Appendix 1 for:

Teaching a Lay Theory Before College Narrows Achievement Gaps at Scale

Outline of Intervention Materials and Procedures Across Experiments

Appendix 1 includes the following information, which applies to all three lay theories intervention experiments:

- Basic overview of the interventions
  - Overview
  - Ostensive purpose
  - Structure
- Intervention materials
  - *Social-belonging* intervention (which was adapted for the *culture* and *critical feedback* interventions in Experiment 3)
  - *Growth mindset* intervention (see Figure S1)
  - Control group materials

Basic Overview of the Interventions

Overview. Each intervention was web-based and consisted of two key components: exposure to intervention content and a writing task (i.e., a "saying-is-believing" exercise). The activity was self-contained and self-paced: all intervention materials were completed within the online module and students led themselves through the activity without facilitation from researchers or school staff. The activity took approximately 25-35 minutes to complete. All procedures were approved by university IRB panels. Procedures were based on past successful research (1, 2).

In Experiment 1, to maintain the double-blind design, school staff administered the surveys and interventions and, except in rare cases, the research team was not present in the classroom during intervention delivery. School staff were unaware of study hypotheses, had not read the intervention content, and did not know condition assignments for individual students or that different students would receive different versions of the survey. Participating students could not see one another's screens due to the cardboard dividers placed between computers.

In Experiments 2 and 3, students completed the materials on their own computers on their own time, and so it was not possible for students to be affected by expectancies from experimenters. It was also highly unlikely for students' condition exposures to be contaminated.

Ostensive purpose. The activity was represented to students as an opportunity to learn more about older students' experiences in the transition to college and to share their own perspective on this transition in an effort to improve the transition for future students. Although students provided informed consent, the activity was not presented as a "study" or as an effort to address inequality. This representation was designed to prevent students from viewing the exercise as controlling, remedial, or stigmatizing. In addition, because students were likely to talk with classmates about the experience (e.g., on social media), we told students explicitly that different students would read about different aspects of the college transition: "Because there are

many aspects of the college transition, we can't share with any one student all the aspects the current students described. So some incoming students will see other portions."

Students were told that their academic records would be accessed. All had the opportunity to provide consent, or not. Students could decline to complete any questions at any time with no penalty.

Structure. After introductory information, students reviewed intervention content. This consisted of survey results and stories from older students, a scientific article, or both. The second part consisted of a "saying-is-believing" writing exercise. In this exercise, students reflected on the intervention message and wrote about how it is true of or relevant to their own experience. Students were told that their writings could be shared with future students to help improve their transition to college. To ensure that students read the materials carefully, pages had automatic timers that prevented them from advancing until a minimum amount of time had passed.

In Experiments 1 and 2, students completed a few self-report measures before beginning the activity. In all three studies, students answered additional questions about their thoughts and feelings about coming to college as well as demographic questions after completing the intervention materials. (Students in Experiment 1 did so only after the social-belonging intervention materials, not after the growth mindset intervention materials).

Intervention Materials

The social-belonging and growth-mindset lay-theory intervention materials were adapted from previous research (3–5). The culture and critical-feedback lay-theory interventions were new but inspired by previous research (6, 7). All intervention materials were tailored to be relevant and appropriate to the experience of students in each target population.

Social-belonging lay-theory intervention. The social-belonging intervention tested in all three experiments was designed to dispel the misperception that only certain students (e.g., disadvantaged students) experience difficulty and question their belonging in college. It conveys that almost everyone worries at first. Further, the intervention shows how students can overcome these challenges with time. In the first portion of the intervention, students read results of a "Current Students Survey" purportedly conducted with older students from their school and schools like theirs (this information was consistent with pilot data collected from students at each school). The survey results conveyed two key ideas: (1) that in the transition to college most students worry about whether they belong, and this is true regardless of race, gender, or other background characteristics and (2) that these worries subside with time when students take active steps to create social ties to other individuals in their college. Following the survey results, students read stories drawn from upper-year students illustrating these key ideas. Students were told these stories had been edited for clarity.

In Experiment 1, two of the stories were:

"When I first got to college, I worried that I was different from the other students. Everyone else seemed so certain it was the right place for them and were so happy here. But I wasn't sure I fit in – if I would make friends, if people would respect me, if it was the right school for me. With time I came to realize that almost everyone comes to college and feels uncertain at first about whether they fit in. It's just something everyone goes through. Now it seems ironic – everybody feels different first year, but really we're all going through the same thing."

And

"My first few months in college I didn't really know what I was doing. I don't think most people do. When I left class, I just went to a study lab. When I Ieft the lab, I just went home and did more work. Even in the car, I was just studying. And it wasn't productive. I was just doing the same problems over and over again. I felt stressed, but that's how I thought college just is – lonely and hard. But then I talked with a few other students in class and we decided to try studying together. It was really helpful – talking about the class, quizzing each other, and going to the TA or professor with questions helped me understand the material better. And we ended up becoming friends too, so I felt less stressed and lonely too. I still hit the books on my own when I need to. But I learned that talking things through with other people helps me get unstuck when class gets tough or I don't understand a problem. College is a new experience. It takes time to learn how to do it. But you don't have to pick between doing well in class and making friends or having a good experience. You can do both."

In Experiments 2 and 3, two corresponding stories were:

"When I got into [school name], I was so excited about becoming a student at such a great place. But sometimes I also worried I might be different from other [school name] students. And when I got to campus, sometimes it felt like everyone else knew they were right for [school name], but I wasn't sure if I fit in. At some point, I realized that almost everyone comes to [school name] uncertain whether they fit in or not. Now it seems ironic—everybody comes to [school name] and feels they are different from everybody else, when really in at least some ways we are all pretty similar. Since I realized that, my experience at [school name] has been almost one-hundred percent positive."

"Initially my transition to [school name] was pretty easy. Hanging out with friends in my dorm was fun, and I met a lot of people early on. After Winter Break, things got harder because I realized that all my really good friends were at home and I didn't have friends like that at school. However, I decided to just let things fall into place. I got involved in extracurriculars, and I met people who had common interests and unique perspectives. I also got to know people in class as study partners who became close friends. I found a comfort zone by exploring my interests and taking the leap into an active life at [school name]. But this took time and before I found my niche at [school name] there were times when I felt quite lonely."

After reading these and other stories, students were asked to complete a writing exercise. Students were first asked to write a brief essay about why it is common for students to initially feel unsure about whether they belong in college using examples from their own past experiences making transitions (e.g., coming to high school). They next wrote a brief essay about how and why these initial worries about belonging are likely to diminish over time as students come to feel at home in college. Students were told that their essays might be provided, anonymously, to future students to improve their transition to college. The stories from the survey materials were reproduced below the essay text box on the same survey page so students could reference them if desired.

Growth mindset intervention. The purpose of the growth mindset intervention is to teach students that intelligence is a malleable quality that can be developed when students put forth effort and use effective strategies on challenging tasks (1, 5). Students first read an article summarizing scientific research supporting this idea. In the saying-is-believing exercise, students wrote essays conveying this idea to future students who might be struggling in school and might feel "dumb." See Figure S1.

Control materials. The control conditions were parallel, active, and positive experiences but lacked the theoretically important intervention messages.

The primary control materials (Experiments 1-3) were identical to the social-belonging intervention in formatting and similar in length but focused on students' adjustment to the physical rather than social environment in college such as getting used to the buildings, the weather, and the campus. Given that some students move long distances to attend college, the message seemed reasonable and even superficially helpful. Indeed, many students in Experiments 2 and 3, stated in response to an open-ended question that the control messages made them feel prepared for college and as though their college cared about them. Similar to the intervention conditions, students in the control condition read survey results from upper-year students and normative stories explaining how they adjusted to the physical environment. In the saying-is-believing exercise, participants wrote how and why students adjust to the physical environment at college.

The growth-mindset control materials (only Experiment 1) included a scientific article that taught facts about the brain, including brain localization and the role of different brain areas in supporting cognitive functioning, but did not discuss the brain's ability to grow and improve with effort. In the saying-is-believing exercise, participants wrote essays to future students about why the brain might be such a mystery to students like them and how it can be helpful to know more about the brain.

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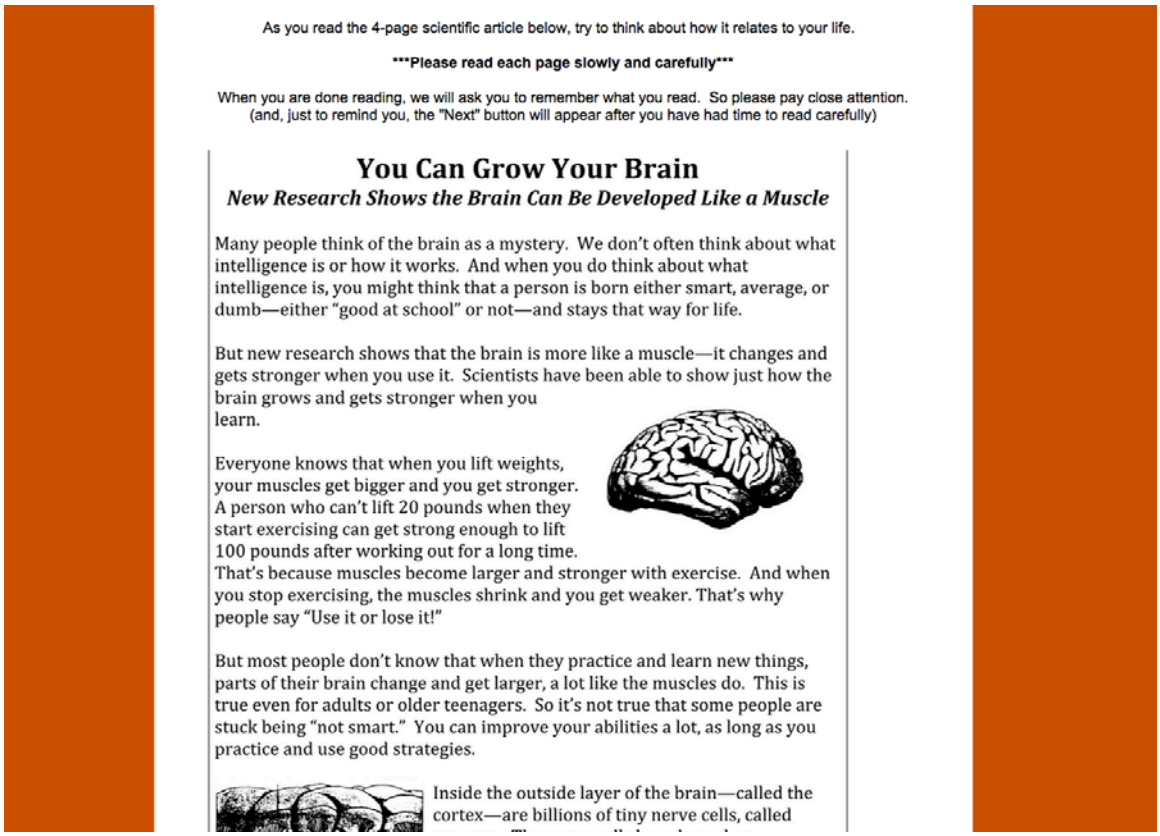
Figure S1. Screen Capture for Growth Mindset Intervention in Experiment 2



