a precise understanding of the psychology of mindsets, they can create improvements in academic outcomes even among chronic low performers. Brief but theoretically-grounded interventions, sometimes delivered over the Internet directly to students and sometimes delivered by teachers in classroom workshops, can redirect negative thoughts like “I’m not a math person” or “I’m afraid to make mistakes” and refocus students on learning. When this is done, students often earn higher grades and are more likely to stay in school, in some cases months or years later. Crucially, many of these findings come from the strongest kind of research design for making causal inferences—double-blind field experiments involving large numbers of students each randomly assigned to a treatment or control condition, with student outcomes obtained from official school records.²

While much research has shown that it is possible to redirect mindsets and raise achievement in the context of a randomized experiment, the field must understand *how to do so reliably, at scale, for diverse populations of students in diverse contexts*. The ultimate goal of these efforts is to create a specific psychological experience for students—one that removes a major barrier to learning and allows students to benefit fully from the educational resources in their environments. As with all research-based educational improvements, many factors can make it difficult to recreate a psychological experience at scale. The present document provides a potential R&D agenda that outlines how the field might begin to learn to successfully use mindset research to remove psychological barriers to learning in diverse contexts.

Although the R&D recommendations outlined here apply to several different research-based mindset interventions—for instance, interventions to change students’ mindsets about their social-belonging in school, interventions to reduce the impact of negative stereotypes in school,

¹ Garcia & Cohen, 2012; Wilson, 2011; Yeager & Walton, 2011

² See below for a description and see Appendix 2 for technical details.

and interventions to remind students of the relevance of their schoolwork³— the present document focuses on *mindsets about intelligence*.⁴ This is because mindsets about intelligence have a great deal of data available in terms of implementation at multiple levels by multiple sources—teachers, researchers, parents, private industry, etc. These data provide a useful case study for illustrating broad themes relevant to other mindsets and perhaps to the “non-cognitive” field more generally.

Definitions of Non-Cognitive Skills and Mindsets

In recent years, there has been a growing understanding of the *non-cognitive skills* that promote student learning.⁵ These factors are called “non-cognitive” because they are not the specific or general intellectual skills that are typically implicated in learning. In another sense these so-called non-cognitive factors are quite “cognitive”—they often involve beliefs or learning strategies that students have developed. Nonetheless, we, along with the broader academic and non-academic community, tend to call the broad cluster of “non-intellectual” factors that affect academic or professional outcomes “non-cognitive skills.”⁶

One set of non-cognitive factors involves *academic mindsets*. Academic mindsets, broadly defined, involve students’ perceptions of themselves and/or their learning environments, and can affect how students perform and whether they put forth or withdraw effort in the face of academic adversity. This includes, for instance, a belief that one’s *intelligence* is fixed versus can grow and improve, a belief that one *belongs* and will be valued in a setting, and a belief that one’s schoolwork has *relevance* for important life goals. It also involves the negative stereotypes that give rise to anxiety, which can interfere with performance.⁷ Past research has found that successfully addressing each of these mindsets, sometimes using brief (1-2 session) theory-based interventions (similar to those outlined below), can improve student performance and reduce achievement gaps in a way that endures over time.⁸ As noted above, we focus primarily on mindsets about intelligence, while acknowledging the important influence that other mindsets have on student outcomes. See the bibliography in Appendix 1 for some prominent examples of other targeted interventions that address student mindsets and related non-cognitive factors.

What Are Mindsets About Intelligence?

³ See Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2009; Hulleman & Harackiewicz, 2009; Walton & Cohen, 2011; also see Ramirez & Beilock, 2011. Also see the bibliography in Appendix 1.

⁴ Blackwell, Trzesniewski, & Dweck, 2007; Dweck, 2006.

⁵ See Dweck, Walton, & Cohen, 2011; Farrington, Roderick, Allensowrth, Nagaoka, Keyes, Johnson, & Beechum 2012; U.S. Department of Education, Office of Educational Technology, 2013.

⁶ See the Farrington et al. 2012 report for more background.

⁷ See Blackwell et al., 2007; Cohen et al., 2009; Ramirez & Beilock, 2011; Hulleman & Harackiewicz, 2009; Walton & Cohen, 2011.

⁸ Also see Garcia & Cohen, 2012; Yeager & Walton, 2011.

Carol Dweck and others have shown that many students have what is called a “fixed mindset.” This is the idea that your intelligence is a fixed quantity—something you only have a certain amount of. Students with a fixed mindset tend to agree with survey items like: “*You have a certain amount of intelligence, and there is not much you can do to change that.*”

In controlled laboratory experiments and in long-term studies in schools, a fixed mindset has many consequences.⁹ See Table 1 for an overview. First, fixed mindset students avoid challenges. They want easier problems that will make them look and feel smart. Second, a fixed mindset leads to unproductive beliefs about effort, like “*If I have to try hard, I’m not smart*” or “*There’s no point in trying if I’m not a natural.*” Last, fixed mindset students are not resilient. Instead, they hide their setbacks and deficiencies, not wanting people to see them as having low ability. They fail to ask for help and even lie about low scores when asked about their performance. And so it is not surprising that in a study of urban minority middle school students, holding a fixed mindset predicted lower math grades over several years.¹⁰ The same findings emerge in many other age groups and contexts.¹¹

Table 1. Fixed and growth mindsets about intelligence.

	Fixed mindset	Growth mindset
Goals	Look smart (don’t look dumb)	Learn
Value of effort, help and strategies?	Lower	Higher
Response to challenge	Tendency to give up	Work harder and smarter
Changes in grades during times of adversity	Decrease or remain low	Increase

Importantly, many students hold the opposite belief—what is called a “growth mindset.” This is the idea that your intelligence has the potential to grow and improve in response to effort, good strategies, and help from others. These students agree with survey items that portray intelligence as a quality that can be developed. From the perspective of a growth mindset, an academic challenge is not a threat to your raw ability; it is an opportunity for learning and improvement. In a growth mindset, effort is a good thing: a student might say “trying harder makes you smarter.” In the face of a problem they cannot solve, a growth mindset student will be resilient, seeking appropriate help or switching strategies, rather than hiding their confusion. In longitudinal studies, a growth mindset predicts an upward trajectory in grades even across difficult school transitions.¹²

What is Known About How to Affect Mindsets?

⁹ See Yeager & Dweck, 2012, for a review of this research.

¹⁰ Blackwell et al., 2007

¹¹ Yeager, 2012

¹² Blackwell et al., 2007

There are at least two ways to think about how to influence students' mindsets in educational settings. First, **everyday interactions** with students, such as the way parents and teachers praise performance, frame critical feedback, structure grading systems, or talk about race and gender, can have a profound effect on mindsets.¹³ Second, researchers have developed **precise, theory-based interventions** that redirect students' thinking toward a growth mindset. These can involve classroom- or Internet-based reading, writing, or video activities lasting from one to several class sessions. Below, we briefly review research demonstrating both ways to affect student mindsets. Next, we outline the key areas of R&D that will help us to apply the lessons from this research more broadly.

Everyday interactions. A number of studies have documented that subtle verbal feedback from adults can put children in a fixed mindset and undermine motivation, and that this can happen even from valued caregivers who are trying to encourage children. A classic paper by Claudia Mueller and Carol Dweck showed that praising young adolescents for their intelligence—saying they were “smart” when they did well—created a fixed mindset and its problems.¹⁴ It put students in a world in which people evaluate intelligence. In contrast, praising the student’s “process” (their effort or strategies) put children in a growth mindset and fostered resilience.¹⁵ In related research, Aneeta Rattan and Catherine Good showed that comforting struggling math students by saying the equivalent of “Overall, you’re smart, but it’s okay—some people just aren’t good at math” taught students a fixed mindset and compromised their motivation. In both cases, practitioners who say these things may be trying to help students feel good. But ironically, these well-intended practice undermine resilience.

Thus, how adults talk to students can change their mindsets and increase their academic tenacity. Can such verbal input, if heard repeatedly, create longer-term changes in a child’s overall motivational framework? Two new studies suggest that it can. Gunderson and colleagues found that how parents praise 1-3 year-old children—whether they praise the child’s effort and process versus ability—predicts whether the child will have a growth mindset and a desire for challenge 5 years later. Similarly, Pomerantz showed that children aged 8 to 12 whose mothers used person praise (“you are smart”) rather than process praise (“you tried hard”) showed more change in the direction of a fixed mindset over a six-month period.¹⁶ Children whose mothers praised smartness also tended to avoid challenges and instead chose tasks where they would learn less but would not fail. It is easy to see how those students, over time, would acquire less knowledge, especially in the face of the rising difficulty of academic work in the middle school years.

In sum, both experiments and longitudinal studies show that even brief everyday interactions that support a growth versus fixed mindset can produce different motivational frameworks in students and powerfully affect learning.

¹³ cf. Masten, 2001

¹⁴ Mueller & Dweck, 1998

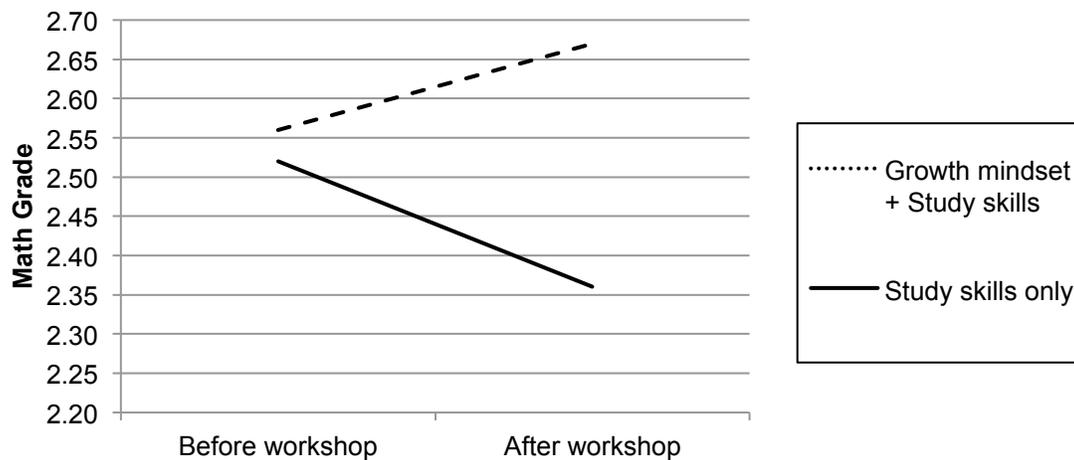
¹⁵ Also see Kamins & Dweck, 1999.

¹⁶ Pomerantz & Kempner, in press.

Precise, theory-based persuasive interventions. As shown above, daily verbal feedback from valued adults, even if well-intended, can create a fixed mindset. Yet through precise theory-based interventions it is possible to soften the built-up residue of a fixed mindset and create lasting changes in motivation and learning. Crucially, this is possible both during adolescence and even later in adulthood. These interventions teach students about neuroscience studies that demonstrate the brain’s potential to grow and change as well as the implications of this fact—that if you get confused or stumble, it does not mean you are “dumb.” The intervention teaches that, in fact, by coping with difficulty and confusion you can grow new connections in your brain become “smarter.” Below, we summarize several interventions that tested this strategy.

Example 1: Classroom-based workshops. Lisa Blackwell and Carol Dweck created an eight-session workshop to teach a growth mindset and study skills and evaluated it with low-income and minority 7th graders in New York City.¹⁷ In it, students learned to think of their brains as muscles that get stronger as you exercise them. Students visualized new neuronal connections growing as they completed hard math problems. Treatment group students also received six sessions of study skills. Blackwell et al. compared this to a control workshop that learned only study skills for eight sessions. The researchers found that the study skills control group continued the normal decline in math grades commonly experienced by middle schoolers. Students who learned the growth mindset with the study skills, however, showed a sharp rebound in their grades, performing significantly better at the end of the semester. See Figure 1.

Figure 1. Effects of growth mindset training on 7th grade students’ math grades (adapted from Blackwell, Trzesniewski, & Dweck, 2007).



Example 2: Internet-delivered one-time reading and writing exercises. Studies such as that conducted by Blackwell et al. have shown that it is possible to change student mindsets through informative workshops. However, at scale, it can be difficult to rely on this strategy because it involves intensive teacher training—something that can introduce heterogeneity in

¹⁷ Blackwell et al., 2007

implementation and also be time and cost-intensive. Furthermore, teachers may prefer even briefer interventions. In recent years, then, Dave Paunesku, Carissa Romero, Greg Walton, and David Yeager have tested whether it is possible to distill the essential messages in the classroom-based mindset interventions into briefer activities (~ 30 minute) and deliver them over the Internet directly to students. If effective, this approach would allow researchers and practitioners to scale mindset interventions to large numbers of students without incurring the human resource costs of visiting every school with trained facilitators.

In the past two years this strategy has been tested with thousands of students. Each test has followed the same general procedure. Below we describe the overall intervention materials and evaluation methods, followed by the results for each population. Because this approach is new, the data have not been published in academic outlets. Therefore details on the procedures and statistical models are presented in the appendix.

Overall intervention procedure. In each of the studies summarized below, a growth mindset was communicated to students via a custom website that students visited either in their school's computer lab during school hours or on their own computer at a time of their choosing (for college students). When students visited this website, the computer randomly assigned them to be presented either with a growth mindset intervention or a control intervention. When they completed the intervention, they were thanked and, from their perspective, the study was over. Student academic records were then obtained from the school or from a national database, depending on the study.