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

Appendix 2a for:

Teaching a Lay Theory Before College Narrows Achievement Gaps at Scale

Outline of Supplementary Information for Experiment 1

This appendix includes the following information pertaining to Experiment 1, conducted with outgoing seniors at an urban charter network:

- Information about study participants and school context
- Information about experimental procedures
    - Overview
    - Data collection and intervention
- Effectiveness of random assignment of social belonging intervention (Table S1)
- Details about how the social-belonging intervention was customized for the urban charter school context
    - Qualitative inquiry—including focus groups and rapid iterative user-centered design—to create a custom social belonging intervention
    - Examples of insights and changes made in response to them (Table S2)
- Manipulation checks
    - Measures used as manipulation checks
    - Results of analyses of manipulation check measures (Table S5)
- Description of primary outcome measures: full-time enrollment assessed via the National Student Clearinghouse
- Results for primary outcomes:
    - Effects of social-belonging intervention within both cohorts (Table S3)
    - Coding of open-ended responses and link to outcomes
    - Focal analyses on full time enrollment re-conducted when dropping individuals who provided poor-quality responses
    - Effects of social belonging intervention are not moderated by pre-randomization characteristics (Table S4)
- Social integration measures;
    - Description of measures to assess social integration in the fall term
    - Analyses of treatment effects on social integration (Figure S2)
    - Mediation analyses using measures of social integration (Table S6)

Participants and School Context

Experiment 1 participants were nearly all outgoing seniors (97%) in two consecutive years at five campuses of an urban charter high school network in a major city on the East Coast of the United States.

In the first cohort (students who graduated from high school in 2012) students from two high school campuses were randomized at the individual level to intervention or control, while students in the remaining two campuses only completed a baseline assessment. This was done to allow for additional correlational, predictive analyses. In the second cohort (students who graduated from high school in 2013), the charter network added a fifth campus, and all of the

outgoing seniors at all five campuses were randomized at the individual level to intervention or control.

The sample was almost entirely African-American; at four campuses, 98% of students were African American, 1% were European American, and 1% were Asian American. At the remaining campus, 67% of students were African American, 13% were European American, and 13% were Asian American. Students across the five campuses were largely low-income—roughly 70% received free or reduced-price lunch—and 67% would be the first in their families to earn any college degree, meaning that they were first-generation college students.

Students were moderately academically prepared for college. In support of students' college readiness, roughly 75% were deemed "proficient" on state tests, a higher rate than among students in comparable local district schools, where 30% were proficient. Students had almost a "B" mean GPA of 2.98, meaning they were adequately engaged in school. At the same time, the mean SAT of students in the sample was 1202 on a 2400-point scale, well below the national average (1498). In addition, historically only 23% of students who graduate from this network of urban charter high schools earn any post-secondary degree within six years; hence there was a great deal of room to improve college persistence outcomes.

Experimental Procedures

Overview. Experiment 1 was a two-session, 2 (social-belonging intervention vs. control) × 2 (growth mindset intervention vs. control) individual-level random assignment, double-blind, active-placebo-controlled, longitudinal intervention experiment. There were equal probabilities of random assignment to each condition, such that 50% of students received the social-belonging intervention, 50% received the growth-mindset intervention, and 25% received both. Students were included in the analytic sample if they saw any screen for the first of the sessions—the belonging session—regardless of whether they completed that session or returned for the second session. This is a conservative procedure.

Following best practices in randomized trials, missing data on covariates were indicated with a dummy variable and a value of zero was imputed in the covariate variable. Both the dummy variable and the covariate with imputed value were included in models. This prevents listwise deletion due to missing data on covariates, and is a transparent method to deal with missing data.

Data collection and intervention procedures. Between February and April of senior year of high school, students completed a baseline survey assessing psychological variables that might predict college persistence. This included measures of belonging uncertainty, growth mindset, the Big 5 personality traits, grit, self-control, and other factors outlined below. In addition, official student records with students' cumulative high school GPAs were obtained. Measures reported in Appendix 2b.

Using baseline data, strata were created to be used in random assignment: within school, prior achievement (GPA dichotomized at the median), and gender. A true random number generator (www.random.org) was used to conduct random assignment. It was effective (Table S1). Conditions did not differ in terms of SAT scores, high school GPA, IQ, or any of the 11 baseline personality or belief variables, all *p*s > .27. Thus, before the intervention the groups were no different in terms of qualities that might predict college persistence.

Next, in May of senior year, students were taken to their school's computer lab to complete the first intervention session—the social-belonging intervention. Students entered their student identification numbers and the software directed them to their pre-assigned experimental condition. Students wore headphones and there were cardboard dividers between computers to maintain privacy. In the social-belonging intervention, each story was accompanied by audio from an actual college student who had been recorded reading the text. Students could not advance past each story until roughly 30 seconds had passed, to ensure that students did not skip ahead. One week later similar procedures were followed to administer the growth-mindset intervention.

Customizing the Social Belonging Intervention

Here we describe the qualitative design process that was carried out in order to customize the social belonging intervention. This process was thought to be important in part because the population of interest in Experiment 1—graduates of urban charter schools—was very different from the population of selective private university students for which the existing social-belonging intervention was designed (1, 2).

Overview. The social-belonging intervention was customized using an iterative process of design, prototyping, and small-scale testing, drawing heavily on best practices for user-centered design. Student who participated in the design and piloting process were former charter high school students who been admitted to college. Most, but not all, of them had ultimately matriculated to college.

The design process privileged students' subjective experiences as a source of information, relying on a series of interviews and activities to elicit qualitative data about the difficulties and struggles students experienced in the transition to college. Insights from this qualitative research were distilled into a set of hypothesized psychological "levers" that were thought to hold students back in college (see Table S2). These were subsequently refined by discussing them in interviews and focus groups with students and in meetings with practitioners who knew students intimately. Furthermore, pilot participants generated as much of the content of the social-belonging materials as possible, so that the materials would match target students' own ideas, experiences, and colloquialisms.

Qualitative insights for social-belonging intervention (see Table S2).

A need for agency in creating belonging. First, students in our pilot interviews sometimes expressed a lack of agency regarding their ability to create their own sense of social belonging in college. Many students had difficulty recalling times in high school when they had had to personally reach out and create ties to peers who did not share their characteristics or background. Instead, students said that for the most part their charter high schools created social relationships for them—for instance, through intensive summer experiences, retreats, after-school activities, etc.

Therefore the intervention emphasized that social belonging is an active process that requires students to take various steps toward creating ties to peers and professors. It furthermore emphasized that these relationships take time to create and do not always pay off, but on average efforts to create connections in college yield benefits in the long run.

Worries about "being social." Second, some pilot students felt that true social integration in college could undermine their prospects of graduation. They described eschewing the desire to

"party" and worried they would "get distracted." Instead many students described their goal as "getting through college" not "making friends." Indeed, some students said that a strategy of avoiding having fun with peers in their neighborhood was how they were able to succeed in high school without getting distracted or going "off track"; they credited their presence in college to their ability to resist the temptation to "be social" before college.

Whereas a strategy of focusing on school, and not friends, in the charter school context did not deprive students of friendships and teacher relationships within this school setting—the charter schools were structured to embed students in rich relational networks—pursuing the same strategy in college might simply leave students without a social network. Leading sociological theories of college success emphasize the importance of "social capital" for success (3). Weak social ties to peers are a valuable source of information about professors who are or are not interesting or fair, about important deadlines, about financial aid, and extracurricular and employment opportunities (4). Having friends may also be essential for students to manage the stress that accompanies the college transition; for instance, it gives students ways to learn that the challenges they face are not uniquely their own but shared, and to problem solve solutions. As we explain below, we sought to license students to create these bonds.

Worries about leaving behind neighborhood friends. Third, friends from college were not (and perhaps could not be) as intimate as friends from high school or from one's neighborhood. Students described feeling that people at college could never truly know or understand their background—especially not if those friends were from suburban areas and did not have direct experience growing up in an urban setting. A pilot student said, "You haven't been through enough with the brief time you share in college to make real friends." Furthermore, many students worried about turning their backs on their "true" friends or their family by making new friends from a different background. That is, not only did students expect that they would not be fully known for who they are, but were concerned that even if they happened to form new close friendships it would be an act of betrayal of their home communities.

The revised intervention addressed the latter two concerns by seeking to license students to create weak social ties to peers in college. It did not argue that friends are never distracting, or that college friends should replace stronger tries to one's community. It unpacked the process through which casual friendships or "chumships" can be helpful for meeting one's educational goals and for reducing stress. It emphasized that college friends do not need to compete with high school friends to have positive effects. The goal of this revision was to lower the bar for friends in college, so that students did not expect to be fully known or understood, only to have peers who could be fun to spend time with, help them relieve stress, and be valuable sources of information about college success. The intervention sought to replace the "either/or" thinking about friends with a "both/and" thinking—that is, that you can *both* stay focused and stay true to friends at home *and* make new friends that help you succeed in college.

Worries that professors do not care. A fourth lever emerging from our design process involved students' beliefs about whether professors cared about them. Pilot participants contrasted their charter high school experience—in which teachers were devoted to students' success, often available by phone until late on Friday or Saturday nights—to college professors who seemed to "not care" whether they succeeded or failed. One student described the experience of moving from her high-performing charter high school, in which teachers shook students' hands as they entered the classroom each day, to a community college classroom, in which teachers lectured unemotionally seemingly without any personal connection to students.

Intervention revisions emphasized that professors' different styles do not necessarily signal a lack of care for students' success. Instead, the intervention explained, a professor's high standards for hard work and personal accountability might reflect his or her care for students' and beliefs about their potential. Thus the materials at least opened up the possibility that seemingly cold professors could, some of the time, care a great deal about a student's success but want the student to be self-sufficient and prepared for the real world of work. The intervention explained how behaviors like going to office hours to ask for help can help students see that professor care develop more personal relationships with faculty—and pay off in the long run.

Manipulation Check Measures and Results

The social-belonging intervention has two messages: (1) that everyone wonders at first whether they will belong in college, and (2) that these worries typically get better over time. Therefore, as a manipulation check, students were asked two sets of questions assessing these two ideas immediately after the intervention was delivered. Both analyses controlled for baseline, pre-intervention levels of belonging uncertainty in order to reduce random error. See Table S5.

Anticipated feelings of belonging. The first set of three questions asked about whether students expected whether they would feel as though they belonged *when they first arrived on campus in the fall*. We expected that the social-belonging intervention would lower these estimates—in effect, helping students adopt a sense of realism about their initial difficulties after arriving on campus. As predicted, the social-belonging intervention *lowered* students' estimates of their initial belonging immediately upon arriving at college (see Table S5).

Students then answered three similar questions about their expected belonging at the end of their sophomore year of college. Analyses showed that social-belonging intervention participants had identical expectations about belonging at the end of sophomore year, $t = 0.17$, $P=0.86$, even though they reported lower expectations about initial belonging.

Anticipated feelings of belonging at the beginning of the first-year	α=.82
Scale:	1=*Not at all* … 7=*Extremely much*
1. To what extent do you think you will feel you fit in at your college when you arrive?	
2. To what extent do you think you will feel you belong at your college when you arrive?	
3. To what extent do you think you will feel at home at your college when you arrive?	

Anticipated feelings of belonging at the end of sophomore year	α=.84
Scale:	1=*Not at all* … 7=*Extremely much*
1. At the end of your sophomore year, to what extent do you think you will feel you fit in at college?	
2. At the end of your sophomore year, to what extent do you think you will feel you belong at college?	
3. At the end of your sophomore year, to what extent do you think you will feel at home at your college?	

Social-belonging intervention participants expected more *growth* in belonging over the first two years in college, consistent with the intervention message. More formally, we calculated and analyzed a difference score (anticipated belonging at end of sophomore year minus anticipated

initial levels of belonging) and found that the social-belonging intervention significantly increased anticipated improvements in belonging over the first two years of college (Table S5).

Primary Outcome Measure

Continuous full-time college enrollment. The National Student Clearinghouse (NSC) is a non-profit database that reports on students receiving financial aid to both private and federal loan providers. It is therefore a nearly comprehensive database of students enrolled in higher education in the United States. The outcome of interest was continuous, full-time enrollment in the fall and spring terms the first academic year following students' high school graduation. The NSC does not report the number of credits earned in a semester, but they do report full-time versus less-than-full-time status after the course drop date.

The NSC covers the large majority of institutions of higher education. In the Northeast region of the U.S., where the current study was conducted and where nearly all participating students attended college, the coverage rate for African American students attending public four-year institutions was 99.6%, at public two-year institutions it was 99.2%, and at private non-profit institutions it was 97% (5).

Previous research has evaluated the accuracy of NSC data. In one analysis (5), researchers compared NSC college enrollment data to student transcripts. Both data sources provided identical estimates of the percent enrolled in college. Still, there are sources of error in the NSC data. First, students' names could be matched incorrectly. To reduce this possibility, we relied on a number of best practices and input from experts in using the NSC database, including submitting multiple versions of first names, including middle names whenever possible, and submitting multiple birthdates where errors in the data were suspected. Next, some institutions are less likely to submit updated NSC data on time. For-profit colleges are less likely to submit data or do so on time and accurately; this can create measurement error for the small proportion of participants attending such colleges (fewer than 10 students in Experiment 1 attended for-profit colleges). We continually updated data for several semesters after initial data inquiries.

Experiment 1 Intervention Effects on Continuous, Full-time Enrollment

Social-belonging intervention effects by cohort. Logistic regression model for social-belonging intervention effects across the two cohorts are presented in Table S3. They were not moderated by individual differences (Table S4). Treatment effects were also not moderated by school, all interaction effect Ps > 0.60. The social-belonging intervention had a significant impact in both Cohort 1 (Raw percentages: Control=34%, Intervention=50%, N=172), logistic regression with covariates Z=2.84, P=0.004, and in Cohort 2 (Raw percentages: Control=31%, Intervention=40%, N=412), logistic regression Z=2.00, P=0.045. Thus the finding replicated in the same schools in multiple years and across different schools in the same charter network.

Experiment 1 Coding of Social-Belonging Intervention Essay Responses

We coded responses in order to: 1) ensure that the large majority of participants wrote valid responses to the intervention, and 2) to carry out sensitivity analyses of whether focal intervention effects changed when excluding participants who wrote low-quality responses.

Two coders, blind to study hypotheses, to each others' assessments, and to any additional information about participants, read each treated student's written response to the social-belonging intervention essay prompt. Using the codebook reproduced below, coders then evaluated whether students' responses sufficiently addressed the prompt, and to what extent. These two coders were highly reliable (r=.97). Below, we reproduce the codebook and include examples of student essay responses from the actual intervention.

Codebook for Coding of the Quality of Essay Responses

Coding Instructions	(Unedited) Representative Student Essays
Code response as "0" if: • Didn't respond to the question; didn't write anything of value; blew it off. • Note: "0" is reserved for responses that are clearly not addressing the material in the survey or the prompt.	*"I got no idea what this is asking me nor do i bother to care."* *"no"*
Code response as "1" if: • Wrote something of value, but didn't seem to understand/grasp the question or had misconceptions • Note: The attempt to address the relevant information in the survey or prompt is sufficient. The idea is to identify the respondents that actually read the information even if the comprehension is not entirely evident. • Note: Response may demonstrate understanding that these worries feelings go away but *LACK* the element of how and/or why.	*"I am really worried about having to work with TAs because I am not a people person. I am really shy, and if I do not know somebody it makes it uncomfortable and hard to go up to someone to ask them a question. It could take time for me to feel comfortable and that makes me wirried because there is not time to loose in college. Especially, when your time, money and future are on the line."* *"i have no feelings towards belonging. that was never a worry of mine. highschool was not hard to transition to, i just did it."* *"As you get used to things you feel more at home and more comfortable in the place you are. The worries about belonging eventually go away because you get used to the place and the people. Things are usuallly scary when their new but eventually they grow o you."*
Code response as "2" if: • Seemed to understand/grasp the question and formulated a response that addressed its core. • Note: Response not only affirms that the feelings go away, but also *MUST* include how and/or why they do. This may be done through personal experiences or general examples.	*"These worries go away because they will make friends they will just have to give it time. Once they settle in they will feel more comfortable. After they meet their professors and know they way around they campus they will feel at home in college."* *"The initial worries about belonging to a college are likely to go away over time because once the student becomes more involve with social groups on campus that interest them they later found friends with the same interest as them. Also when student undestand that they can go to office hours to meet with their professor to discuss a situation, they later feel that the professors are there for them and want them to succeed. The initial feelings will also go away after learning more about the campus. For eample, a students might go on campus blind, not knowing where many things are, and once they realize this they are more likely to feel at home."*

	"The initial worries about belonging are likely to go away over time as students come to feel at home in college as they talk to TA's, join extracirriculars, and really interact with people. There are clubs and social events available at a lot of colleges.Interacting with professors also make school easier for people. Theres many things and activities that go on in college to assure that students are not bored but comfortable." *"These worries that most incoming freshmen feel can be disintegrated by simply doing what you love to do and finding others who love doing the same thing. For example if you love playing soccer, like i do,then join a soccer club and be in activities that will take your mind off those worries. Eventually the people in the club you are in will eventually talk to you and you will be friends. Also, Im thinking of becoming clos friends with my roommate becasue you both are most likely to be together for the rest o college and is really the first perosn you might meet adn can be the best oppurtunity to make a friend. Just joining clubs that you like is a great way to start meeting new people adn also make new friends so that later you will not feel that feeling of ot belonging at school adn feel like you are at home."* *"The initial worries about belonging fade away with time because students get used to the environment in college. Students start getting more involved and the feeling of not belonging extinguish because there is more friends, extracurriculars, and other stdent organizations that the student is in. All these stuff starts getting normal to student meaning that it has adapted and is able to feel more confident to be able to do more in campus."* *"As time passes, we become more accustomed to the new environment. It doesn't seem so foreign anymore. We meet so many different people with interesting stories and backgrounds and we learn so much that it becomes almost too difficult to see ourselves somehere else. Joining different organizations and clubs gives us the opportunity to meet other people who share the same interests and passions. We begin to realize that we are actually not all that different. In class, we also meet students who share the sae love for an academic subject. Although not everyone will be the same in terms of experiences, in the end, we realize that despite the differences, there are still similarities between us. Whether you are passionate about sports, medicine, culture, or anything else, you will always find others who share the same passion."* *"Students like me can get over their worries as they transition to college if they participate during lectures that the professors presents. This will help them be notice by professors when showing concerns of assignments they may need assist on. Also, the can meet other peers if they created a study group or join clubs that interested them. Once they take these opportunities that's in stored for them; they will fit in college and become more open-minded. Follow these suggestions will support them of a long way in college."*

Focal analyses dropping individuals who provided lower-quality responses. In Cohort 1 of Experiment 1, only 3% of participants wrote a response to the social-belonging intervention that was given a score of "0," and 12% wrote a response that was given a score of "1." We re-conducted our focal analysis—a logistic regression predicting continuous, full-time college enrollment with the social-belonging intervention and controlling for SAT scores and high school GPA—when (1) dropping the four individuals who provided very low quality

responses to the belonging intervention (an average score of zero out of 2), and (2) when dropping the 23 individuals who provided modest-to-low quality responses to the belonging intervention (a score of 0 or 1 out of 2). In both of these models, the focal results were the same and were significant: *OR*=2.83, *Z*=2.55, *P*=0.011 and *OR*=2.82, *Z*=2.39, *P*=0.017, respectively. Because these analyses did not alter the conclusions of our research we did not carry out the same analysis with the second cohort.