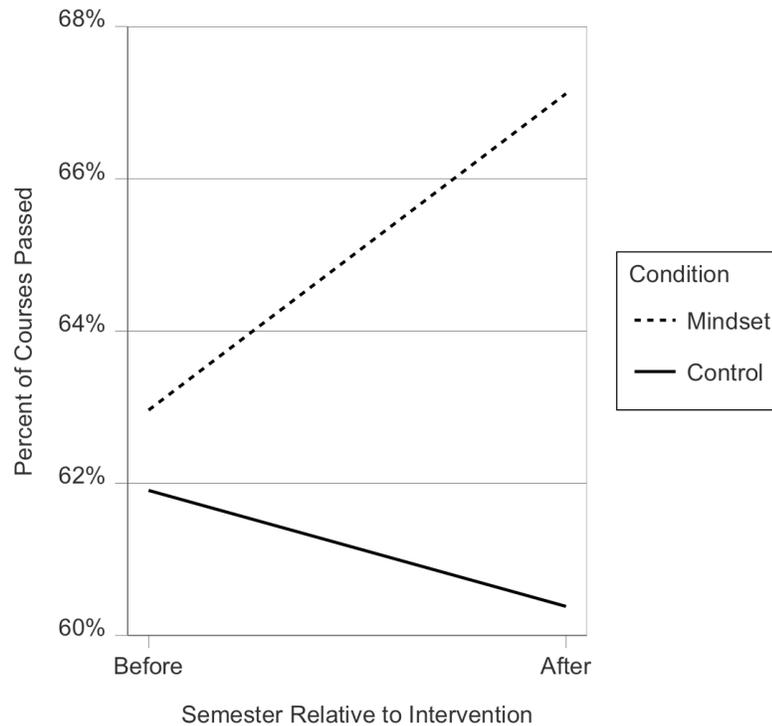
Students randomly assigned to the growth mindset intervention condition typically read an article describing the brain's ability to restructure itself as a consequence of effort and changing strategies. The article focused on the implications of these neuroscientific findings for students' potential to become more intelligent through study and practice. This message was reinforced through several writing exercises. In the first, students summarized the scientific findings in their own words. In the second exercise, they read about a hypothetical student who was becoming discouraged and starting to think of himself as "not smart enough" to do well in school. Students were asked to advise this target student based on what they had read about the growth mindset. In a control condition, students completed an analogous activity that taught facts about memory and the brain but did not mention that intellectual ability is malleable. Below, we describe the effects of this intervention procedure in several different populations.

High school students. Some experiments have tested whether a growth mindset intervention could affect low-achieving high school students' GPAs across all academic subjects (Math, Science, English and History). In the spring of 2012, students at 13 high schools across the country ($N = 1594$) participated in a web-based growth mindset intervention experiment. At the end of the term, students' official grades in academic subjects were collected. Analyses focused on changes in overall GPA and on the percent of courses failed.

There were significant but small effects for the whole sample. However, among the low-achieving students (bottom tercile), the growth mindset treatment improved overall GPA by 0.18 grade points, a significant improvement. Much of this effect was explained by preventing students from failing their courses. Within this high-risk population of students, control-group

students passed 60% of their classes, compared to 67% among growth-mindset treatment group students. This is depicted in Figure 2.

Figure 2. Effects of growth mindset training on high school students' course passing rates, among low-performing students (the bottom third in terms of pre-intervention GPA).



Community college students. Nationally, community college students are disproportionately more likely to be low-performing, low-income or students of color. Thus an important question for creating educational equality is whether it is possible to improve these students' prospects for completing a college credential. Paunesku, Yeager and colleagues tested this in a study similar to that described above, conducted with students at a community college in the Los Angeles metropolitan area (predominately Latino students; $N = 715$) in the Fall of 2011. At the beginning of the Fall semester, students completed the one-session growth mindset intervention via the Internet. At the end of the term, researchers obtained official records from the registrar. The primary outcome was post-intervention GPAs in all academic subjects (Math, Science, English, History, etc.). Analyses showed that the one-time growth mindset intervention raised overall GPA by 0.18 grade points compared to the control group who learned facts about the brain, a significant difference.

A secondary question was whether a growth mindset message might benefit students who might be most likely to have a strong belief that they are not “math people”—that is, students who have enrolled in community college but are taking developmental (pre-college) math. Indeed, in a survey of developmental math students at 21 colleges across the country conducted by the Carnegie Foundation for the Advancement of Teaching, nearly 70% of students endorsed a fixed mindset about math ability, saying a person is just a “math person” or not, and there is nothing

they can do about it.¹⁸ In the present study, we looked at the effects of the intervention specifically on math course dropout among the sub-sample of developmental math students ($N = 292$). The growth mindset treatment reduced dropout from the course by over half (Control: 20% dropped out; Growth mindset treatment: 9% dropped out), a significant difference. Thus, learning that your “math brain” can grow and develop could benefit even adults who have likely experienced a lifetime of feeling “dumb” at math.

Students transitioning out of a high-performing charter school. Other recent experiments have tested whether growth mindset interventions might help address college persistence problems faced by graduates of high-performing urban charter high schools. Many high-quality charter schools such as KIPP, YES, Aspire, Achievement First, or Mastery achieve high graduation and college acceptance rates, relative to comparable students at traditional schools or lower-performing charter schools. Yet these high-performing schools report that far too few of their students successfully complete college within 6 years—in some cases fewer than half. Some might view this as a critique of the school curriculum or student body. Another possibility however is a psychological one—perhaps students’ mindsets contribute to the difficulty they have persisting until graduation.

Building on past research by Joshua Aronson, Catherine Good, and Claude Steele,¹⁹ a new intervention conducted by Yeager, Walton, and Dweck rested on the notion that racial minority students may worry that their intellectual ability will be viewed negatively in college, and that this worry could be an impediment to persistence in college. If so, then learning that intelligence is not a fixed trait but can be developed through education might alleviate some of the threat of negative stereotypes and allow students to more readily embrace the challenges of college.

In light of this possibility, Yeager, Walton, and Dweck conducted a growth mindset intervention with all outgoing seniors at two urban charter schools on the East coast ($N = 160$) in the spring of 2012. Nearly all of the students were African American and low-income (i.e., received free or reduced-price lunch). In May of senior year students completed a version of the brief web-based growth mindset materials described above (randomly assigned at the individual level). This intervention was customized through a four-month R&D process that drew on extensive focus groups, interviews, and pilot tests. The customized intervention emphasized not only that people’s intelligence can be developed but also that your “know how” in college—your skills in navigating the environment—can grow and improve as you face new challenges. It communicated that if you struggle adjusting to college it does not mean you are “dumb” or that you “don’t belong” but rather that you are growing your “know how” to succeed in college. Randomly-assigned control students learned brain facts.

No contact was made with students after the intervention was delivered in May of their senior year. Instead, researchers, working with school officials, measured college persistence rates via the National Student Clearinghouse (NSC), a non-profit database that tracks full-time enrollment (at many colleges, full-time enrollment is defined as 12+ credits; note that the NSC does not

¹⁸ Silva & White, 2013; Yeager, 2012.

¹⁹ See Aronson, Fried, & Good, 2002; Steele, 1997.

report GPA, so college grades are not available as an outcome in this study). Analyses of these data are ongoing, but the initial results are striking. Raw data show that 49% of control-condition students were enrolled full-time in college but 66% of growth-mindset condition students were, a significant difference.²⁰ This effect was not diminished and remained significant when controlling for other predictors of college persistence, like SAT scores. These findings are supportive of the overall idea that one barrier to college persistence is a concern that one's intelligence could be negatively stereotyped and undermined by everyday setbacks. However, even brief one-time interventions that teach that intelligence is not static but can grow powerfully affected college enrollment.

Full-scale implementation at a large institution. Is full-scale implementation of a web-based growth mindset intervention within an institution possible? Yeager, Walton, and Dweck tested this in a randomized experiment conducted at a large four-year university in Texas. Students at this university graduate on-time at a lower rate than might be expected based on their academic credentials (roughly 50%)—rates that are especially low for African American students (39%)—making it a suitable place to test whether a growth mindset intervention might help increase those rates both in the general population and among students more likely to face negative intellectual stereotypes.

As a part of online freshman orientation activities—in which students filled out medical forms and learned how to sign up for classes—all incoming students were required to complete a 30-minute overview of the “university mindset.” In this activity, students were randomized (at the individual level) to a version of the growth mindset intervention described above or to a placebo control group that discussed adjusting to the physical layout of a new city and a college campus. The growth mindset intervention from past studies was customized for this university by conducting interviews, focus groups, and pilot tests with current upperclassmen, who wrote about the difficulties they had making the transition to college.

Over 91% of incoming students successfully completed the intervention ($N = 7,342$). Research assistants reliably coded the quality of the open-ended intervention responses and found that fully 96% provided substantive responses to the prompt. No participants were excluded from analyses on the basis of their responses, however, so as to estimate an “intent-to-treat” effect, which is important in estimating the effect of the treatment in real-world terms. Thus, this study is close to a census of the freshman class, making it a reasonable demonstration of what a fully “scaled-up” growth mindset intervention might look like.

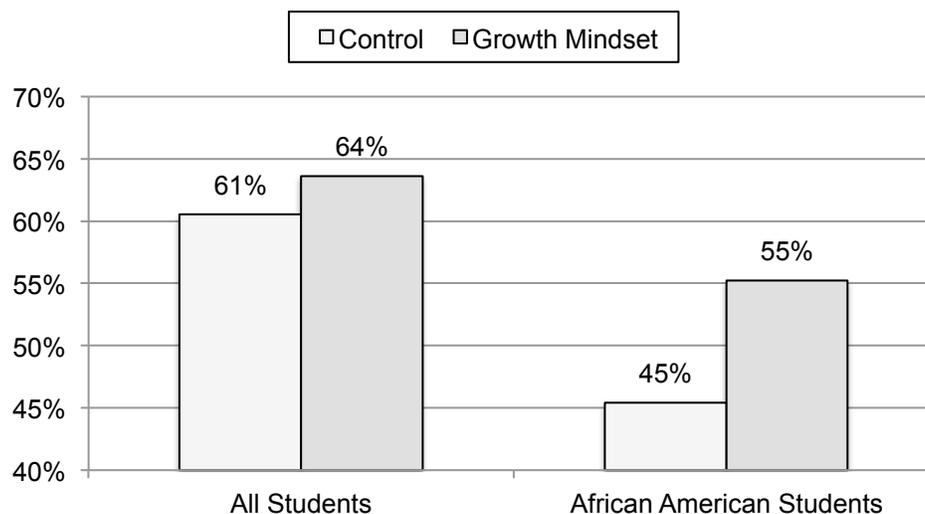
Students completed the growth mindset materials between May and July of 2012. It took roughly 22 minutes to complete and students did so using whatever computer they used to complete the rest of their orientation materials. Although students will continue to be tracked through college, for the present analyses credit attainment information was obtained from the University registrar for the Fall 2012 semester. The focal outcome was the percent of students

²⁰ See Appendix 2 for more information.

who obtained more than the minimum number of credits (12+ gpa-bearing credits: a past analysis found that this was one of the strongest predictors of on-time graduation).²¹

The growth mindset intervention increased the rate at which students in the full sample earned 12+ credits from 61% in the control to 64% in the growth mindset treatment, a significant difference.²² These effects were larger for African American students, who may face negative stereotypes about their intellectual ability. While only 45% of African American students in the control group earned 12+ credits, this number was increased to 55% in the treatment condition, also a significant difference. This corresponded to a 63% reduction in the achievement gap in credit earning between White students and African American students, as a function of a one-time growth mindset intervention delivered over the Internet months before school started. These findings are illustrated in Figure 3. All of these findings remained significant and were slightly larger when adjusting for covariates that predict credit attainment, like SAT scores, high school class rank, and sex.

Figure 3. Percent of students earning 12+ credits in the first semester of college as a function of growth mindset treatment, among all students (N = 7,342) and African American students (N = 356). Figure shows effects of the web-based growth mindset intervention delivered in the summer before freshman year at a large four-year university.



Relation to traditional interventions. Mindset interventions are, of course, only part of the solution to problems of low achievement and group disparities in education. Mindset interventions do not replace traditional school reforms; instead, they allow students to take advantage of educational opportunities available to them. Fully addressing systematic issues in education thus requires continuing investments in improvements to teaching and instruction as

²¹ Diehl, 2012.

²² See appendix 2 for regression output.

well as other programs to support children and families. Indeed, well-run schools are a fundamental human right for students, even apart from their impact on learning.

At the same time, it can be helpful from a policy perspective to put the size of the effects of mindset interventions into context by comparing them to other non-mindset interventions in the literature. How do the effects of mindset interventions compare to traditional educational reforms tested at a similarly large scale? Many interventions are randomized at a school or classroom level, making them ill-suited for comparison to growth mindset training. However, one well-designed line of research by Goldrick-Rab and colleagues has examined the impact of offering entering college students \$3,500 scholarships if they remain enrolled as full-time students. Because a sub-set of students in these studies were randomly assigned at the individual level to be offered these scholarships, researchers could evaluate the impact of doing this on analogous student outcomes to those summarized above, making this one interesting case against which to compare effects of growth mindset training. Goldrick-Rab found that offering students \$3,500 scholarships had full-sample effects on full-time college enrollment (earning 12+ credits) of 2.4 percentage points.²³ Comparable effects of growth mindset interventions on college outcomes were 3 percentage points for full-time enrollment in the full sample, and 10 to 17 percentage points for African American students, who statistically are at higher risk of not persisting through college. Thus, the available evidence obtained from experiments with many thousands of students suggests that growth mindset interventions delivered over the Internet at no cost to institutions can be at least as effective as the effect of offering \$3,500 scholarships.²⁴

Summary. These findings demonstrate the possibility that even brief but theoretically informed methods to communicate a growth mindset to students can affect their academic performance and resilience. However, additional research is needed to build on these demonstrations and provide specific guidance for practitioners to reliably affect student mindsets in diverse settings. Below we outline an R&D agenda that summarizes what more needs to be learned to effectively and responsibly use mindset research and to positively affect more students.

What Do We Need to Learn to Effectively Scale Mindset Research in Education?

Larger-scale experimental studies are needed to understand the conditions that maximize or reduce the impact of mindset interventions. For instance, what kinds of students benefit most? In what kind of contexts do students benefit most? And what kinds of strategies to impart a growth mindset are most effective?