Experiment 1 Effects of Growth-Mindset Intervention

Not unexpectedly given the correlational results in Appendix 2b, the growth-mindset intervention had no significant effect on continuous full-time enrollment, *OR*=.94, Z=.34, *P*=0.73, and did not significantly interact with the belonging intervention, *OR*=.69, *Z*=1.03, *P*=0.30. As noted, over 80% of students already had a growth mindset, and variance in mindsets was not predictive of college persistence (Appendix 2b).

Experiment 1 Mediation of Social Belonging Intervention by Social Integration in College

To explore possible mediating mechanisms of the social-belonging intervention, we obtained data from a school-administered survey of a non-random subsample of Cohort 1 intervention and control students (*n*=51). In November, six months after the intervention, students in the first cohort were contacted by staff from the charter school network and asked to complete a survey about the transition to college. (Due to a change in school staff and hence research partnership, it was not possible to carry out this survey for the second cohort.) For most students, there was no valid email address on file—many students discard their high school email when they enter college. In addition, many students and their families regularly change cell phone numbers because they often use pay-as-you-go plans. Therefore students needed to be recruited via Facebook, Twitter, and other informal channels as well as phone and email when available. Students were offered $5 by the school for completing the survey. Altogether, 32% of the possible 160 students in Cohort 1 completed the fall survey.

Three self-reported measures from the school-administered fall follow-up survey were combined to create a metric of social integration at the institution. The questions were:

Living on campus	
Response options:	1= *Dorm or other on-campus housing* 0 = *Off-campus* or *commuting / living at home*
1. Which of the following best describes your current housing arrangement?	

Used academic support services	
Response scoring:	1=*Students said they used any of these support services,* 0=*They did not use any.*
1. When you need help with academic, social or life challenges, where do you seek help? [Check all that apply] (Options ranged from a series of "On-campus support offices" to "Professor / Instructor (office hours)" or "Upperclassmen" or "Peers (Friends/Roommates)."	

Joined extracurriculars	
Response scoring:	1=*More than zero hours per week,* 0=*Zero hours per week on extracurricular activities.*
1. So far this semester, how many hours per week do you spend participating in extracurricular activities	

These three dichotomous measures were summed to create an index signifying the degree to which students took active steps to become socially integrated in their institution, ranging from 0 to 3 (M=2.1, SD=0.96). Predictive validity for this metric is presented in Table S6.

In the survey subsample a significant effect of the social-belonging intervention on college persistence emerged (P=0.003; see Table S6), meaning that this subsample could provide a reasonable initial test of whether students' social integration in their institution mediated the year-long college-persistence intervention effect. Students who completed the follow-up survey did not differ noticeably on individual differences measured at baseline, ts<1, compared to those who did not complete the follow-up.

Students who completed the social-belonging intervention in May reported significantly more behaviors reflecting social integration in the institution on the survey in November (social-belonging intervention: M=2.50 out of 3, SD=0.74; Control: M=1.79, SD=1.01), $t(50)$=2.76, P=0.008, d=0.78. That is, treated students were more likely to say that they used student support services, lived on campus, and/or joined extracurricular activities.

Next, behaviors indicating greater integration in the institution in turn predicted continuous full-time enrollment over the year (see Table S6). In a causal mediation analysis (6), there was a significant indirect effect of the social-belonging intervention on college persistence through reported behaviors signifying greater social integration in college, b=.15 [.03, .29], P<.01. The social-belonging intervention increased students' reports that they took active steps to be socially engaged with their institutions, increasing the likelihood that they would persist at full-time at the college over the first year after high school. Thus, the survey sub-sample provides evidence consistent with the idea that the social-belonging intervention increased college persistence by changing students' behaviors and thus social realities. However, as noted, in the manuscript, this analysis was exploratory and had a number of limitations, including small sample size and non-pre-specified creation of a composite. Both of those issues are addressed in Experiment 2.

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Table S1. Experiment 1: Effectiveness of Random Assignment to Social-Belonging Intervention or Control.

	Control		Social-Belonging intervention			
	M or %	*SD*	*M or %*	*SD*	Test statistic (t or χ^2)	*P*
SAT score	824.75	150.78	807.75	154.08	0.71	.48
High school GPA	3.09	0.55	3.02	0.50		
Belonging uncertainty	2.14	1.11	1.96	0.99	1.07	.29
Growth mindset	4.53	1.48	4.49	1.25	0.18	.86
Test anxiety	3.08	1.10	2.91	1.10	0.94	.35
Internal locus of control	4.64	0.83	4.58	0.74	0.50	.62
BFI extraversion	3.56	0.80	3.42	0.78	1.06	.29
BFI agreeableness	4.00	0.74	3.90	0.84	0.80	.42
BFI conscientiousness	3.75	0.65	3.63	0.73	1.11	.27
BFI neuroticism	2.38	0.86	2.38	0.89	0.04	.97
BFI openness to experience	3.79	0.80	3.68	0.81	0.83	.41
Grit	3.38	0.63	3.47	0.63	0.88	.38
Self-control	3.56	0.71	3.48	0.81	0.67	.51
Fluid intelligence	80.90	14.93	79.96	15.47	0.39	.70
Gender	63%		61%		0.05	.82

Table S2. Summary of Qualitative Insights From the Design Process That Informed Customization of the Social-belonging Intervention in Experiment 1.

Insight	Example	Corresponding Revision to Intervention Content
1. Students lack agency for creating social belonging at college, instead believing it should "happen" to them.	A student who would sit in her car, looking at peers, and wondering "how did everyone else make friends?"	Explain the *active* steps students have to take to make connections to professors and other students, and that these take time to pay off.
2. Students believe casual friendships are distracting, not helpful, so they do not make friends.	A student who said he made sacrifices to go to college to "do me," i.e., get a degree, not have fun or make friends.	License students to create weak social ties by emphasizing their benefits for college and career goals and for reducing stress in school.
3. Students believe college friends will never know them as authentically as high school friends or family and so they hesitate to connect.	A student who said that his peers in college were not "friends;" they just "hang out."	Emphasize that college friends do not have to compete with older friends in order to be helpful for meeting academic goals or reducing stress.
4. Students believe college teachers do not care about you as much as charter school teachers, and so they do not go to them for help.	A student who said that "in high school teachers shake your hand and look you in the eye when you walk in the class; in college, teachers don't do this … they don't care about you."	Explain that in college professors have a different way of showing they care; they show it by giving tough critical feedback or holding students to a higher standard, to prepare them for a career or life in general.

Table S3. Effect of the Social-Belonging Intervention on Continuous, Full-Time College Enrollment in Experiment 1.

	OR	*Z*	*p* =
Social-belonging intervention	1.76	2.86	0.004
SAT score	3.14	5.04	0.000
High school GPA	2.15	5.28	0.000
Gender	1.30	1.17	0.240
N	584		
Pseudo R^2	.28		

***Note**: Models are logistic regressions with robust standard errors. Outcome variable: 1=enrolled full-time in the fall and the spring semesters, 0=not enrolled or enrolled part-time either the fall or spring or both. OR=Odds Ratio. All predictors except for the social-belonging intervention variable are standardized to have a mean of zero and a standard deviation of 1. Also includes dummy variables for school, not shown in regression table.*

Table S4: Experiment 1: Results from Separate Logistic Regressions Testing for Moderation of the Social-Belonging Intervention by Individual Differences.

Moderator tested	*b*	*Z*	*P*
SAT score	-0.42	-1.41	0.16
High school GPA	-0.21	-0.89	0.37
Belonging uncertainty	0.37	0.91	0.36
Growth mindset	-0.29	-0.84	0.40
Test anxiety	-0.62	-1.34	0.18
Internal locus of control	-0.16	-0.42	0.67
BFI extraversion	0.00	0.00	1.00
BFI agreeableness	0.49	1.27	0.21
BFI conscientiousness	0.03	0.07	0.94
BFI neuroticism	0.30	0.72	0.47
BFI openness to experience	0.57	1.42	0.16
Grit	-0.57	-1.36	0.17
Self-control	-0.10	-0.20	0.84
Gender	0.33	0.81	0.42

***Note**: Each row represents the test of a Social-Belonging Intervention × Moderator interaction in a separate logistic regression model that also includes in it the condition variable, the moderator, and SATs and GPA as covariates. b=unstandardized regression coefficient. All moderators were centered.*

Table S5. Experiment 1: Regressions Predicting Immediate Post-Intervention Self-Reports

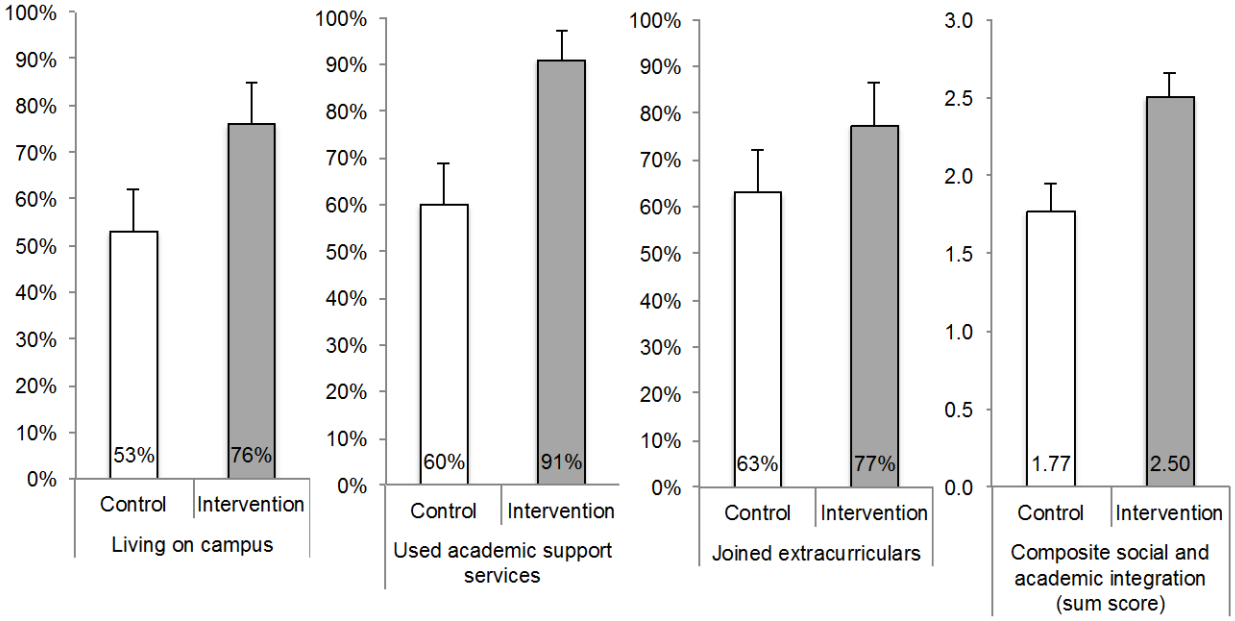
	Expected initial feelings of belonging			Expected *increase* in sense of belonging from beginning of college to the end of sophomore year		
	b	*t*	*P*	*b*	*t*	*P*
Social-belonging condition variable	-0.49	-2.35	0.02	0.62	3.23	0.00
Baseline belonging uncertainty	-0.56	-5.02	0.00	0.12	1.29	0.20
SAT	0.00	-0.12	0.91	-0.30	-1.41	0.16
GPA	0.14	0.56	0.58	0.001	1.95	0.05

Table S6. Experiment 1 Mediational Analyses: A Social-Belonging Intervention Affects Continuous Full-Time Enrollment By Facilitating Social Integration in College.

	OLS regression predicting social integration (*a* path)			Logistic regression predicting enrollment (*c* path)			Logistic regression predicting enrollment (*b* and *c'* paths)		
	β	*t*	*P*	*OR*	*Z*	*P*	*OR*	*Z*	*P*
Social-belonging intervention	0.38	3.08	0.003	7.36	2.41	0.016	2.18	0.98	0.326
Social integration	-	-	-				3.69	3.25	0.001
SAT score	0.31	1.87	0.068	3.00	1.37	0.171	0.07	0.85	0.397
High School GPA	0.04	0.32	0.751	1.85	1.57	0.115	0.75	1.38	0.167
N	50			50			50		
R^2	.28			.08			.36		

***Note**: Social integration=sum of three possible behaviors (using academic support services, joining extracurricular activities, or living on campus); range: 0 to 3. β=Standardized regression coefficient; OR=Odds Ratio. Models use robust standard errors. Results limited to the sub-sample of Cohort 1 students who completed the optional follow-up survey. The indirect (mediated) effect was significant, b=.15 [.03, .29], p<.01.*

Figure S2. Effect of social-belonging lay theories intervention on social and academic integration indices, Cohort 1 only, *N*=51.



Appendix 2b for:

Teaching a Lay Theory Before College Narrows Achievement Gaps at Scale

Outline of Correlational Analysis Conducted with Data from Experiment 1

This appendix includes the following information from a correlational analysis of outgoing seniors at an urban charter network:

- Measures used in correlational study of predictors of college persistence
- Correlational analyses showing that belonging uncertainty predicts persistence
- Correlational analyses showing that measured growth mindset does not predict persistence in this sample (though see Appendix 3, Experiment 2).
- Full regression table for correlational analysis (Table S7)

Participants

See Appendix 2a and the manuscript for school and sample information. Analyses were conducted with data from the first cohort of students because only Cohort 1 included data on fluid intelligence, an important covariate in this correlational analysis. Cohort 1 included more participants from the same charter network in the same city attending other schools that were not offered the intervention (two comparison schools where students were not randomized to condition). To prevent the interventions from influencing this correlational analysis, the analysis only includes students randomized to not receive the social belonging intervention. Analyses including Cohort 2, which did not provide data on fluid intelligence, produced comparable results on the focal variables.

Measures

Survey measures. Survey measures assessed on a baseline survey in Experiment 1 are summarized in the tables below. In addition to these, we collected official school record variables such as SAT scores and cumulative high school grade point average (GPA). In Cohort 1 of Experiment 1 only, we also included a web-administered fluid intelligence test score.

Prospective Belonging Uncertainty	**Adapted from Walton & Cohen, 2011**	α=0.82
Scale:	1=*Not at all true* 2=*Slightly true* 3=*Somewhat true* 4=*Very true* 5=*Completely true*	
1. Sometimes I worry that I will not belong in college. 2. I am anxious that I will fit in at college 3. I feel confident that I will belong in college (reverse-coded) 4. When I face difficulties in high school, I wonder if I will really fit in when I get to college		

Growth Mindset of Intelligence	**Hong et al., 1999**	α=0.83
Scale:	*1=Strongly Disagree* *2=Disagree*	

	3=Mostly Disagree *4=Mostly Agree* *5=Agree* *6=Strongly Agree*
1. You have a certain amount of intelligence, and you really can't do much to change it. (reverse-coded) 2. Your intelligence is something about you that you can't change very much. (reverse-coded) 3. You can learn new things, but you can't really change your basic intelligence. (reverse-coded)	

Test Anxiety	**Selected from Spielberger, 1980**	α=.82
Scale:	1=*Not at all true* 2=*Slightly true* 3=*Somewhat true* 4=*Very true* 5=*Completely true*	
1. Even when I'm well prepared for a test, I feel very nervous about it. 2. During a test I often get so nervous I forget the answers that I know. 3. As soon as an exam is over, I try to stop worrying about it, but I just can't. 4. During a test I often think about what will happen if I fail.		

Locus of Control	**Rotter, 1989**	α=.46
Scale:	1=*Not at all true* 2=*Slightly true* 3=*Somewhat true* 4=*Very true* 5=*Completely true*	
1. When I make plans, I am almost certain I can make them work. 2. Many of the unhappy things in people's lives are due to bad luck. (reverse-coded) 3. You have very little influence over the things that happen to me.		

Big Five Personality Inventory	**John & Srivastava, 1999**
Scale:	1=*Not at all true* 2=*Slightly true* 3=*Somewhat true* 4=*Very true* 5=*Completely true*

Extraversion (α=0.60)
1. I am energetic and full of life.
2. I show my emotions openly.
3. I am fast-paced. I move and react quickly to things.
4. I talk a lot.

Agreeableness (α=0.82)
1. I am a warm person. I am kind to other people.
2. I give, lend, and share things.
3. I am considerate and thoughtful of others.
4. I am helpful and I cooperate with other people.

Conscientiousness (α=0.68)
1. I am neat and orderly.
2. I pay attention well and can concentrate on things.
3. I plan things ahead. I think before I do something.
4. I can be trusted. I am reliable and dependable.

Neuroticism (α=0.70)
1. I am nervous and fearful.
2. I worry about things for a long time.
3. I tend to go to pieces under stress. I get upset when things are tough.

4. I feel unworthy. I have a low opinion of myself.

Openness to Experience (α=0.65)

1. I am curious. I like to learn and experience new things
2. I daydream. I often get lost in thought or a fantasy world.
3. I am creative in the way I think, work, and play.
4. I have a good imagination.

Grit		**Duckworth & Quinn, 2009**	α=.83
Scale:	1=*Not at all true* 2=*Slightly true* 3=*Somewhat true* 4=*Very true* 5=*Completely true*		

1. New ideas and projects sometimes distract me from previous ones.(reverse-coded)
2. Setbacks don't discourage me.
3. I have been obsessed with a certain idea or project for a short time but later lost interest. (reverse-coded)
4. I am a hard worker.
5. I often set a goal but later choose to pursue a different one. (reverse-coded)
6. I have difficulty maintaining my focus on projects that take more than a few months to complete. (reverse-coded)
7. I finish whatever I begin.
8. I am diligent. I don't give up.

Self Control in Academic Situations		**Patrick & Duckworth, 2013**	α=.75
Scale:	1=*Not at all true* 2=*Slightly true* 3=*Somewhat true* 4=*Very true* 5=*Completely true*		

1. I come to class prepared.
2. I pay attention and resist distractions in class.
3. I remember and follow directions.
4. I get to work right away rather than procrastinating.

Continuous full-time college enrollment. NSC data are described in Appendix 2a.

Results of Correlational Analyses

We asked whether the constructs of interest—belonging uncertainty and growth mindset—predicted college persistence rates among these generally academically prepared urban charter high school graduates.

Prior performance. As predicted, GPA and SAT scores were strongly predictive of continuous, full-time enrollment (see Table S7). This provides encouraging evidence about the validity of the NSC-reported full-time enrollment data.

Belonging uncertainty. Next, over half of students (53%) reported some level of uncertainty about whether they would belong at their college (an average of "slightly" or higher on the scale). Furthermore, the continuous measure of belonging uncertainty predicted full-time enrollment over the first year, *OR*=0.66, *Z*=-2.60, *P*=0.009 (see Table S7).

Illustrating this, among students who reported any belonging uncertainty in May of senior year of high school (an average of "slightly" or higher on the scale), 38% were enrolled full time

throughout the first year; among those who reported no uncertainty this number was 51%. Table S7 shows that the continuous measure of belonging uncertainty was predictive of full-time enrollment above and beyond measures of academic preparation (Model 1 in Table S7) and both cognitive and non-cognitive measures relevant to predict college persistence (Model 2 in Table S7).

Growth mindset does not predict persistence. Interestingly, a growth mindset did not appear to predict college persistence in this population. There was very little variance in students' mindsets: 81% already endorsed a growth mindset (score > 3.5, the midpoint on the growth mindset scale). This small amount of growth-mindset variance was unrelated to college persistence. Anecdotally, we know that school administrators and teachers in these high-performing urban charter schools routinely read and utilize research on mindsets.

Table S7. Belonging Uncertainty Predicts Continuous, Full-Time College Enrollment Among Untreated First Cohort Students in Experiment 1.