These research questions overlap with the interests of educational practitioners. Practitioners also want to affect student mindsets and raise achievement and they want to do it well. To do so they need a larger “toolkit” of validated everyday practices for changing mindsets and they need principles for how to apply these effectively in diverse classrooms. At the same time,

²³ See p. 38 in Goldrick-Rab, Harris, Kelchen, & Benson, 2012;
<http://finaidstudy.org/documents/Goldrick-Rab%20Harris%20Kelchen%20Benson%202012%20FULL.pdf>

²⁴ Goldrick-Rab et al., 2012

practitioners often ask for assessments so they can learn whether they are effectively changing mindsets. For reasons we outline below, existing mindset assessments, while suitable for research purposes, are less suitable for informing rapid improvements in applied settings.

Below, we outline three broad areas for R&D that represent the highest priorities for both researchers and practitioners: (1) *Principles* for effective interventions; (2) *Everyday practices* that affect mindsets; (3) *Assessments* that measure short-term changes in mindsets and related behaviors so as to provide data to inform improvement efforts.

I. *Principles: Understanding how to maximize the effects of mindset interventions.*

A crucial area for research and development is to better understand the conditions that allow mindset interventions to have maximal and sustained effects. Some research and theory can shed light on these conditions. However, many of these ideas require further testing on a much larger scale. This is a high priority for research going forward.

Below, we show that past mindset interventions have three essential qualities: They (1) successfully target students' beliefs about themselves and their educational environments, (2) are delivered in a psychologically precise and potent way, and (3) tap into *recursive processes* in school (virtuous cycles) that sustain the effects of the initial intervention.²⁵ As we state below, these principles of effective interventions are grounded in theory and past research but require further testing to give practitioners more concrete guidance.

Targeting students' beliefs. Mindset interventions begin by understanding students' beliefs and their impact. Mindset interventions may seem small to outside observers, and often they are brief and low-cost relative to other reforms. However, to a student who worries that a poor test score means that she is stupid or could be seen as stupid, or who believes that members of his racial group are not respected in school, learning that the brain is not static but can form new connections and become smarter when challenged can be powerful. This message assuages the specific fears that can stifle learning and can thus have strikingly large effects on student outcomes.

Because mindset interventions work by targeting student beliefs, research needs to identify the specific beliefs that matter in a given educational setting to have an impact. In many cases, this has led researchers to conduct extensive interviews, focus groups, and pilot tests to inform alterations to intervention materials. This was the case in the community college, charter school, and four-year college intervention experiments noted above. In other cases, however, materials are not customized but, rather, are designed to be effective for a wide-range of students and are simply administered to many students, as in the high school experiment noted above. It is important to conduct research on when mindset interventions require customization (and, if so, how and to what extent) and when they do not—when they are “robust” in different contexts and with different populations and how they can be made more robust.

²⁵ For other discussions of these ideas, see Garcia & Cohen, 2012; Yeager, Walton, & Cohen, 2012; Yeager & Walton, 2011.

The finding that existing mindset interventions have had significant effects with diverse populations creates a significant opportunity: Can even non-customized mindset interventions be effective in changing students' mindsets and improving academic outcomes on a national level? We can answer this question almost immediately, in the next few years. With coordination, we could evaluate an existing one-time, web-based growth-mindset interventions with a national probability sample of schools from various grade levels. Of course this would involve some thinking about logistics, but this is exactly the sort of problem that government-sponsored research routinely solves. The NSF funds the General Social Survey and the National Election Studies, the latter of which conducted a representative-sample web-based study in the 2008 election, demonstrating the feasibility of probability-based web surveys. With a panel of psychologists, education researchers, government officials, and experts in probability-based sampling, something analogous could be accomplished for mindsets. This type of free, web-based intervention would not address all causes of fixed mindsets in school (let alone all psychological causes of underachievement). Thus, the rest of the R&D agenda outlined below involves ways to address mindsets in more contextually appropriate ways. In the meantime, however, a high-priority scientific objective we can achieve in the near term is to estimate how effective a "baseline" growth mindset intervention could be, especially for low-performing or disadvantaged students.

Customizing for Native American communities. Some recent research customized the typical growth mindset intervention to make it more consistent with the beliefs of a particular population. Stephanie Fryberg observed that the traditional "individualistic" framing of a growth mindset—the idea that you can grow your own personal intelligence—was not as motivating for Native American populations, who tend to focus more on community-based goals like contributing to family or community. When the growth mindset message was reframed as a means to achieve valued collective outcomes, such as contributing to family, this seemed to produce important improvements. For instance, one school community adopted the new, collectivistic growth mindset framing throughout the school (and beyond)—teachers, principals, and parents employed the message that "*you help your community when you grow your brain.*" Although not evaluated experimentally, analysis of school records showed a remarkable turnaround—the school went from being one of the lowest-performing schools in the state in state test scores to one of the highest in two years. However, no published research has directly compared this community-oriented growth mindset framing to the more traditional independent one. Future research could directly test whether such revised framings are more evocative and effective for some populations.

Future directions. There are at least two additional areas of "low hanging fruit" for which it may be important to customize growth mindset messages. We consider these below.

Early childhood. The interventions summarized above rely on a person's ability to learn facts about brain malleability and to understand the relevance of these ideas to schoolwork. How can such messages be adapted so they are developmentally appropriate for young children? Research shows that mindsets are operative in young children and affect their challenge-seeking and persistence. Even subtle hints that people from different groups are "good" or "bad" at certain tasks can produce in children a fixed mindset about those tasks and undermine resilience.

For instance, Andrei Cimpian and colleagues showed that 4-7 year-old children who hear, for instance, that “boys are really good at this,” infer that raw ability is necessary to complete a given task.²⁶ As a consequence, *both* boys and girls subsequently underperform when they attempt difficult problems on this task. In addition, as we have noted, praise directed at young children can affect children’s mindsets, challenge-seeking, and persistence.²⁷ Research that builds on these findings could inform theories about how to customize messages to instill productive mindsets in young children. Can we train teachers in Head Start and other early childhood programs to communicate a growth mindset wisely? Would this be an economically efficient way to strengthen the long-term effects of early childhood interventions?

Adult vocational education. As the US economy changes and adult workers are increasingly required to retrain in emerging technologies, it can be especially important for adults to have a growth mindset—to believe that “old dogs” can learn “new tricks.” In today’s economy, many employable adults have been laid off, for instance when their jobs became obsolete due to outsourcing or new technology. Adults with a fixed mindset may feel they cannot acquire expertise in emerging industries quickly enough to gain new employment. A tailored growth mindset intervention, however—one that focused on acquiring new job skills—might be a missing ingredient in adult education programs that seek to help unemployed adults reenter the workforce. A potential area for innovation is to investigate what would be necessary to apply growth mindset ideas effectively with this population.

Specific recommendations:

- Use large-scale experiments to learn how robust the effects of a *non*-customized mindset intervention are for different groups of students (a “baseline” mindset intervention). For instance, a population-average effect size could be estimated if a probability-based sample of K-12 schools and universities participated in individual-level randomized experimental interventions.
- Conduct laboratory and field experiments to learn where it is helpful or necessary to customize mindset messages to yield larger effects for specific populations (e.g., race/ethnic groups; gender groups; age groups; students in specific educational contexts).
- Use RFPs or other mechanisms to accelerate growth mindset intervention research in areas ripe for innovation, such as early childhood and adult vocational training. If successful, consider public policies that facilitate the implementation of growth mindset interventions in early childhood and adult educational programs.
- Conduct research on the best methods for customizing mindset interventions effectively in diverse applied settings. For instance, can we develop protocols for conducting user-centered design and then train educational professionals to do this work?

Psychologically wise delivery. As noted, mindset interventions change how students think or feel about themselves in school. If an intervention does not deliver its message in a way that leads to these changes, it will not be effective. Each intervention summarized earlier used a

²⁶ Cimpian, Mu, & Erickson, 2012

²⁷ Mueller & Dweck, 1998

delivery mechanism that drew on research about how to make messages stick.

Rather than simply presenting an appeal to a student, mindset interventions frequently enlist students to generate the intervention itself. These are active experiences, not passive exposures. For instance, one delivery mechanism involves asking students to write letters to younger students advocating for the intervention message (e.g., “Tell a younger student why the brain can grow”). As research on the “saying-is-believing” effect shows, encouraging students to author a persuasive appeal and advocate for it to a receptive audience is a powerful means of self-persuasion.²⁸

Similarly, rather than telling students how they should use a growth mindset in their lives, interventions sometimes ask students to generate how they could. In these respects, the interventions provide a built-in element of personalization—individual students respond to intervention prompts in ways that customize the intervention message for themselves, potentially making the intervention message most relevant to their own personal experience and increasing the robustness of the intervention across diverse students. However, this element has not been tested in past research. An important R&D question involves whether built-in personalization elements increase the robustness of interventions in diverse populations and how this robustness may be further improved.²⁹

Although these delivery mechanisms are psychologically powerful and reliable, they are often subtle. The web-based growth mindset interventions did not expose students to an overt persuasive appeal (e.g., “You should do your homework to grow your brain”) or tell them they are receiving “an intervention” to help them. Instead, they used a “stealthy” approach to avoid feeling controlling or stigmatizing by conveying that student recipients are seen as in need of help.³⁰ At the same time, some successful in-person growth mindset workshops have explicitly emphasized to students that the message is intended to benefit them or their class. For instance, in Fryberg’s customization for Native American populations, a growth mindset was an explicit tool for personal and social change. An important empirical question, then, is when a growth-mindset intervention should be subtle and stealthy and when it should be more overt and explicit.

What is the right length for a mindset intervention? This is also an empirical question. A worry is that excessive repetition of the same message risks conveying that students are seen as in need of help and risks undermining the credibility of the message (“thou doth protest too much”). At the same time, it may be helpful to have redundancy in mindset messages, so students who may be unaffected by an initial intervention have additional opportunities to benefit and so that students can connect an initial mindset message with ongoing academic experiences. An important area for R&D is to use randomized experiments to test whether “booster” shots delivered periodically can provide needed redundancy in the delivery of mindset messages and thus enhance effects without undermining the original intervention.

²⁸ Aronson, 1999

²⁹ For other examples, see Cohen et al., 2009; Hulleman & Harackiewicz, 2009; Walton & Cohen, 2011.

³⁰ Robinson, 2010; Ross & Nisbett, 1991

Specific recommendations:

- Research that tests whether “personalization” elements increase the robustness of mindset interventions in diverse student populations and, more broadly, how to increase robustness.
- Research that varies the type of persuasive appeal used in a growth mindset experiments, comparing methods that are more overt to methods that are “stealthier,” to understand which approach is more effective in particular situations.
- Research that tests whether mindset interventions at multiple levels—students, influential peers, teachers, parents, principals—produce larger effects.
- Research that evaluates “boosters” of an intervention, and that identifies what kind, in what contexts, and delivered when boosters are effective.
- Research on developmentally sensitive methods—for instance, methods that pay attention to adolescents’ concerns about autonomy—that may be needed to successfully address student mindsets on a wide scale.

Recursive processes. What can seem especially mysterious is how a brief or one-shot mindset intervention can generate effects that persist over long periods. A key to understanding the long-lasting effects of psychological interventions is to understand how they set in motion self-reinforcing processes.

In education, early success begets more success. When an intervention leads a student to study, learn, and build academic skills, they are better prepared to learn and perform in the future. As students feel more comfortable in school, they build better relationships with peers and with teachers—relationships that support higher levels of achievement in the future. As students perform well, they are placed in higher-level classes—gateways that raise expectations, expose them to high-achieving peers, and put them on a trajectory of success. Well-timed, well-targeted mindset interventions can improve students’ relationships, experiences, and performance at a critical stage and thus improve students’ trajectory through their school careers.³¹

To date, not enough research has directly tested the specific recursive processes that determine the long-term impact of mindset interventions. Such research is important for psychological and sociological theories of education, but it is also important for practitioners who aim to optimally time and tailor interventions to maximize their impact.

For instance, research should assess the optimal timing of interventions. If mindset interventions help students acquire foundational skills they can use later in school, or if they allow students to seek out help from teachers sooner, potentially forming better teacher-student relationships, interventions delivered earlier in school or in the school year may be more effective.³² At the same time, it may never be too late to teach someone that the brain can grow and be developed and improve their academic outcomes, as among adults taking developmental math in

³¹ Garcia & Cohen, 2012

³² Cook, Purdie-Vaughns, Garcia, & Cohen, 2012

community college, summarized above.

Specific recommendations:

- Experimental studies that investigate recursive processes directly—that is, that track the effect of mindset interventions on real-time change in student confidence, challenge-seeking, relationships with peers and teachers, learning, and long-term educational attainment. This will be increasingly possible as learning happens online and student work and communications are captured in real-time.³³
- Experimental studies that discover the optimal timing for the delivery of interventions (both timing within a school year and developmental timing, such as during childhood versus adolescence) to improve theories of recursive processes and provide more specific recommendations for practice.
- Studies that assess features of social and educational environments that allow mindset interventions to set in motion virtuous recursive processes or that prevent them from doing so (e.g., whether students are exposed to high-quality instruction and curriculum, have opportunities to pursue higher-level coursework, and have opportunities to form better relationships with peers and teachers). These contextual features may determine whether mindset interventions can generate long-term change in a given setting or not.

II. *Practices: Expanding the “toolkit” of day-to-day practices that instill productive mindsets.*

Research on mindsets has produced several recommendations for what to say and what not to say to students to create a growth mindset and to forestall a fixed mindset. But practitioners have many thousands of conversations with students every academic year, and they need more—and more tailored and more useful—recommendations for everyday practice than the experimental literature has yet produced.

There are at least three ways to rapidly expand the “toolkit” of day-to-day practices that instill productive mindsets. The first and most immediately actionable strategy is to dramatically accelerate the amount of randomized intervention research conducted by psychological researchers in applied settings. We outline examples of this type of research below, and this constitutes much of the focus of our specific recommendations.

We acknowledge, however, that randomized experiments may test the efficacy of classes of practices but may not generate enough specific advice for practitioners. Thus, we suggest two additional potential future directions that are worthy of consideration. One is to create more ways for practitioners to learn rapidly about the effectiveness of their own classroom practices. Another is to facilitate a marketplace in which private companies create materials and practices based in theory and evaluated in rigorous research, which teachers and schools can then use. After discussing the acceleration of experimental research, we discuss these speculations.