	Model 1			Model 2		
	OR	*Z*	*P*	*OR*	*Z*	*P*
Belonging uncertainty	0.66	-2.60	0.009	0.60	-2.11	0.035
SAT score	2.53	3.07	0.002	2.48	3.16	0.002
High school GPA	2.15	3.44	0.001	2.19	2.83	0.005
Growth mindset				1.11	0.49	0.624
Test anxiety				1.03	0.13	0.898
Internal locus of control				1.07	0.28	0.780
BFI extraversion				1.16	0.68	0.495
BFI agreeableness				0.90	-0.43	0.670
BFI conscientiousness				0.76	-0.99	0.325
BFI neuroticism				1.13	0.45	0.651
BFI openness to experience				0.68	-1.68	0.092
Grit				1.05	0.19	0.853
Self-control				0.98	-0.08	0.932
Fluid intelligence				1.27	1.10	0.273
Gender				1.16	0.64	0.523
N	185			182		
Pseudo R^2	.25			.29		

***Note**: Models are logistic regressions with robust standard errors. Outcome variable: 1=enrolled full-time in the fall and the spring semesters, 0=not enrolled or enrolled part-time either the fall or spring or both. OR=Odds Ratio. All predictors are standardized to have a mean of zero and a standard deviation of 1. Sample sizes vary across models because some students did not provide data for some variables.*

Appendix 3 for:

Teaching a Lay Theory Before College Narrows Achievement Gaps at Scale

Outline of Supplementary Information for Experiment 2

This appendix includes the following information pertaining to Experiment 2, conducted with incoming first-year students at a flagship public university:

- Information about the participants and university context
- Analyses of historical data to inform the designation of advantaged and disadvantaged status
- Information about experimental procedures
    - Overview
    - Data collection and intervention
- Effectiveness of random assignment to condition (Table S8)
- Customization of intervention materials
    - Customizing the growth mindset intervention (not done in Experiment 1)
    - Customizing the social-belonging intervention
    - Customizing the control condition
- Experimental effects on manipulation check items (Table S9)
- Pre-random-assignment survey measures used to evaluate the efficacy of random assignment
- Information about how the primary outcome (full-time enrollment) was obtained and calculated.
- A correlational analysis of growth mindset in the Experiment 2 context
    - Showing that individual differences in privately held growth mindsets predict full-time enrollment, net of prior preparation
    - And students' perceptions that their teachers would apply fixed mindset thinking to them also predicted full-time enrollment, net of prior preparation
- Results for primary outcomes:
    - Treatment effects separately for each condition (Table S10)
    - Analyses showing that analogous treatment effects are achieved when analyzing both *attempting* a full-time course load and also *completing* a full-time course load, by student sub-group (Table S11).
    - Coding of open-ended survey responses showed that nearly all respondents wrote valid responses and that results were no different including or excluding non-respondents.
    - Treatment effects were not moderated by individual differences (Table S12)
- Social integration measures;
    - Description of measures to assess social integration in the fall term
    - Analyses of treatment effects on social integration (see Figure S3)
    - Mediation analyses using measures of social integration (Table S13)
- Year-over-year comparisons of fall full-time enrollment rates, testing effects on full-scale reduction in inequality (Table S14)

Participants and University Context

A total of 8,089 first-time college students entered the public flagship university in the fall of 2012. Of these, 7,335 viewed any intervention material and could be matched and merged with official records, yielding a response rate for the primary analytic sample of 91% (the other 9% enrolled at the university but never completed orientation materials).[1]

Racial, ethnic, and socioeconomic diversity. Forty-six percent of students said that they were European American, 24% said they were Hispanic or Latino, 19% said that they were Asian or Asian American, and 5% said that they were African American. There was less socioeconomic diversity: eighty-one percent reported that at least one parent or legal guardian had earned a post-secondary degree, classifying them as continuing-generation students. The remaining 19% of students were first-generation students.

Policies affecting student body composition and psychology. Due to state law, 85% of students at this university were admitted because they finished high school in the top 10% of their senior class. Because some high school classes are more academically prepared for college than others, there is nonetheless a great deal of variability in student preparation among this group. Indeed, many students come to this university from urban or rural areas on the basis of high school rank alone, even if they have low SAT scores.

Determining Advantaged or Disadvantaged Designation With Theory and Historical Data

There were notable gaps in college degree attainment in historical data analyzed by the university's Dean and in our own analyses. Overall the university has low 4-year graduation rates: just 50% of students who entered in the fall of 2002 to the fall of 2006. More directly relevant, the university also has substantial achievement gaps. While 57% of European American students and 55% of Asian students earned a degree in four years, just 40% of Hispanic / Latino and African American students did so. Similarly, 60% of continuing-generation students (of all races and ethnicities) earned a degree in four years, compared to 43% of first-generation students (of all races and ethnicities).

In analyses we conducted with historical data from the entering class of 2010 and 2011 (N = 14,216), there were differences by race and first-generation status in terms of full-time enrollment in the first semester of college, an early indicator of eventual graduation (historical data were not available to our research team for the spring semesters in these years). Specifically, European-American (92%) and Asian (91%) students were more likely to earn 12+ GPA-bearing credits in the first semester of college as opposed to Hispanic/Latino (83%) or African-American (77%) students. The latter two were highly statistically significantly different from the former two, $\chi^2(1)$ Ps < 0.001.

In addition, the social-class gap in full-time enrollment in the first semester of college was apparent within each of these racial and ethnic sub-groups:

- European American: 92% continuing-generation vs. 90% first-generation, $\chi^2(1)$ P=0.06,
- Asian: 93 % vs. 85%, $\chi^2(1)$ P<0.001,

[1] By comparison, the response rate for the U.S. Census Bureau's Current Population Survey, the gold standard in government surveys, is 85%, while the response rate for the 2010 Decennial Census was 71%.

- Hispanic / Latino: 85% vs. 81%, $\chi^2(1)$ P=0.01;
- African-American: 79% vs. 73%, $\chi^2(1)$ P=0.06.

Note that the social-class gap was largest for Asian students at this university, with first-generation Asian students finishing 12+ credits at the same rate as Hispanic / Latino continuing-generation students. The same was not true in Experiment 3.

Continuing-generation students, regardless of race / ethnicity, and African-American and Hispanic / Latino students, regardless of social class constituted the "disadvantaged" group.. See S10 for results showing that treatment effects across these sub-groups.

Experimental Procedures

Overview. Experiment 2 used a four-cell design similar to that of Experiment 1: a control condition, a social-belonging intervention condition, a growth-mindset intervention condition, and a condition that combined elements of both interventions. It differed because it was delivered via a one-time, self-administered, approximately 30-minute web-based experience during the summer before students' first year of college, unlike Experiment 1, which involved two sessions, delivered in high school classrooms.

Using official records, strata were created for random assignment. Students were randomized to condition within college, prior achievement (SAT scores dichotomized at the median), race/ethnicity, and gender strata. A true random number generator (www.random.org) was used to conduct random assignment, which was effective; see Table S8.

Delivery procedures. Great effort was made to maximize response rates and persuasiveness. First, for logistical purposes the entire intervention needed to be in a single administration. Therefore, it was not possible to conduct a separate baseline survey or to deliver interventions over two sessions as in Experiment 1.

Next, the intervention materials were embedded as a link on the "pre-orientation" website hosted by the university's student support offices. One week before attending a week-long on-campus orientation, students were sent an email instructing them to complete about ten tasks listed on the website (e.g., reading about how to register for classes, the university honor code, and on-campus health care). The link to the intervention materials came directly after a requirement to obtain a meningococcal vaccination. Materials were presented as information about the "university mindset."

On-campus university orientation sessions began in late May and ended in late July, so students completed the intervention from mid-May to mid-July, one week before coming to campus. They could complete it at their convenience. Analyses of date and time of day of survey completion yielded no significant moderation effects, and so these variables are not discussed further.

Some students (roughly 9%) either did not attend an orientation session or did not complete all of their materials in advance of orientation. When the latter occurred, students completed the other materials (regarding honor code, etc.) on paper during orientation, but they were not required to complete the web-based intervention materials. Thus the primary reasons for non-response include (a) students who skipped orientation, or (b) students who did not complete any pre-orientation materials before attending on-campus orientation.

Customizing the Social-Belonging and Growth-Mindset Interventions

Qualitative work. We conducted a series of student focus groups and interviews to understand the potential psychological implications of the context in which this experiment was conducted. We followed a similar protocol as in Experiment 1. This produced a number of insights.

Concerns about intelligence due to merit for admission. First, we found that students were aware of the possibility that they were admitted to the university due to a law providing admission solely on class rank and not to a broader assessment of their academic preparation (e.g. SAT scores). They were further aware that peers may view them as less intelligent or less likely to succeed in college, because they may have been admitted through a "loophole" rather than what was perceived as for their intellectual merits. It was common for students—especially first generation students or minority students—to make statements such as "I was smart enough at my high school to get in to [college name] but I'm not sure if I'm smart enough to graduate."

Concerns about intelligence due to low-status majors. Contributing to this is the fact that, although students can be admitted to the university solely on the basis of their class rank, they have to apply to majors. Admission to a major is on the basis of SAT scores. As some majors (e.g., business, engineering) are more competitive than others (e.g., education), there is an additional preparation-based stratification within the university that many students were aware of and openly discuss in terms of "smart majors" and "dumb majors."

Concerns about intelligence due to explicit statements made by professors. Furthermore, we learned that some professors of entry-level courses in more selective majors sometimes tell students that they are making their courses difficult in order to give failing grades to students who do not belong. Hence, setbacks are sometimes explicitly presented to students by professors as information about their overall belonging or ability to succeed in the major or the university in general.

Altogether, a number of factors (admissions policies, college major selection policies, school culture, etc.) may have led students to wonder whether their intelligence would be impugned by peers and professors. Thus we expected that both a social-belonging and a growth-mindset intervention might benefit students.

Customizing the growth mindset intervention. Following this pilot research, the growth mindset intervention materials were revised. The most significant change was adding normative stories from upperclassmen that emphasized various themes from the pilots.

Three themes from the piloting work were:

(1) receiving critical feedback from a difficult professor does not mean that you are "dumb;"

(2) getting low grades does not mean you are not prepared for college—it means that you may not be using effective study strategies, and so you have to ask for help from peers, professors, or academic support services to improve your strategies; and

(3) when the bureaucracy of college is difficult to navigate, it does not mean that you are not smart enough to get through college—it means that you have to grow the "know how" part of your brain.

Crucially, stories reflecting these themes were all attributed to students in the top percentile ranks of their high school class, so that students could see that even those who seemed "smart" still struggled but eventually succeeded.

Customizing the social-belonging intervention. Following this pilot research, the standard social-belonging intervention materials from past research (1) were deemed an appropriate fit for the concerns of students in this setting. Therefore, the social-belonging intervention materials were revised to include idiosyncratic information appropriate to the present study's university. Relatedly, idioms typical for students residing in this university's region of the country were added to increase authenticity.

Creating a combined growth mindset and social-belonging intervention. The combined condition included the article explaining the neuroscientific evidence in support of a growth mindset—the idea that intelligence is malleable. Students then completed one brief writing exercise explaining why the content of that article is true. Next, students completed an abbreviated version of the social belonging intervention, which included only three stories from upperclassmen.

Revising the control condition. Unlike Experiment 1, which required two control conditions because it had two sessions, this study consisted of a single session and therefore required a single control condition. The social-belonging control condition was used. As in Experiment 1 and the social-belonging condition of this study, a number of idiosyncratic changes were made to make the materials appropriate for this setting (e.g., focusing on live music in the city, the football team, school traditions, the surrounding area, etc.). This was a conservative control group; indeed, on a final open-ended question asking students asked what they learned in the survey, a number of students in the control condition said that they learned "that my college cares about helping me adjust to college."

Experiment 2 Effects on Manipulation Checks

Recall of treatment messages. Immediately following the intervention material, students were asked one question assessing recall of the intervention messages. Students' answers were coded as correctly recalling the intervention message when they chose the any of the correct answers corresponding to their condition assignment, indicated below.

Recall of intervention message
We told you that you would have to remember what you read! Please answer the question below: What is the most central message from the activity you just completed? (check all that apply) ❑ That students worry initially that they don't belong at [school name] but come to feel at home at [school name] with time. *[correct answer for the social-belonging condition or combined condition]* ❑ That students get used to the physical environment at [school name] with time. *[correct answer for the social-belonging control condition]* ❑ That students come to understand social and political issues in a more sophisticated way in college. ❑ That people's brains can grow and get smarter with effort over time *[correct answer for the growth mindset condition or combined condition]* ❑ That people have many different parts to their brain and these parts serve different . functions

Analyses of these data showed that 93% of students in all three intervention conditions successfully recalled their corresponding message, and this did not differ across the intervention conditions. Some students chose both a correct answer and an incorrect answer, but this did not differ across conditions.

Immediate effects on theoretically-relevant self-reports. As in Experiment 1, we assessed a number of self-reported expectations immediately following the interventions. Items were written to be sensitive to the social-belonging intervention, to the growth-mindset intervention, or to both. Results are shown in Table S9.

Expected initial feelings of belonging. As in Experiment 1, three questions asked about whether students expected whether they would feel as though they belonged *when they first arrived on campus in the fall*. As in Experiment 1, we expected that the social-belonging intervention would lower these estimates, and it did (see Table S9). Students who received the growth-mindset intervention, however, did not differ from controls, which was expected because the intervention focused on academic difficulty, not social difficulty. Students who received *both* the social-belonging and the growth-mindset intervention fell between the social-belonging and growth-mindset interventions (see Table S9).

Unfortunately, the items asking about projected belonging at the end of sophomore year were not assessed in Experiment 2, due to space limitations.

Beliefs about why college instructors give critical feedback. Two questions assessed students' beliefs about why college students receive critical feedback in class. Note that these questions were not asked in Experiment 1, because in that study there were no immediate post-intervention self-reports assessed after the growth-mindset session. The two items were strongly (negatively) correlated and so they were combined into a single metric.

Belief that professors' critical feedback is meant to be helpful	
Scale:	*1=Not at all* … *7=An Extreme Amount*
Sometimes professors and teaching assistants (TAs) criticize students' work and ideas. To what extent do you think they do so… 1. To help students improve and grow. 2. To find out which students have more or less academic potential. (reverse-coded)	

The growth-mindset was expected to have the greatest effect on interpretations of critical feedback from professors. The social-belonging intervention also touches on this message, albeit briefly, in only one of the stories from upperclassmen. Therefore it was also expected to affect these beliefs. Indeed, Table S9 shows that all three interventions showed significant effects in the theoretically expected direction compared to controls, with the growth mindset condition showing an effect twice as large (by standard deviations) than the social-belonging only condition.

Moderation. None of the results for these manipulation checks differed by student demographics such as race or first-generation status (all moderator tests were non-significant). This means that the effects of the interventions on actual college outcomes that differed by sub-group cannot be explained by differential attention paid to the intervention materials by different sub-groups of students, or by differential persuasiveness of the materials.

Measures

Pre-random-assignment survey measures. Immediately before the online interventions, baseline belonging uncertainty and growth mindset were assessed for use in examinations of the effectiveness of random assignment and when testing moderation. Student SAT scores or SAT

equivalence (for those who took the ACT but not the SAT), student high school class rank (coded as a percentile, with 100 corresponding to a rank of 1st in the class), and student race and gender were all obtained from the university admissions office.

Prospective Belonging Uncertainty	**Adapted from Walton & Cohen, 2011**	α=.82
Scale:	1=*Not at all true* 2=*Slightly true* 3=*Somewhat true* 4=*Very true* 5=*Completely true*	
1. "Sometimes I worry that I will not belong in college." 2. "I am anxious that I will fit in at college" 3. "I feel confident that I will belong in college" (reverse-coded) 4. "When I face difficulties in high school, I wonder if I will really fit in when I get to college"		

Growth mindset	**Hong et al., 1999**	α=.82
Scale:	*1=Strongly Disagree* *2=Disagree* *3=Mostly Disagree* *4=Mostly Agree* *5=Agree* *6=Strongly Agree*	
1. You have a certain amount of intelligence, and you really can't do much to change it. (reverse-coded) 2. Your intelligence is something about you that you can't change very much. (reverse-coded) 3. You can learn new things, but you can't really change your basic intelligence. (reverse-coded)		

Continuous full-time college enrollment. Working with the university registrar, we obtained fall and spring enrollment data and credit attainment data for all first-year full-time students who began college in the fall or summer of 2012. Two types of measures were available.

First, we obtained whether students attempted 12 or more credits after the course drop date (the date when "shopping" courses ends and a course will end up on a student's transcript if they drop or fail it). This matches what is presented in Experiment 1, because this is the outcome reported to the National Student Clearinghouse. Note that unlike in Experiment 1, in the present study there is no measurement error in full-time enrollment because data were obtained directly from the registrar.

Second, we obtained data on whether students *earned* 12 or more credits each semester. This number could differ from the number of credits students attempted if a student failed a course, took an "incomplete" grade, or used one of their "Q drops," which is an exemption where a student can drop a course after the drop date. Because actually earning credits can be more important for eventual graduation than only attempting credits (because a student could attempt too many credits and end up failing some classes), analyses focus primarily on this outcome: the percent of students who earned 12+ credits in a given semester.

Preliminary Correlational Analyses Showing Predictiveness of Growth Mindset in the Experiment 2 Context

We conducted a predictive analysis that parallels Experiment 1. To avoid contamination, we constrained the sample to the 3,770 students who did not receive any growth-mindset training (i.e., students in the social-belonging-only and control conditions). The items used to assess the growth mindset are reported above.

Students' own private mindsets. A logistic regression showed that a measured growth mindset, assessed during the summer, predicted continuous, full-time enrollment over the first year of college (earning 12+ credits in both the fall and spring semesters), OR=1.11, Z=2.49, P=0.013. This regression controlled for SAT scores, high school class rank, and gender. A second logistic regression found that a measured growth mindset significantly positively predicted students' likelihood of being categorized as "green" level of risk on the fall survey, again controlling for SAT scores, class rank, and gender, OR=1.28, Z=2.10, P=0.035. These analyses provides further evidence that the growth-mindset intervention was a good fit for this university context, unlike the context of Experiment 1 where mindset was not predictive of student outcomes. Interestingly, neither of these relations were moderated by disadvantaged status.

Expectations about the mindset climate. Next, one item asked immediately post-intervention (as a manipulation check) provided an additional preliminary correlational data point. This item, described below, asked participants whether they thought that professors criticize students *"To find out which students have more or less academic potential."* This is a measure of an expectation of a "fixed mindset" climate. In the present study's control condition, the belief that professors are trying to find out if you have potential negatively predicted earning 12+ credits in the fall, OR=.87, Z=2.82, P=0.005, controlling for SAT scores, class rank, and gender. Thus, it was both students' private beliefs and their expectations of the beliefs of their professors that predicted their persistence—hence it may be useful to learn from the institution that the institution sees students as capable of growing.

Experiment 2 Effects on Continuous, Full-time Enrollment

Unlike Experiment 1, where only the social-belonging intervention showed effects compared to the control condition, in the present study all three intervention conditions (social-belonging only, growth-mindset only, or combined) showed a similar pattern compared to the control condition. See Table S10. Thus the three interventions are combined in analyses reported here and are compared to the roughly one-fourth of students in the control condition.

Treatment effects were analogous when examining 12+ credits *attempted*, the Experiment 1 outcome, and when examining 12+ credits *earned*, the preferred outcome due to its relation to actual degree attainment. See Table S11.

Treatment effects were not moderated by individual differences that we measured. See Table S12. In general, the interventions exhibited analogous effects across the different racial, ethnic and social-class sub-groups that constituted the "disadvantaged" group.

Coding of Essay Responses

Pairs of independent research assistants, blind to treatment outcomes, reliably coded the quality of each of the 7,335 open-ended intervention responses (Krippendorff's α=.83). That is, each response was coded twice. Differences between the two coders were reconciled by a third party. Fully 96% of participants provided substantive responses to the prompt. The remaining

4% of students wrote nothing or non-responses such as “I don’t know.” All of these students were retained in analyses, as in Experiment 1. Treatment effects were not moderated by the coder-rated quality of essay responses.

Experiment 2 Mediation by Social and Academic Integration on Fall Survey

The full survey battery and the algorithm used to code it are proprietary intellectual property of the private firm that administered the survey. However sample items are reproduced below. Generally, the survey assessed social integration in the institution, academic plans perceptions of academic struggle, academic stress and anxiety, and academic support behaviors.