³³ For a discussion of the use of data mining and rapid analytics for R&D in education, see US Department of Education, Office of Educational Technology, 2012, 2013.

Accelerating field-experimental research on “everyday practices.” Recall that much research has shown that the everyday ways in which adults talk to children can create mindsets that support or undermine resilience. For instance, Gunderson and colleagues showed that children who are praised during for “process”—effort or strategies—have more growth-oriented motivational frameworks up to five years later,³⁴ and Pomerantz and colleagues showed that children who are praised more for “smartness” showed more fixed mindsets over time.³⁵ These observational, correlational studies have identified some likely inputs to children’s mindsets.

These examples reinforce the need for experimental research that isolates the impact of day-to-day verbal feedback on students’ mindsets and achievement—and that gives practitioners concrete feedback about how to talk to children effectively. Effectively promoting mindsets can be difficult and counterintuitive for parents and teachers. Past research shows how easy it is easy for even well-intentioned efforts to motivate students to backfire and cause harm. As we noted earlier, this is true when adults praise a child as being “smart at that” or when they comfort a struggling child by saying “Overall you are smart, but maybe you’re not a math person.”³⁶ Adults may have strong, deeply held intuitions about what to say to students to boost their confidence. Absent strong experimental research, we may fail to question our intuitions and instead continue to use verbal feedback we believe to be effective but in fact is either inert or harmful.

Thus, continued experimentation on the sometimes counterintuitive ways that productive mindsets can be built or undermined is an essential part of the R&D agenda. Two examples that have done this are below. However, as we state, much more research is needed.

First, some research has taken advantage of recent advances in online education to accelerate learning about effective “everyday practices” that support student mindsets. For instance, Dave Paunesku and colleagues have conducted randomized experiments on the online learning website Khan Academy (khanacademy.org) with more than 250,000 students. The Khan Academy website allows students to watch brief (~ 3 minute) videos about math concepts and then take diagnostic assessments on those concepts. The Khan Academy website allows students to watch videos about math concepts and then take diagnostic assessments on those concepts. Over a period of several months, researchers presented to one groups of students statements embodying a growth mindset (e.g., “*When you learn a new kind of math problem, you grow your math brain!*”) at the top of screens during a unit of fractions, and to another group of students encouraging statements that did not convey a growth mindset (e.g., “*If at first you don’t succeed, try again.*”). The placebo statements represented phrases that educators commonly use to motivate students and convey an overall positive attitude but they do not spark a growth mindset. A randomly selected third of students saw no encouraging statements at the top of their screens. The researchers then tracked the number of problems online learners successfully completed over the ensuing few months. Growth-mindset feedback increased the percent of correct

³⁴ Gunderson, Gripshover, Romero, Dweck, Goldin-Meadow, & Levine, in press.

³⁵ Pomerantz & Kempner, in press.

³⁶ Mueller & Dweck, 1998; Rattan et al., 2012

problems students solved by 3-5%, depending on the task, compared both to students who received placebo encouragement and to students who received no encouragement. Moreover, this effect was fully maintained even after students completed the section on fractions and moved on to the next set of math concepts during which they no longer saw the growth mindset phrasing.³⁷ All told, this research suggests that a growth mindset can be built using brief but theory-informed messages—something that positive and supportive but generic statements do not.

Other research has examined day-to-day practices using experiments conducted in brick-and-mortar school settings. As one example, research by Geoffrey Cohen, Julio Garcia, Valerie Purdie-Vaughns and David Yeager examined what method of providing critical feedback would most effectively communicate to students that teachers see them as having the potential to grow and improve.³⁸ A common intuition is that the most effective way to provide feedback is to first compliment students to raise their self-esteem, and then to hit them with critical feedback. However, Cohen and colleagues began with the premise that what students need is not hollow self-esteem boosting but the belief that their teacher believes in their potential to learn and grow and to meet a higher standard. The researchers tested this by conducting a series of experiments in middle school classrooms. Seventh grade students first wrote drafts of an essay about a personal hero. Next, teachers marked up these essays with standard critical feedback, including both substantive criticisms (e.g., comments on organization and content) and bland encouragement (e.g., “overall nice job.”). Before students received the graded essays, researchers appended brief notes hand-written previously by teachers. In the treatment condition, the note emphasized the high standards of the course and conveyed the teacher’s confidence in the student’s potential to meet this standard (“I’m giving you these comments because I have high standards and know that you can meet them”). The key dependent variable was whether students turned in a revised essay in the next week. Findings showed that only 40% of control students revised the essay but 80% of students who received the high standards and personal assurance note did. The effects were even more striking for African American students (17% in the control vs. 72% in the treatment).

This type of field-based experimental research on everyday practices affecting mindsets is relatively rare, unfortunately.³⁹ Why? Many barriers stand in the way. First, there are simply not enough researchers trained to conduct rigorous field-experimental research on teacher practices. Most experimental psychologists are not trained to conduct research in field settings and many educational researchers are not trained to conduct theory-driven, precise experiments. Second, it is logistically difficult and time-intensive to conduct this research; for instance, it takes time to build trusting partnerships between researchers and schools. This makes it difficult to conduct more than one such experiment in a school year—far below the standard rate for a typical experimental psychologist, who might conduct twenty experiments with undergraduate participants in a year. Hence, conducting practically useful research on teacher practices seems to be at odds with the professional incentives of experimental researchers. Third, the analysis and publication process is slow, often requiring several years of data analysis, writing, and journal

³⁷ See the appendix for technical details.

³⁸ Yeager, Walton, & Cohen, 2013

³⁹ For a rare exception, see, e.g., Destin & Oyserman, 2009; 2010.

submission after a study has been completed. While it is important to have these types of publications, there is no way for bottom-line findings from mindset experiments to quickly reach practitioners.

It is crucial then to reduce barriers for researchers to conduct field-experimental research on teacher practices and to accelerate the analysis and dissemination of that research. Below we provide specific recommendations for doing so:

Specific recommendations:

- Accelerate the pace of experimentation by using online learning environments such as MOOCs as laboratories for conducting brief, large, iterative randomized experiments on methods to improve student mindsets—similar to what software engineers call “A/B testing.”⁴⁰
- Consider creating “big science” analogues in psychology and education—how can researchers pool common resources and relationships with schools to conduct more experiments and analyze data more quickly? NSF-funded initiatives such as the ANES, GSS, or TESS may be guides.
- Create alternative outlets for faster dissemination of results of experiments on effective (and ineffective) “everyday practices,” without undermining the potential for later publication in disciplinary outlets.
- Continue to support and expand researcher-practitioner networks that produce and disseminate research-tested methods to improve mindsets.

Future directions. As noted, there are at least two additional ways to accelerate learning about effective everyday practices to promote productive mindsets: (a) empowering practitioners to learn from their experiences, and (b) fostering private innovation.

A. Create ways for practitioners to partner with researchers and to learn more rapidly what effectively promotes mindsets. Practitioners are likely to implement mindset ideas in their classrooms regardless of what researchers produce. A key question, then, is this: How can we empower practitioners to learn whether their local innovations are helpful or harmful for students? And how can we help practitioners share and scale innovations that are effective?

This question is especially important because the history of school reform teaches us that promising ideas, when scaled, frequently lose their essential ingredients. Even when the materials given to students are replicated across contexts, the psychological or educational heft of an exercise can be lost. Project-based learning activities that require students to do independent research and produce a scale model can quickly turn in to a trip to an arts-and-crafts store or a visit to Wikipedia.⁴¹ In some cases innovations became inert versions of their former selves. In other cases they can be transformed into something harmful. This can potentially happen to nearly all educational innovations, and it can certainly happen to psychological interventions.

⁴⁰ Also see U.S. Department of Education, Office of Educational Technology, 2013.

⁴¹ See, for instance, a discussion of the “California mission project” in Yeager & Walton, 2011

One well-known example in psychology comes from the self-esteem movement. Researchers produced an enormous amount of rigorous, large-sample research showing that low self-esteem is an excellent predictor of poor life outcomes—depression, stress, health, educational attainment, aggression, etc.⁴² However the application of this research in educational settings was to praise children to boost self-esteem. This recommendation rested on the faulty assumption that doing *anything* positive to a person would boost self-esteem and improve academic outcomes—for instance, praising people for being “smart,” complimenting people for mediocre performance, handing out trophies for last place performances. Ironically, this misapplication of the research may have led to some of the problems that students now face in terms of fixed mindsets. And the self-esteem movement is widely viewed as a misinterpretation of research findings and a misguided attempt to turn them into practice.

It is important to prevent mindset research from being misinterpreted and misused at scale. For this reason, one priority future direction is to design ways for practitioners to learn more quickly from their efforts to address mindsets in classrooms. Teachers hoping to instill in children the belief that they can grow and improve might tell them that they have hidden talent or that “you’re the best”—both phrases that could imply the importance of fixed ability relative to peers.⁴³ How can practitioners learn more rapidly whether their efforts to address mindsets in classrooms have retained the essential psychological message or not?

One future possibility involves training specialists who can help teachers learn about the latest experimental findings on everyday practices that promote mindsets and then use continuous improvement processes to make these work reliably in their classrooms.⁴⁴ Just as it is common for a school to have instructional coaches who use formative assessments to help teachers appropriately scaffold their instruction, it is possible to imagine “mindset coaches” who use data to inform improvement in schools. These professionals would not be develop new theories about mindsets but would, rather, be trained to use formative assessments and then work with teachers to acquire and respond appropriately to evidence about the effects of their classroom-based mindset practices.⁴⁵

In this spirit, organizations such as the Carnegie Foundation for the Advancement of Teaching have begun to train “improvement specialists” to track data related to motivation and persistence over time with teachers—like the number of students who ask questions or show up for class—and then help teachers implement small changes to improve students’ mindsets and increase learning behaviors.⁴⁶ By conducting this kind of data-informed, small-scale improvement research, teachers and improvement specialists have worked to identify, for instance, which routines seem to make students comfortable asking questions about concepts they do not

⁴² e.g. Donnellan, Treziesniewski, Robins, Moffitt, & Caspi, 2005

⁴³ For research showing this was the case in one growth mindset training study, see Shumow & Schmidt, 2013.

⁴⁴ See a discussion of improvement research in Bryk, Gomez, & Grunow, 2011.

⁴⁵ See Yeager & Walton, 2011, for a discussion of related ideas.

⁴⁶ Silva & White, 2013

understand—a leading indicator of long-term knowledge acquisition. If this feedback process is repeated over many cycles with many practitioners testing a larger number of classroom innovations, schools or districts might amass a large, local evidence base for effective practices.⁴⁷ In the next section we discuss in greater detail why existing measures of mindsets may be ill-suited for this task and we outline what kinds of measures might be more suitable.

B. Foster private innovation and large-scale dissemination through rigorous evaluation and government certification of mindset interventions. In medicine, companies that create safe, effective “interventions”—like drugs and medical procedures—and that deliver these interventions on a large scale to address health problems can reap significant financial rewards. These incentives motivate companies to develop new interventions that are safer, more effective, and more robust than prior interventions and to scale them rapidly. This marketplace works in part because the government plays a critical role. Working through the Food and Drug Administration (FDA), the government acts as an honest broker that evaluates the evidence regarding the safety and effectiveness of new medical interventions and certifies new interventions that meet relevant standards to the public and the health care industry. This certification allows companies to sell their product and reap the financial reward.

Perhaps a similar approach would be effective in education. The government could encourage private companies to develop new mindset interventions designed to be more effective or more robust than existing interventions or to be better suited for a given student population. Through a combination of private research, academic research, and government research, evidence could be acquired evaluating the effectiveness of a given intervention product. Government panels could then review this evidence and, if the product meets relevant standards, certify the product as safe and effective for a given population. This certification could then help or allow companies to sell intervention products to schools or to others in the educational environment (e.g., to parents). For instance, the federal government could grant states or school districts access to additional funds (e.g., a new portion of Title I dollars) to be used specifically for certified intervention products that reliably reduce achievement gaps or benefit low-performing students.

Government certification is especially important because in some cases poorly applied psychological interventions may cause harm. It is important for vendors of educational products to show not only that the product is *based* on solid research, but also to provide evidence that it actually produces the psychological experience that the research says is important for student learning and, in turn, affects challenge-seeking, persistence, resilience and learning.

In short, with the proper incentive structure, insights from research on academic mindsets can be more efficiently turned into reliably effective interventions in partnerships with private industry. A future challenge to the field is to learn how to do this responsibly.

III. *Assessments: Measures that allow researchers and practitioners to learn more rapidly from efforts to change mindsets.*

⁴⁷ Bryk et al., 2011

One item high on the list of requests from practitioners is a set of measures of academic mindsets and other non-cognitive factors. Specifically, practitioners want measures so they can (a) identify teachers or schools who do or do not promote productive mindsets, to inform evaluations; (b) identify specific students who have a mindset that puts them at risk so they can be given a personalized intervention; and (c) help thoughtful practitioners learn from their efforts and optimize their classroom climates to promote mindsets. These different purposes are *accountability, remediation, and improvement*.⁴⁸

Existing measures are sometimes unsuitable for accountability, remediation or improvement purposes. Unfortunately, the measures of non-cognitive factors commonly available to practitioners were designed for an entirely different purpose: *theory development*. That is, many of the available student self-report measures were designed for testing the relation between mindsets and outcomes, e.g., the relation of a fixed mindset to GPA—not for diagnosing mindsets at the individual level or for determining whether an effort to promote a growth mindset was effective. While measures for theory development are helpful to the extent that they illuminate average trends that can inform decision-making at an aggregate level, they are less helpful for the purposes requested by practitioners. Said another way, many existing measures of non-cognitive factors are not well-suited for accountability, remediation or improvement.

There are many examples of why this might be true. One compelling unpublished example comes from research by Angela Duckworth, a leader in the field of measures of non-cognitive factors. She measured levels of self-reported “grit”—or passion and perseverance for long-term goals—among students attending West Point military academy and found that levels of grit actually went *down* significantly over the four years at West Point, despite the fact that this is highly unlikely to be the case (West Point students undergo tremendous physical and mental challenges as a part of their training.)⁴⁹ Instead, according to Duckworth, it is likely that they were now comparing themselves to a very gritty peers or role models and revising their assessment of themselves accordingly.

There are also examples in the published literature. A team of researchers at Mathematica recently conducted an evaluation of the effect of KIPP charter schools on student test scores.⁵⁰ KIPP schools have longer school hours, longer school years, more challenging coursework, and teachers with more demanding standards than traditional schools. Indeed, in this study, KIPP students completed 30-50 more minutes of homework per night compared to district students (depending on the analysis). Simply on the basis of completing more work, students in the KIPP system were predicted to have made greater gains in their mastery of academic concepts according to state tests. And, in fact, researchers found that KIPP students, when compared to students who lost the lottery and went to the district school instead, showed greater mastery of academic concepts. Importantly, however, the researchers also compared the two groups of students in terms of their self-reports on a large battery of non-cognitive factors, including school engagement, self-control, academic self-concept, and effort and persistence in school.

⁴⁸ Also see a discussion of different uses of data in Yeager & Bryk, 2013

⁴⁹ Angela Duckworth, personal communication.

⁵⁰ Tuttle, Cleason, Knechtel, Nichols-Barrer, & Resch, 2013

Strikingly, the researchers found *no* differences between the student populations in terms of these items. That is, while according to all objective standards—demanding curriculum, number of hours studying, etc.—KIPP students exhibited more self-control, stayed more engaged in their schoolwork, and expended more effort, they rated themselves no more highly along these factors. Again, it is likely that they adjusted their ratings to the new comparison group.

As we have been suggesting, it is possible that the reason for this is a change in the *reference* that students are using when answering questions used in these studies, something that has been noted by several past researchers.⁵¹ For instance, when students are asked to agree with the statement “I try hard in school” they may instead be answering the question “I try hard in school *compared to other people around me*” or “... *compared to how much harder I could be trying.*” When students are surrounded by very different peers working at very different rates, or when they have been exposed to the potential to work even harder than they are now, as in an intervention, then it can be difficult to collect data that is meaningful for the purposes outlined above (e.g., to evaluate schools). This feature of the psychology of questionnaire design can potentially undermine any comparisons between classrooms, between schools, or over time within individuals. In addition, many measures of self-reported mindsets, even if unbiased, cannot be administered repeatedly and they are not likely to be sensitive to short-term changes in student behavior because they assess global beliefs rather than concrete actions.

New measures of non-cognitive factors are needed. New measures that would be of great benefit to the field would have many or all of these features:⁵²

- They would assess *behaviors* that indicate the possession of productive mindsets or non-cognitive skills. Instead of asking students how much they agree that “I like trying hard problems where I can learn a lot,” a measure might embed real choices between easy and hard problems on a homework assignment and count how often students choose to work on hard problems instead of easy problems.
- They would be *valid* at the level of analysis they are used for—we could assess the percent of students who chose hard tasks where they could learn a lot as opposed to easy tasks where they could get a high score.
- They would be *repeatable*—that is, the meaning and validity of the measure would not be altered by repeated use.
- They would be *brief*—they cannot be long or redundant, because then practitioners could not use them repeatedly over time.
- They would be *convenient* and *unobtrusive*—measures must be easy to collect and analyze, for instance analyzing whether students review their work or not when doing homework in an online course management platform.

Ideally, a suite of such measures could be developed in age-appropriate ways. They could be delivered as stand-alone activities via the Internet or embedded in the web of daily instruction, for instance by data mining online instructional system data.

⁵¹ Biernat, 2003

⁵² Yeager & Bryk, 2013

These new, briefer, behavioral measures are extremely useful for research-practice partnerships. If practitioners are going to work with researchers to put their “everyday practices” for promoting mindsets to the test, they will need measures that can tell them whether, in the short term, their actions have led to improvements in student mindsets. Thus, to the extent that the field seeks to create researcher-practitioner partnerships for continuous improvement in the classroom, creating valid measures to tap this improvement is one of the highest priorities.

It is important to mention, of course, that the types of student behaviors that could be assessed via the new suite of non-cognitive measures are not only relevant to growth versus fixed mindsets. Other highly important mindsets—such as mindsets about belonging, about negative stereotypes, or about relevance of the schoolwork—might also affect similar behaviors such as effective strategy use, challenge-seeking, persistence, etc. Thus such measures could be usefully applied to the evaluation of many interventions that seek to enhance students’ engagement with learning.

Specific recommendations:

- Drive toward agreement among relevant stakeholders (researchers and practitioners) to define a set of important behaviors that new measures should assess.
- Commission a set of measures of behavioral profiles that signal the presence of positive academic mindsets. These should be brief, scalable (e.g., web-based), repeatable, relatively unobtrusive, sensitive to short-term changes, comparable across classrooms and schools, and predictive of long-term outcomes.

Future directions.

Using non-cognitive measures for school or teacher accountability. One long-term future direction is to consider whether such measures could be designed for accountability purposes. For instance, at the end of standardized tests, students could have optional problems that could be explicitly framed as either challenging or easy. Or achievement test performance could be analyzed to determine how well students bounced back from difficulty or wrong answers. It may be possible to incentivize schools that produce larger numbers of “learners” rather than rewarding schools only on the basis of producing “knowers.”

Human Capital Development

To carry out the R&D mission outlined here, it is essential to significantly increase the available community of researchers skilled in conducting experimental research on mindsets in field settings in education. A high priority is thus to expand opportunities for advanced training in this area for psychologists and educational researchers, through postdoctoral fellowships, summer training institutes, and other initiatives.

In addition, as noted, it may be possible to train a new class of professionals to conduct continuous improvement research in educational settings, specialized in working with teachers to remove motivational barriers that harm students, especially at-risk students, and in assessing the effects of such local innovations. Of course, to train these professionals well it will be essential to increase our knowledge base of the principles, practices, and assessments that are likely to

affect mindsets in applied settings. Therefore we see the building of this human resource throughout education as depending critically on accomplishing the R&D objectives outlined here.

How Can We Get Started?

Truly solving problems related to student mindsets will require dedicated efforts to change teaching and perhaps parenting practices. These efforts can be started immediately and should be pursued in the long-run. At the same time, the most immediate short-term goal—something that could be accomplished in the next two years—is to estimate how effective existing growth-mindset interventions (“baseline” interventions) can be at a population level, and what factors lead to variance in intervention effectiveness. This can be done by delivering interventions via the Internet to a probability sample of students in middle school, high school and college. A panel of experts from government, educational practice, and academic research could evaluate a growth mindset intervention by assessing effects on achievement over time and estimating heterogeneity. Through a web-based platform it would also be easy to compare several different mindset interventions, to find out what works best and for whom and in what setting or context. We could also compare what delivery strategy is most effective, and whether certain details of the delivery, like “stealthiness” and personalization, really matter. Mindset interventions will not benefit every student or every school. But there is enough evidence for the promise of these interventions to expect to find at least average benefits for low-performing students or for negatively stereotyped students. This may be a powerful catalyst for the reduction in achievement gaps. Even small effects in large populations can have important implications for equity. Given the potential to learn a great deal about the effectiveness and limitations of current intervention strategies to address mindsets, it is important to consider how to make this a reality in the very short term.

Second, there is enough evidence that our national obsession with “smartness” and “talent” undermines student learning and thus our national competitiveness, especially when considering achievement in STEM-related fields and among students who face negative intellectual stereotypes. We should ask: Can we redirect the national conversation away from a focus on “smart” children to a focus on “learning” children? As a nation we could eliminate the phrase “I’m not a math person” from our vocabulary—a phrase that, itself, contributes to race, gender, and socioeconomic inequality in STEM fields.⁵³ Such a sea change is not unheard of. As a society we have for the most part eliminated racial epithets from casual conversation. Can we do the same regarding mindsets? Instead of it being common to hear “I’m not a math person,” can we make it ubiquitous to hear “I’m a math learner”? With coordinated PR and social media and with teachers wise to the power of a growth mindset we can imagine a world where no child’s prospect of success in education is diminished by harmful mindsets about the fixedness of ability.

Conclusion

⁵³ See, e.g., Rattan et al., 2012

As anyone who works in education knows, problems facing students and schools are complex and multi-determined. There are no silver bullets, but mindset interventions can be helpful for student learning, and even necessary. When we give students the belief that they can grow and learn in school, that they are not limited by fixed inability, and that they belong and are valued, we motivate them to take advantage of the social and educational resources in school. We help them to learn from the teaching and curricula present there, to develop relationships with people in school, and ultimately to acquire skills they need for long-term success.

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Appendix 1: A Selective Bibliography of Mindset and Self-Regulation Interventions

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Oyserman, D., Bybee, D., and Terry, K. (2006). Possible selves and academic outcomes: How and when possible selves impel action. *Journal of Personality and Social Psychology*, *91*, 188 - 204.

Expectancy-Value Theory

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Appendix 2: Methodological and Statistical Supplement

Khan Academy Trial

Methods

In January 2013 we modified all fractions exercises on Khan Academy (khanacademy.org) to randomly present users with one of five different types of header messages. The headers were presented immediately above each fraction problem (see Figure A1). Once assigned to a header condition, users were randomly exposed to one of the within-condition header messages on all fractions exercises. The conditions included:

1. A no-header control group in which users did not see a header; this is the default on Khan Academy.
2. Two types of control statements:
 - a. Placebo encouragement, e.g., “Some of these problems are hard. Just do your best,” and “Always do your best and you'll get something out of the experience.”
 - b. Science statements, e.g., “Did you know: An elephant brains weighs $7/2$ as much as a human brain,” and “Did you know: Dolphins can blow rings of bubbles underwater. Can you?”
3. Two growth mindset condition:
 - a. Mindset headers, e.g., “Remember, the more you practice the smarter you become!” and “If you make a mistake, it's an opportunity to get smarter!”
 - b. Mindset headers with a link. This condition was identical to the Mindset headers condition except that there was also a link to another page at which students could read more about the malleability of the brain.

The two control statement conditions and the two growth mindset conditions were collapsed together because they did not significantly differ in any analyses. This experiment is still in progress, but the most recently analyzed data (presented here) include 265,082 participants. Demographic characteristics are not known because Khan Academy does not usually collect these data. Analyzed data include all data collected on participants by Khan Academy before and since the experiment started. Analyses focused on the number of problems participants completed and the number of “proficiencies” they earned. Khan Academy deems a user proficient at a particular concept when its algorithms estimate the user's probability of correctly answering the next problem at above 94%.

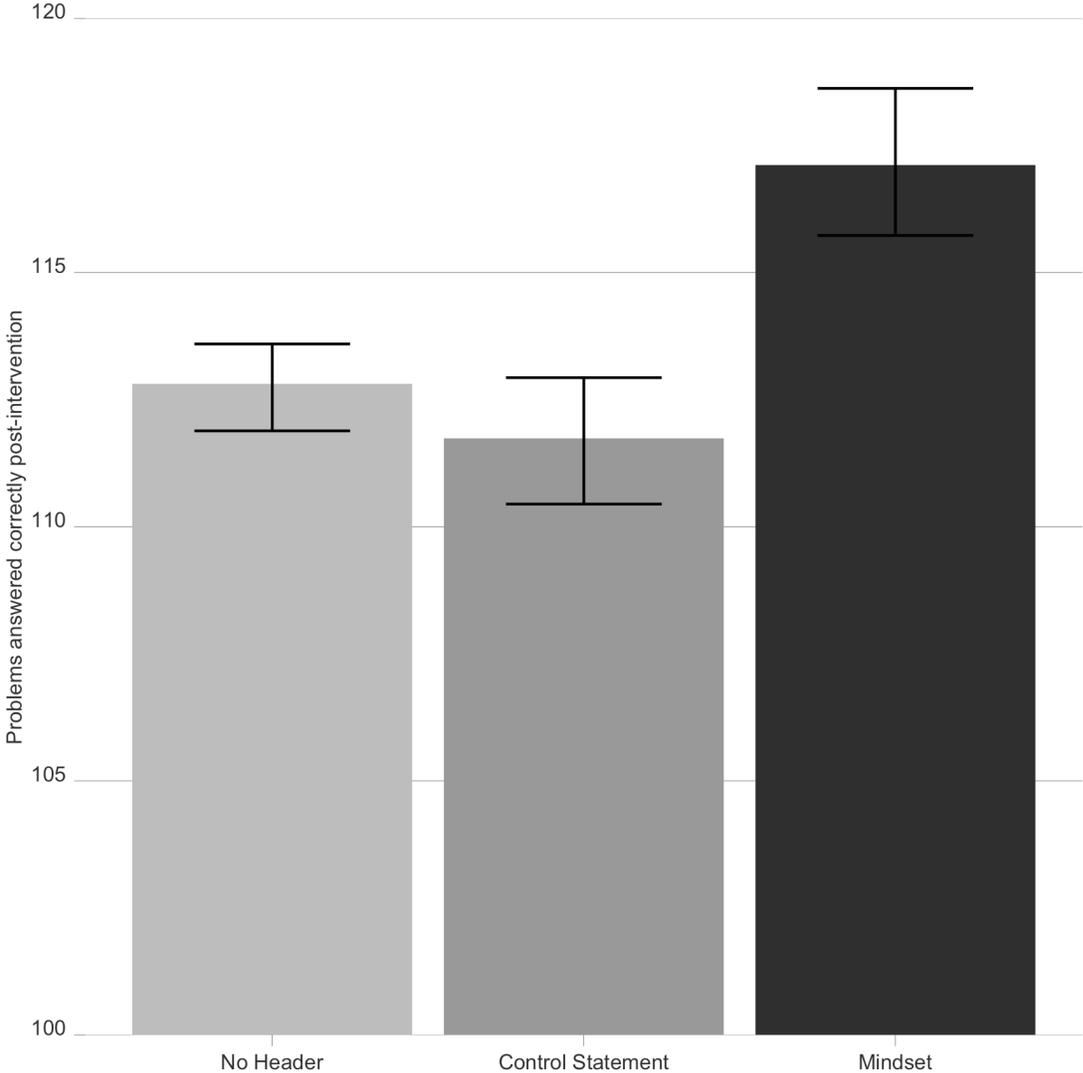
The data were most closely approximated by a zero-inflated negative binomial distribution—they were characterized by strong left skew with a very long right tail and an excess of zero values. So we used the `pscl` package in R to assess the effects of the mindset condition on the number of problems correctly completed and the number of proficiencies earned. We also confirmed the statistical significance of the findings using a non-parametric Mann-Whitney-U Test.

Results

The data showed a main effect of mindset condition on both the number of problems students successfully completed following the intervention and the number of concepts in which they earned proficiencies. Relative to the no-headers control group, students in the mindset conditions increased the rate at which they answered problems correctly by 4.5% ($p < 0.001$) and the rate at which they earned proficiencies by 2.7% ($p = 0.002$). The control statements did not have a significant impact on either outcome, $ps > 0.20$. See Figure A2.

Importantly, these effects were just as strong on exercises that did not display the condition-specific header (i.e., exercises targeting concepts besides fractions). Relative to the no-headers control group, students in the mindset conditions increased the rate at which they answered non-fractions problems correctly by 4.6% ($p < 0.001$) and the rate at which they earned non-fractions proficiencies by 3.4% ($p = 0.002$). The control statements did not have a significant impact on either outcome, $ps > 0.18$.

Figure A2. The mindset condition increased the number of problems users answered correctly.



High School Trial

Methods

Participants were 1594 secondary school students (525 Latino, 277 Asian, 371 White, 174 Black, and 247 other/mixed ethnicity) in grades 9-12 at 13 high schools in the Southwestern and Eastern U.S. Eight were public schools, four were charter schools, and one was a private school. The schools varied widely in socioeconomic characteristics; in five schools, 0-10% of students were receiving free or reduced lunch because of their low household income; in two schools the figure was 11-50%; and in the remaining six schools, over half of students were from low-income households.

The study consisted of two 45-minute sessions spaced approximately two weeks apart ($M = 13$ days). Both sessions were administered in each school's computer lab during the spring semester, between January and May 2012. Students were randomly assigned to a control condition or to one of three intervention conditions—a growth-mindset intervention, an alternate intervention (not discussed here for simplicity, though its effects were virtually identical), or a combined intervention condition. The first session included the growth-mindset intervention or its control condition and the second session included the alternate intervention or its control condition. Students' spring semester grades in academic courses served as the primary outcome.

In the growth-mindset intervention, students read an article describing the brain's ability to restructure itself as a consequence of effortful practice. The article focused on the implications of these neuroscientific findings for students' potential to become more intelligent through study and practice (See Figures A3 and A4). This message was reinforced through several writing exercises. In one, students summarized the scientific findings in their own words. In the second, they read about a hypothetical student who was becoming discouraged and starting to think of himself as "not smart enough" to do well in school. The writing exercise asked participant students to advise this target student based on what they had read.

The primary outcome was students' official grade in academic courses (math, English, natural sciences, social sciences, and foreign languages). Grades were coded on a 0-4.3 scale (0=F, 1=D, 1.3=D+, ... 4.3=A+). We dropped students for whom only pre-study or only post-study academic records were available (because they enrolled or disenrolled from the school during the study).

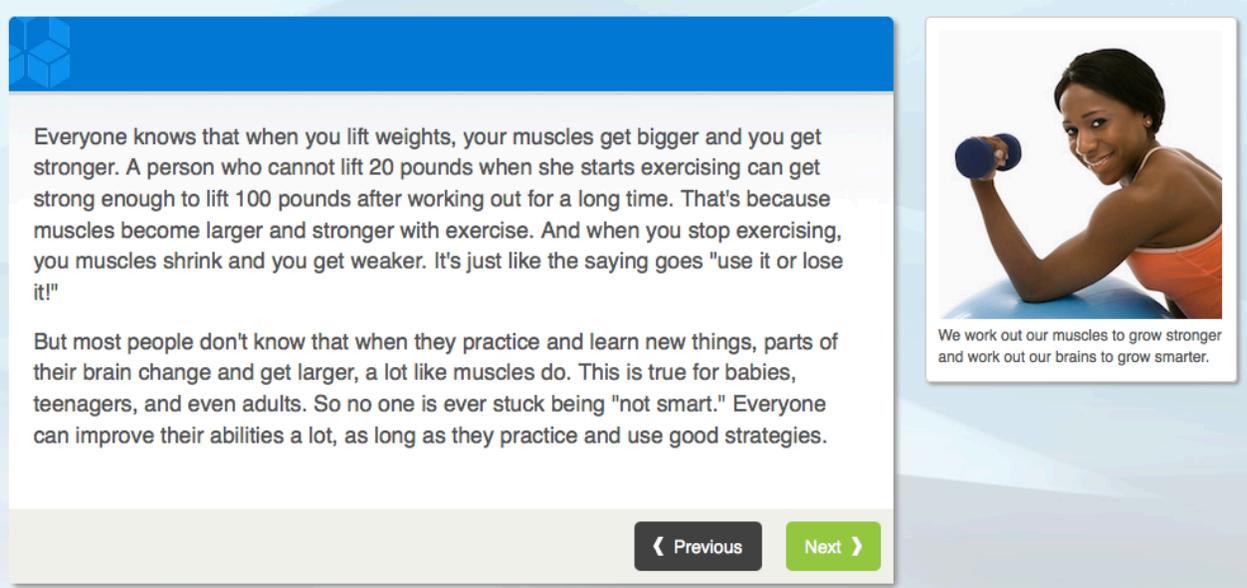
Results

First we used a mixed effects linear regression to test the effects of exposure to the mindset treatment on students' academic trajectories. We created a mindset dummy code (1=exposed to mindset, 0=not exposed to mindset) and an alternate treatment dummy code (1=alternate treatment alone, 0=all others). Then we assessed the interaction between time and each of these dummy codes on grades. An interaction between mindset treatment and time indicated that students' grades improved as the result of exposure to the mindset treatment ($B = 0.04$, one-tailed $p = 0.04$). Second, a negative interaction between pre-intervention GPA and mindset treatment on post-intervention GPA ($B = -.05$, $p = 0.05$) indicated that the intervention's effect on grades was stronger for lower-performing students. Breaking the data up by pre-intervention performance tertiles, mindset treatment effects were much larger among the bottom third of students, those with pre-study GPAs from 0-2 points, ($B = 0.18$, $p = 0.002$) than in the middle third ($B = 0.04$, $p = 0.74$) or top third ($B = -0.02$, $p = 0.39$) of students. See Table A1.

We also examined effects on credit attainment in the bottom third of students. These students accounted for 95% of failed academic courses. Students in the bottom tertile failed 37% of all of the courses they took while students in the middle and top tertile failed only 1.4% and 0.1%, respectively. Bottom-tertile students assigned to the growth-mindset treatment were more likely to pass courses following the intervention than control group students (OR = 1.54, $p = 0.03$). In this high-risk population, the course pass-rate in the semester before the intervention was 61.9% in the control group and 63.0% in the treatment group. In the semester after the intervention, the rate in the control group dropped by 1.5% to 60.4% but climbed by 4.1% to 67.1% in the mindset treatment group. See Figure A5 and Table A2.

High School Figures

Figure A3. A screenshot from the growth mindset intervention uses the metaphor that the brain is like a muscle.



Everyone knows that when you lift weights, your muscles get bigger and you get stronger. A person who cannot lift 20 pounds when she starts 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, you muscles shrink and you get weaker. It's just like the saying goes "use it or lose it!"

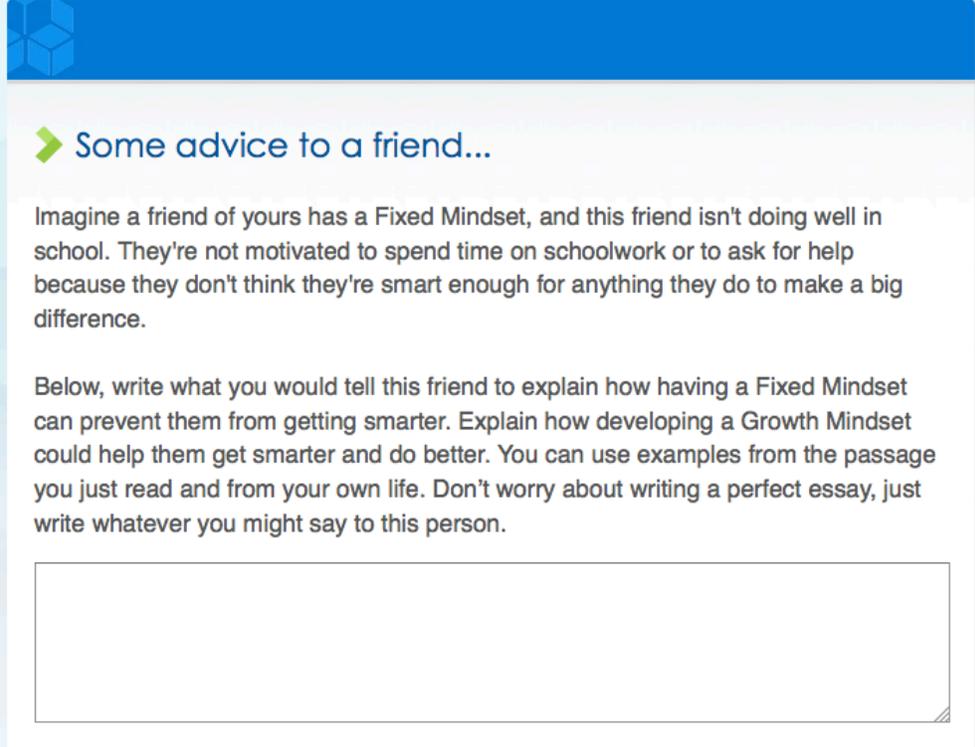
But most people don't know that when they practice and learn new things, parts of their brain change and get larger, a lot like muscles do. This is true for babies, teenagers, and even adults. So no one is ever stuck being "not smart." Everyone can improve their abilities a lot, as long as they practice and use good strategies.



We work out our muscles to grow stronger and work out our brains to grow smarter.

◀ Previous Next ▶

Figure A4. A “saying is believing” exercise at the end of the growth mindset intervention leads students to endorse the message and self-customize it by tying it to their own life.



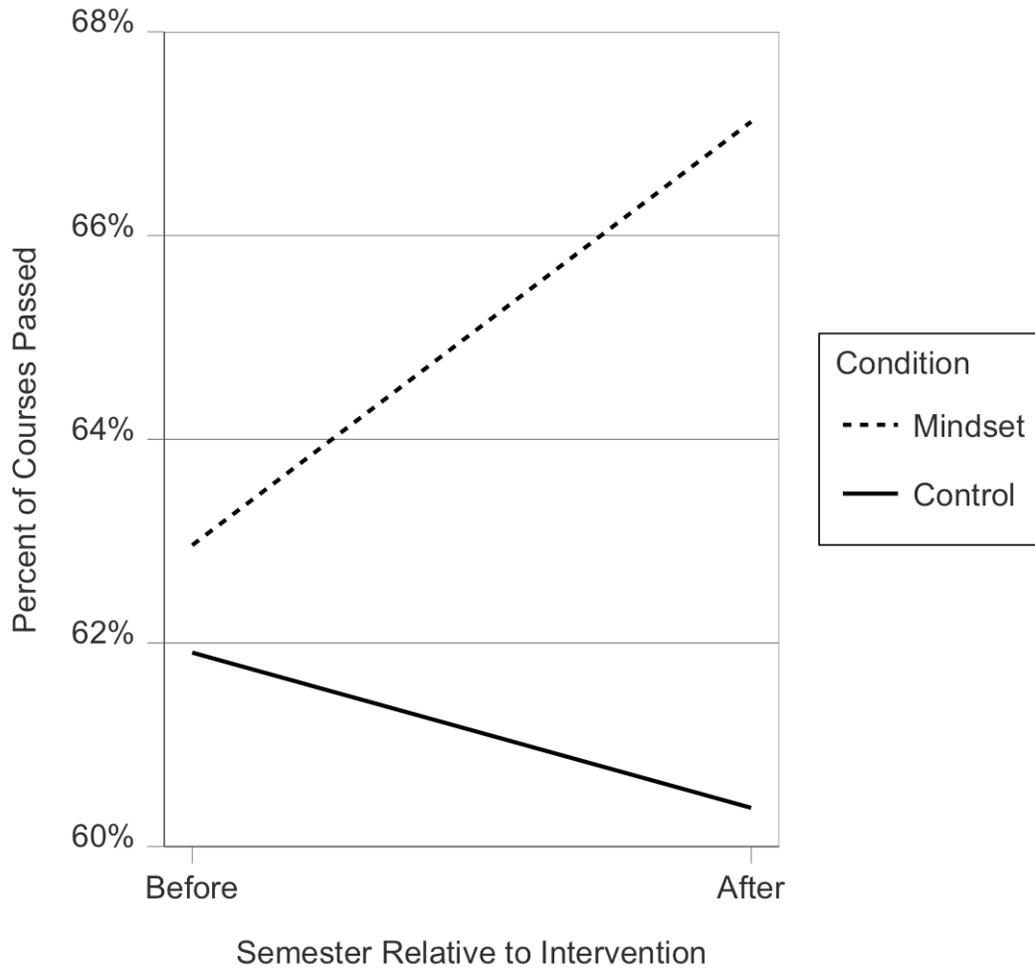
Some advice to a friend...

Imagine a friend of yours has a Fixed Mindset, and this friend isn't doing well in school. They're not motivated to spend time on schoolwork or to ask for help because they don't think they're smart enough for anything they do to make a big difference.

Below, write what you would tell this friend to explain how having a Fixed Mindset can prevent them from getting smarter. Explain how developing a Growth Mindset could help them get smarter and do better. You can use examples from the passage you just read and from your own life. Don't worry about writing a perfect essay, just write whatever you might say to this person.

[Empty text box for writing]

Figure A5. Treatment increased the rate at which students in the bottom third, by pre-study grade point average, passed courses.



High School Tables**Table A1. Full regression model for the analysis of post-intervention GPA.**

	All Students	Bottom Third	Middle Third	Top Third
Intercept	2.50*** (0.23)	1.56*** (0.11)	2.63*** (0.07)	3.58*** (0.05)
Time	-0.04 (0.02)	0.00 (0.05)	-0.06 (0.03)	-0.05* (0.02)
Mindset Treatment	-0.01 (0.05)	-0.05 (0.06)	0.01 (0.04)	-0.02 (0.03)
Alternate Treatment	0.07 (0.06)	0.03 (0.08)	0.00 (0.06)	0.00 (0.04)
Time X Mindset Treatment	0.04 (0.02)	0.18** (0.06)	-0.01 (0.04)	-0.02 (0.03)
Time X Alternate Treatment	0.04 (0.03)	0.14* (0.07)	0.04 (0.06)	-0.05 (0.03)
AIC	30219.57	10726.64	9536.21	6134.20
Log Likelihood	-15099.78	-5353.32	-4758.10	-3057.10
Num. Obs	13359	4128	4557	4674
Num. Students	1594	535	525	534
Num. Courses	385	263	294	257
Num. Schools	13	13	13	11
Variance Student	0.55	0.19	0.11	0.07
Variance Course	0.23	0.37	0.20	0.05
Variance School	0.68	0.10	0.02	0.01
Variance Residual	0.39	0.60	0.37	0.17

*** p < 0.001, ** p < 0.01, * p < 0.05, p < 0.1

Table A2. Full regression model for the analysis of credit attainment in the bottom third of students by prior achievement.

	Model
Intercept	2.56*** (0.49)
Time	-0.05 (0.16)
Mindset Treatment	0.07 (0.21)
Alternate Treatment	0.19 (0.27)
Time X Mindset Treatment	0.43* (0.20)
Time X Alternate Treatment	0.37 (0.25)
AIC	3785.78
Log Likelihood	-1883.89
Num. Obs	3881
Num. Students	535
Num. Courses	258
Num. Schools	13
Variance Student	2.24
Variance Course	2.02
Variance School	2.25
Variance Residual	

*** p < 0.001, ** p < 0.01, * p < 0.05, † p < 0.1

Community College Trial

Methods

Participants were 715 students (382 female; 330 Latino, 67 Asian, 116 White, 120 Black, and 82 other/mixed ethnicity) at a community college in the Los Angeles metropolitan area. At the beginning of the fall semester, students completed a single 50-minute session in their schools' computer lab. Each student was randomly assigned to a control condition or to one of three intervention conditions—a growth-mindset intervention, an alternate intervention (not discussed here for simplicity), or a combined intervention condition. Both interventions took place during the same session.

In the growth-mindset intervention, students read an article describing the brain's ability to restructure itself as a consequence of effortful practice. The article focused on the implications of these neuroscientific findings for students' potential to become more intelligent through study and practice. This article emphasized that even adults' brains can grow and change with effort. It also explicitly discussed math ability as a type of intelligence that can be grown. This message was reinforced through several writing exercises. In one, students summarized the scientific findings in their own words. In the second, they read about a hypothetical student who was becoming discouraged and starting to think of himself as “not smart enough” to do well in school. The writing exercise asked participant students to advise this target student based on what they had read. See Appendix 2.

Academic transcripts were collected from the college at the end of the semester. The primary analysis focused on the effects of mindset treatment on students' grades in all academic courses (computer science, education, humanities, foreign languages, math, natural science, and social sciences). Course grades were coded on a 0-4 point scale, where F=0, D=1, C=2, B=3, and A=4. Grades that do not affect grade point average were excluded from this analysis because they could not be readily converted to this numeric scale, e.g., “W” for withdrawal and “P” for passing on a pass/fail basis. Of the 715 participating students, 620 received grades in academic courses.

A secondary analysis focused on the subset of 292 students enrolled in developmental math courses. Developmental math courses can have high drop out rates. One of the goals of customizing the mindset intervention to discuss adults' ability to improve at math was to reach this potentially higher risk population.

Results

We used a mixed effects linear regression to test the effects of exposure to the mindset treatment on students' grades in academic courses. Random intercepts were specified for each student, course, and academic department. Fixed effects included pre-study GPA and status as a new student (dummy coded). The mindset treatment increased students' semester grades by 0.18 points, $t = 2.11$, $p = 0.03$. See Table A3 for the full regression model and Figure A6. The mindset treatment did not significantly influence dropout across all academic courses, $Z < 1$.

The secondary analysis focused on the effects of the mindset intervention on achievement in developmental math courses. The growth mindset treatment did not influence students' course

grades, $t < 1$. However, it reduced the dropout rate by over 50%. In the mindset condition only 9% of students dropped out of developmental math courses, as compared to 20% in the control condition, OR = 0.43, $Z = -2.42$, $p = 0.02$. See Figure A7 and Table A4.

Community College Figures

Figure A6. Students randomly assigned to the growth mindset treatment earned higher semester GPAs after the intervention.

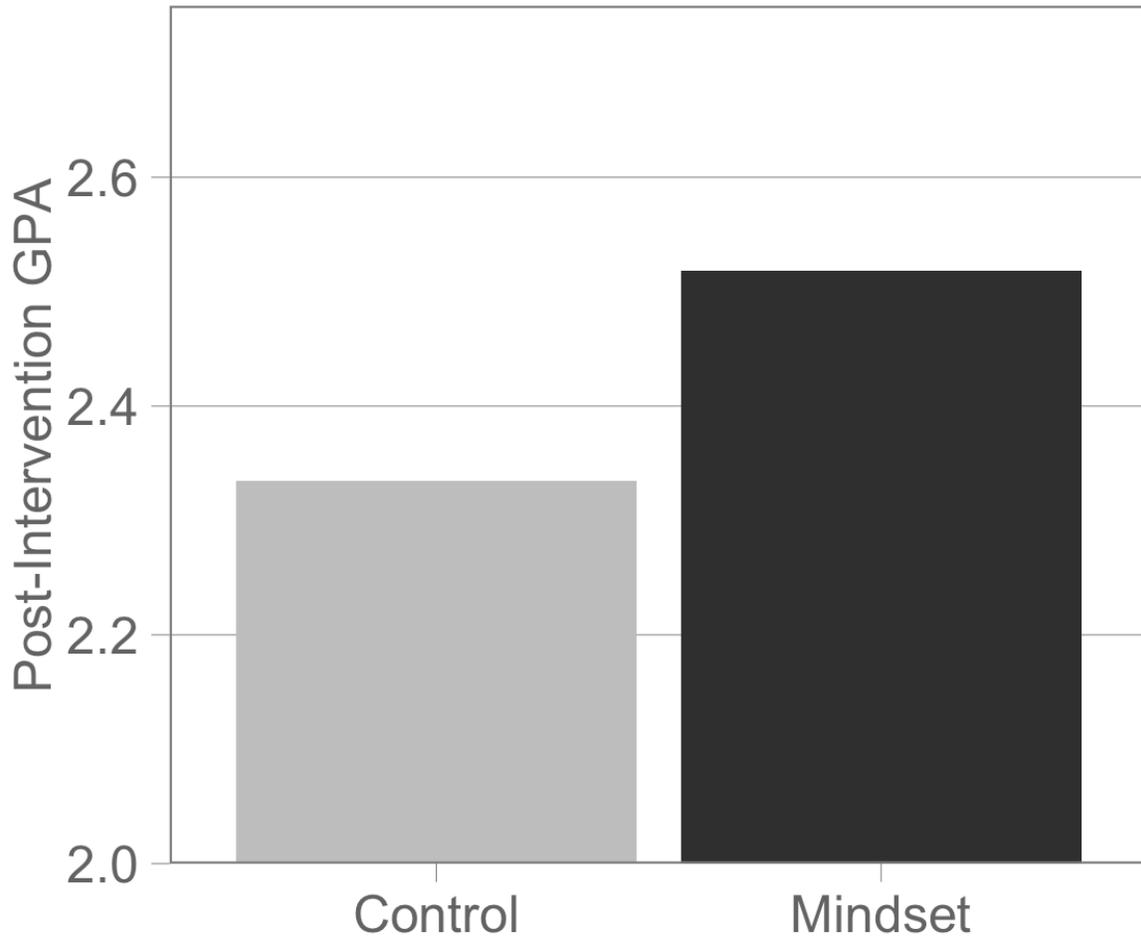
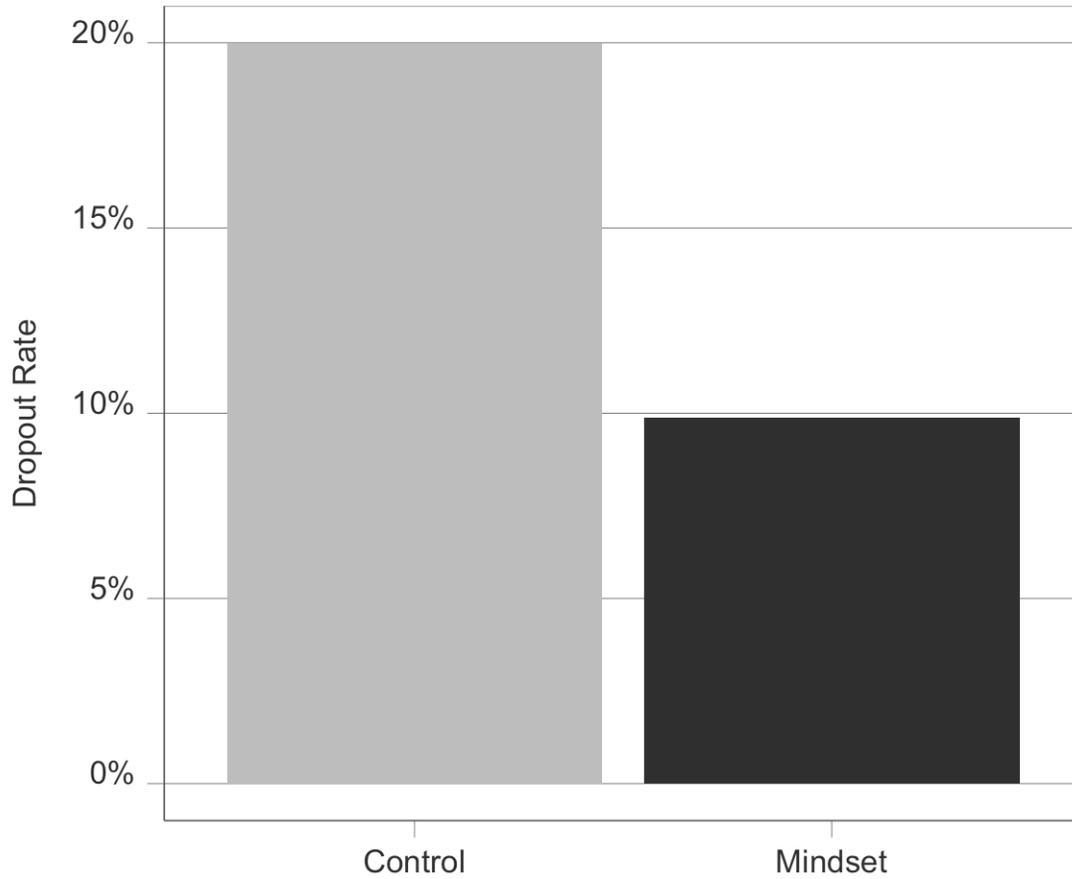


Figure A7. Exposure to the growth mindset intervention reduced dropout from math courses in the sub-sample of students taking developmental math.



Community College Tables**Table A3. Full regression model for the analysis of post-intervention GPA (full sample)**

	Model 1
Intercept	0.63*** (0.22)
Mindset Treatment	0.18* (0.08)
Alternate Treatment	-0.01 (0.08)
Prior GPA	0.65*** (0.07)
New Student	-0.34*** (0.09)
AIC	4683.75
Log Likelihood	-2332.88
Num. Obs	1514
Num. Students	620
Num. Courses	158
Num. Departments	36
Var. Student	0.72
Var. Course	0.07
Var. Department	0.14
Var. Residual	0.75

*** p < 0.001, ** p < 0.01, * p < 0.05, † p < 0.1

Table A4. Full regression model for the analysis of course drop-out among developmental math students.

	Model 1
Intercept	-1.39*** (0.23)
Mindset Treatment	-0.83* (0.35)
AIC	243.96
Log Likelihood	-118.98
Num. obs.	292
Num. groups: class	6
Variance: class.(Intercept)	0.02
Variance: Residual	

*** p < 0.001, ** p < 0.01, * p < 0.05, † p < 0.1

Charter High School Trial

Method

Participants were 160 students attending an urban charter high school in a major city in the East coast. Ninety-two percent of students were African American, 4% were White and 4% were Asian. Nearly all were on free or reduced-price lunch, an indicator of low socio-economic status.

In May of 2012, college-going high school seniors completed the experimental materials in the school's computer lab during an elective class. It took an average of 20 minutes to complete. In a randomly-assigned treatment group students read a scientific article summarizing the science underlying the growth mindset. They then answered questions about the scientific content of the article, and finally they wrote a letter to a future students in which they explained how that student might remember that the brain can grow and develop when they face challenges during the transition to college. In a control group, students read a highly similar article about the brain, only it focused on the parts of the brain and how they can be used to optimize memory. They then completed an analogous set of writing prompts. No teachers from the schools were aware of the growth mindset content nor had they read the materials. In addition, no school staff were aware of student treatment or control condition assignment.

In November of 2012 school staff submitted students' names to the National Student Clearinghouse (NSC) to assess whether students were enrolled in college full-time or not (for more information on the NSC and for an example of another study using the NSC to assess long-term impact of a college persistence intervention, see Goldrick-Rab, 2012). The primary dependent variable was full-time enrollment (cf. Goldrick-Rab, 2012), which is a strong predictor of on-time graduation (Diehl, 2012). From the school, researchers also obtained official high school records and scores on the SAT, to use as a covariate in analyses (note that all significant treatment effects remained significant when using no covariates).

Results

Preliminary analyses of raw data showed that forty-nine percent of control condition students were enrolled full-time in November according to the National Student Clearinghouse, compared to 66% of students in the growth mindset treatment condition, a significant difference, $Z = 2.22$, $p = .026$.

Charter table.**Table A5. Full regression model for the analysis of full-time enrollment (unstandardized logistic regression coefficients).**

	Model 1
(Intercept)	-9.93 ^{***} (1.73)
Mindset Treatment	0.89 [*] (0.40)
SAT Score	0.01 ^{***} (0.00)
AIC	161.46
BIC	173.79
Log Likelihood	-76.73
Deviance	153.46
Num. obs.	161

*** p < 0.001, ** p < 0.01, * p < 0.05

Statistical models

Full-Scale Implementation at a Large Four-Year University

Method

This study was a partnership between the research team and the university provost and deans. Participants were all incoming freshmen at a large four-year university in Texas ($N = 7,342$). As a part of freshman orientation, completed over the summer in the weeks before an on-campus orientation experience, students were required to visit a website and learn about the transition to the university. Most of the information was procedural, involving information about signing up for courses or changing majors or getting required vaccines. However one required link described the “[University in Texas] Mindset” (UT mindset for short).

Students were directed to the university orientation website through an email from the New Student Services center. This email informed them that all of the modules were required for enrollment. In fact, however, students could enroll without completing the modules. Nevertheless, roughly 92% did do. At the end of the semester, official credit attainment records were obtained from the university registrar.

Prior to inviting students to complete the web-based module, all students were randomly assigned, blocked on race, gender, college within the university, and SAT score (bottom vs. top percentile). True random numbers were obtained from random.org and used in the random assignment procedure. As expected, there were no differences between mindset treatment and control groups in terms of any variable we measured.

Participants open-ended responses to the intervention or control group prompts were coded by independent coders blind to condition or hypotheses. Over 96% of responses were identified as valid and reasonable replies to the prompts. Here are some unedited example responses to the growth mindset writing prompts:

Example 1

[This] is a huge school and I know that it is going to be filled with a lot of "smart" people. Although I have not actually experienced this firsthand yet, I had a similar experience in high school. I opted to go to a small, magnet school that was basically an accumulation of all the smart people from all the other high schools. I was overwhelmed, but then I realized if I worked hard I would be able to succeed. I guess, one of the biggest thing for me was to dedicate the time necessary to each subject so that I could fully grasp the concepts I needed to learn. Trust me, when you get that assignment, project and test back with the wonderful score...it will pay off. And later down the road when you're able to recall the concepts, you'll be surprised at how well you know the subject. So essentially, what I'm trying to say is that there's no such thing as a "smart" or "dumb" person, the "smart" people just had more practice...but everybody is able to catch up to that level once they put in the necessary time.

Example 2

Hi there. / I had the same issue with the transition from middle school to high school: I had straight As in middle school, and all of a sudden I was getting Cs. I felt stupid. New environments provoke new emotions, I guess. / Even worse, it felt like asking a question meant that you were admitting you were dumb... but that feeling isn't true at all. / You waste time and opportunity by thinking like that. That time and opportunity could be used to ask questions and better yourself. In fact, I think that those who ask questions are the smart ones - the ones that have the confidence to ask questions, the ones that constantly have the courage to gain more knowledge. / At one point, you have to get over how uncomfortable you are with seeking help or approaching a professor. That's already a big step to growing. Imagine all the opportunities you would have to grow. You don't want to limit your resources, and other brains are some of the best resources to use to grow your own brain. (Hey, in a new age of technology, natural human knowledge is so, so valuable.) / I'm a strong believer in hard work, and the things you want don't come easy without it. To get the things you want, you have to work hard and do things you've never done. Try new strategies! Talk to new people! Grow that brain! / / You're not dumb. You just have to realize your potential. And find the right way to do it. (Easier said than done, I know.)

Example 3

Hi! / I heard you are starting to have a hard time in college. From experience, I know exactly how you feel. When I started college, I worried about not being "smart" enough for the class and was often very shy to seek for assistance. But believe me, everybody undergoes the same thoughts. Just because a class seems hard, it doesn't automatically mean that you are dumb. / As a matter of fact, I learned that it is never too late to learn! Did you know that the brain is like a muscle and with enough exercise, it can grow? / Yes, it is true. Just like an athlete exercises to get stronger, if you open your mind to learning new things, your brain grows with more knowledge on any particular topic. / So although you are struggling in a class, it doesn't mean that you aren't meant for it. It may be challenging, but I encourage you to find a way to learn. You may need to concentrate on the topic even more, but it isn't as difficult nor boring as it sounds. Around the campus, there are many students, Teacher Assistants, and professors who can give you the best study advice they can give, and I encourage you to go out and seek these great opportunities and tips that they have to offer. / Well, I wish you the best of luck, and remember keep exercising that brain!

Example 4

Dear friend, / / As a student who was once in your shoes a few years ago, I too thought I was prepared for college and would breeze by with the study methods I had in high school. Although, I realized soon after that I was far from the truth. I want to tell you that every student has his or her low point in college either by feeling intimidated by their professors or feeling lost in such an enormous campus; but it's an awakening for them to realize that its only another challenge to overcome and improve one's study habits and socializing skills. The professors are not going to

hold your hand and expect you be successful in life; just like a coach is not going to spike the volleyball, make the free throw or jump the hurdle for you. They challenge you to face that obstacle head on and if you fall, you get back up and try again. When I reached my low point first semester of my freshman year, I had to seek advice from other students in my classes and tutors and realized that they too were in the same boat as I was. We later worked together, shared study habits and soon become great friends. Now, I have confidence in registering for new classes instead of dreading to type in that ID number just to get it over with. As a friend with experience, I am telling you to have dedicated and a open mind when you set foot on campus because it will make you college experience significantly better.

Results

In the full sample of students, the growth mindset treatment caused a 3 percentage point increase in the percent of students earning 12+ GPA-bearing credits (Control: 60%; Treatment: 63%). As predicted, this effect was especially strong for African American students, who may face negative stereotypes about their intelligence (Control: 45%; Treatment 55%).

Full-Scale Implementation Figures

Figure A8. Screen Shot of Web Portal Directing Students to the Growth Mindset Intervention

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[E-mail NSS](#)
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[SSB 3.410](#)

NSS

[NSS Home](#)
[Bevo Bulletin Guide for New Students](#)
[NSS FAQs](#)
[Resources for New Students](#)
[Resources for Families](#)
[UT Austin Lingo](#)
[Local Hotels](#)
[NSS Mission Statement](#)
[Students Hooked on Texas](#)
[Contact NSS](#)

Pre-Orientation Requirements

Welcome, David Scott Yeager

Please see [this webpage](#) for additional information about freshman orientation including testing information, travel arrangements, etc.

You must now complete the following requirements

While most of the modules are brief, some will take extra time and attention, so please plan accordingly. You may log back on at any time to complete these requirements, and can reference the materials at any time. You must complete all components by the time you check in at orientation. You will not be allowed to register for classes until you have completed all requirements.

Required Completion	Status
1. How to Prepare for Registration Click here to view the video presentation Click here to download the video transcript as a Word document.	pending <input type="checkbox"/> I have viewed this presentation and acknowledge that I am responsible for the content presented
2. How to Register Click here to view the video presentation Click here to download the video transcript as a Word document.	pending <input type="checkbox"/> I have viewed this presentation and acknowledge that I am responsible for the content presented
3. First-year Interest Groups information Click here to download the FIG information (pdf)	pending <input type="checkbox"/> I have read this information and acknowledge that I am responsible for this content
4. Signature Course information Click here to download the Signature Course information (pdf)	pending <input type="checkbox"/> I have read this information and acknowledge that I am responsible for this
5. How to Change Colleges Click here to go to the Changing Colleges at UT page	pending <input type="checkbox"/> I have read this information and acknowledge that I am responsible for this
6. Important Campus Resources Click here to go to the Important Campus Resources page	pending <input type="checkbox"/> I have read this information and acknowledge that I am responsible for this
7. Meningococcal Vaccine Requirement Click here to read the Meningococcal Vaccine Requirement information	pending <input type="checkbox"/> I have read this information and acknowledge that I am responsible for this
8. The "UT Mindset" Click here to hear about social and academic life at UT from current Sophomores, Juniors and Seniors, and to provide your opinions about the transition to UT. Set aside <u>30-45</u> minutes of time to complete this survey carefully and privately before clicking the link. <i>Please do not press the "back" button in your browser during the "UT Mindset" activity.</i>	complete <input checked="" type="checkbox"/> This box will be checked automatically when you have completed the entire activity.
9. University of Texas Honor Code Click here to download the University of Texas Honor Code	pending <input type="checkbox"/> I have read this information and I agree

Figure A9. First screen seen by participants in the scaled-up growth mindset intervention.

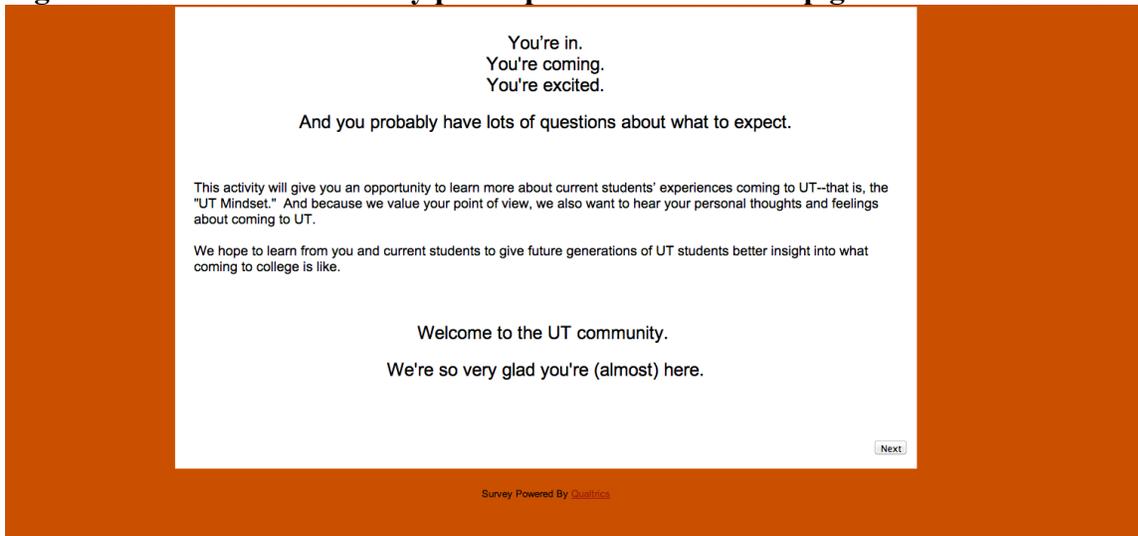


Figure A10. Screen shot of growth mindset article read by participants in the scaled-up intervention.

"UT Mindset" Article

As you read the 4-page scientific article below, try to think about how it relates to your life.

*****Please read each page slowly and carefully*****

When you are done reading, we will ask you to remember what you read. So please pay close attention. (and, just to remind you, the "Next" button will appear after you have had time to read carefully)

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 and use good strategies.





Inside the outside layer of the brain—called the cortex—are billions of tiny nerve cells, called

Full-Scale Implementation Tables**Table A6. Full logistic regression model predicting 12+ GPA-bearing credits in the Fall semester.**

	Model 1
(Intercept)	-6.55 ^{***} (0.30)
Mindset Treatment	0.15 [*] (0.06)
SAT	0.00 ^{***} (0.00)
High school class rank	0.02 ^{***} (0.00)
Sex	0.30 ^{***} (0.05)
AIC	8901.24
BIC	8942.65
Log Likelihood	-4444.62
Deviance	8889.24
Num. obs.	7343

*** p < 0.001, ** p < 0.01, * p < 0.05

Table A7. Full logistic regression model predicting 12+ gpa-bearing credit attainment, African American students only.

	Model 1
(Intercept)	-6.52 ^{***} (1.70)
Mindset Treatment	0.50* (0.25)
SAT	0.00 ^{***} (0.00)
High school class rank	0.02 (0.01)
Sex	0.35 (0.24)
AIC	476.48
BIC	499.75
Log Likelihood	-232.24
Deviance	464.48
Num. obs.	357

^{***} p < 0.001, ^{**} p < 0.01, ^{*} p < 0.05

Appendix 3: Text from Growth Mindset Intervention (Community College Trial)

Think about the article that you just read. What are all the reasons why scientists say that people's math ability can grow and get better with effort and practice?

Please summarize them briefly below.

[text box]

[page break]

In the article, you learned 3 things:

1. When you work hard and learn new things, your brain grows new connections and you get smarter.
2. The more you challenge yourself, the smarter you will become.
3. Smart people are the ones who have practiced more—they have built up their reading and math "muscles."

Think about an example from your own life. What is something you weren't good at at first. Then you practiced it using a good strategy and became really good at it. Write about it and explain how you became good at it.

[text box]

[page break]

Not all math students know that the brain can get smarter, even though it may help them succeed. And we want to get your help, so we can learn more about how to explain it to them. We're hoping you can explain--in your own words--that the brain gets smarter when people use good strategies and try hard.

Imagine a friend who is struggling in school. This friend used to do pretty well in school but now is having a hard time and is starting to feel dumb. Write a letter to your friend to encourage him or her—tell them about what you just learned about the brain and why they shouldn't be discouraged.

For example, you can tell them:

- a) how they can get smarter if they work hard and use a good strategy,
- b) how they should work hard to build their reading and math muscles,
- c) how they are not dumb, they just need to practice using a good strategy,
- d) how they can ask the teacher or other students to help them learn better ways to study.

Or any other tips you have for learning in school and getting smarter.

(Don't worry about writing a perfect final draft. We just want to know how you would say this to another student in your own words.)

[text box]