Construct	**Sample item(s)**
Social integration in the institution	1. During this term, to what degree do you intend to participate in a student organization? 2. To what degree are you connecting with people: Who share common interests with you? 3. To what degree are you making friends with others in [your] hall/building?
Academic plans	1. To what degree do you intend to come back to this institution for the: Spring term?
Perceptions of academic struggle	1. How many courses are you struggling in? 2. “To what degree are you certain that you can persevere on class projects even when there are challenges?”
Academic stress and anxiety	1. To what degree are you experiencing stress regarding motivating yourself to get your work done on time? 2. To what degree do you feel anxious about an exam even when you’re well prepared?
Academic support behaviors	1. Have you talked with your instructor regarding your difficulties?”

Using a proprietary algorithm, the firm coded responses to the survey and then combined them to create a final variable with three levels: “green,” indicating non-problematic levels of risk, and “yellow” or “red” levels, indicating problematic levels of risk. The latter two levels did not distinguish students in terms of student outcomes (both “yellow” and “red” showed a 75% chance of students being enrolled full-time both semesters, compared to 86% among those designated “green”), so analyses focused on a dichotomous variable coded such that 1=green (non-problematic) social and academic risk, 0=“yellow” or “red” (problematic) social and academic risk.

We used these fall survey data to replicate and extend the Experiment 1 mediational finding regarding how and why a brief preventative psychological intervention could have effects lasting an academic year. Here we focus on the sub-group of students who showed these long-term effects: first-generation students and African American and Hispanic/Latino students.

First, within the sub-group of 678 students in this group who completed the fall survey, there was a slightly larger effect of the intervention on continuously earning 12+ credits (In this sub-sample: Control: 69%, Interventions: 75%; in the full sample it was a 4 percentage point difference) and this reached marginal significance in a logistic regression controlling for SAT scores, high school rank and gender, OR=1.45, Z=1.88, P=0.061 (see Table S13). Thus it was possible to test for an indirect or mediated intervention effect.

Next, the intervention significantly reduced the proportion of these students who were found to have problematic levels of social and academic risk, as measured by the aggregated risk

score, *OR*=1.95, *Z*=2.46, *P*=0.014. This means that students who received the interventions were less likely to provide problematic responses to questions assessing their social integration at college, their use of academic support services, their overall confidence in college, etc.

Finally, levels of social and academic risk reported in fall of students' first year predicted continuously earning 12+ GPA-bearing credits both semesters, *OR*=2.68, *Z*=3.60, *P*<0.001, and in a causal mediation analysis (2) significantly mediated the intervention effect on continuous full-time enrollment, unstandardized *b*=0.01 [0.001, 0.03], *P*=0.04. See Table S13.

References

1. Walton GM, Cohen GL (2011) A brief social-belonging intervention improves academic and health outcomes of minority students. *Science (80-)* 331(6023):1447–1451.

2. Imai K, Keele L, Tingley D (2010) A general approach to causal mediation analysis. *Psychol Methods* 15(4):309–334.

Table S8: Effectiveness of Random Assignment in Experiment 2.

	Control		All interventions			
	M or %	*SD*	*M or %*	*SD*	Test statistic (t or χ^2)	*P*
SAT score	1261.90	155.04	1263.89	158.32	-0.49	.62
High school percentile rank	89.62	13.56	89.51	13.75	0.30	.76
Belonging uncertainty	2.24	0.82	2.24	0.81	0.36	.72
Growth mindset	5.10	0.93	5.12	0.95	-0.88	.38
Gender	55%		56%		0.00	.98

Table S9. Experiment 2: Effect of Interventions on Immediate Self-Reported Manipulation Checks.

Dependent variable	Control	Social-belonging intervention	Growth-mindset intervention	Social-belonging + mindset intervention	Any intervention
Expected initial feelings of belonging					
Raw mean	5.30	5.05	5.31	5.22	5.20
SD	1.65	1.56	1.58	1.57	1.58
d for comparison to control	-	.156	.006	.050	.06
P-value for comparison to control	-	.000	.896	.114	.04
Belief that professors' critical feedback is meant to be helpful					
Raw mean	4.54	4.67	4.79	4.70	4.72
SD	0.88	0.90	0.95	0.92	0.93
d for comparison to control	-	.142	.271	.175	.198
P-value for comparison to control		.000	.000	.000	.000

Note: *All outcomes assessed on a 1-7 scale. Values are raw and unadjusted. d=Cohen's d effect size. P-values are from OLS regressions controlling for SAT scores, high school class rank, and gender.*

Table S10: Experiment 2: Effects on Primary Outcome Variables By Condition

Dependent variable, by sub-group	Control	Social-belonging intervention	Growth-mindset intervention	Social-belonging+mindset intervention	Any intervention
Earning 12+ credits in Fall 2012					
All first-generation students and all African American and Hispanic/Latino students (disadvantaged students, *N*=2,737)					
Raw %	82%	85%	86%	86%	86%
P-value for comparison to control	-	.096	.017	.033	.009
All continuing-generation Asian- and European-American students (advantaged students, *N*=4,705)					
Raw %	90%	89%	90%	90%	90%
P-value for comparison to control	-	.863	.926	.664	.913
Earning 12+ credits in Fall 2012 and Spring 2013					
All first-generation students and all African American and Hispanic/Latino students (disadvantaged students, *N*=2,737)					
Raw %	69%	72%	74%	73%	73%
P-value for comparison to control	-	.235	.028	.048	.024
All continuing-generation Asian- and European-American students (advantaged students, *N*=4,705)					
Raw %	79%	80%	79%	80%	80%
P-value for comparison to control	-	.788	.977	.725	.697
Designation as "non-problematic" level of risk on fall of first-year student survey					
All first-generation students and all African American and Hispanic/Latino students (disadvantaged students, *N*=2,737)					
Raw %	86%	93%	90%	92%	92%
P-value for comparison to control	-	.019	.186	.055	.016
All continuing-generation Asian- and European-American students (advantaged students, *N*=4,705)					
Raw %	91%	91%	92%	96%	93%
P-value for comparison to control	-	.962	.765	.048	.322

Note: *Percentages are raw, unadjusted values. P-values are from logistic regressions controlling for SAT scores, high school class rank, and gender.*

Table S11. Effects of Interventions on College Persistence Outcomes, by Sub-Group in Experiment 2 (Raw Percentages).

	Attempting 12+ credits (after course drop date)						*Earning* 12+ credits in GPA-bearing courses (at semester's end)					
	In Fall 2012			Continuously (Fall 2012 + Spring 2013)			In Fall 2012			Continuously (Fall 2012 + Spring 2013)		
	Control	Any Intervention		Control	Any Intervention		Control	Any Intervention		Control	Any Intervention	
All students												
Raw %	89%	90%		78%	80%		87%	88%		75%	77%	
n	2062	5281		2062	5281		2062	5281		2062	5281	
χ^2			2.47			5.170			3.443			2.823
P =			.116			.023			.064			.093
Hispanic/Latino students												
Raw %	84%	87%		71%	75%		81%	85%		68%	72%	
n	496	1252		496	1252		496	1252		496	1252	
χ^2			2.907			3.254			4.039			2.623
P =			.088			.071			.044			.105
African American students												
Raw %	84%	88%		74%	74%		81%	87%		70%	71%	
N	104	253		104	253		104	253		104	253	
χ^2			1.067			0.017			1.874			0.021
P =			.302			.895			.171			.886
Asian students												
Raw %	92%	91%		83%	82%		91%	89%		81%	79%	
n	382	976		382	976		382	976		382	976	
χ^2			0.386			0.328			0.691			1.813
P =			.534			.567			.406			.178
European students												
Raw %	92%	92%		79%	83%		89%	90%		77%	80%	
n	944	2443		944	2443		944	2443		944	2443	
χ^2			0.052			4.693			0.349			3.404
P =			.820			.030			.555			.065
All continuing-generation												

students											
Raw %	91%	91%		80%	81%		89%	89%		78%	78%	
n	1705	4399		1705	4399		1705	4399		1705	4399	
χ^2			0.025			1.475			0.046			0.197
P =			.874			.224			.829			.657
All first-generation students												
Raw %	82%	88%		68%	75%		78%	86%		64%	72%	
n	357	882		357	882		357	882		357	882	
χ^2			8.002			6.047			11.425			7.298
P =			.005			.014			.001			.007
All first-generation students and all African American and Hispanic / Latino students (disadvantaged students)												
Raw %	85%	88%		72%	76%		82%	86%		69%	73%	
n	752	1909		752	1909		752	1909		752	1909	
χ^2			4.777			4.884			6.839			5.041
P =			.029			.027			.009			.024
All continuing-generation Asian- and European-American students (advantaged students)												
Raw %	92%	92%		81%	83%		90%	90%		79%	80%	
n	1310	3372		1310	3372		1310	3372		1310	3372	
χ^2			0.002			1.123			0.005			0.073
P =			.966			.289			.943			.787

Note: *All percentages are the raw, unadjusted values. χ^2 statistics and P values are from the likelihood ratio test on the intervention variable in logistic regressions that control for SAT scores, high school class rank, and gender.*

Table S12: Experiment 2: Results from Separate Logistic Regressions Testing for Moderation of Any Intervention by Individual Differences.

Moderator tested	*B*	*Z*	*P*
SAT score	-0.07	-0.63	0.53
High school percentile rank	-0.08	-0.92	0.36
Belonging uncertainty	0.02	0.28	0.78
Growth mindset	-0.07	-1.08	0.28
Gender	0.01	0.05	0.96

***Note**: Analyses conducted within the sub-group of students theoretically expected to benefit most from the intervention—first-generation students and all African American and Hispanic / Latino students. Each row represents the test of an Intervention × Moderator interaction in a separate logistic regression model that also includes the "any intervention" condition variable, the moderator, and SATs and high school percentile rank as covariates. All moderators were centered. Moderation results were not when testing each intervention condition separately.*

Table S13. Experiment 2 Mediational Analyses: Psychological Interventions Affect Continuous Full-Time Enrollment for First-Generation and Racial Minority Students Over the First Year of College By Reducing Social and Academic Risk Factors.

	Logistic regression predicting "non-problematic" levels of social and academic risk (*a* path)			Logistic regression predicting continuous full-time enrollment in this sub-sample (*c* path)			Logistic regression predicting continuous full-time enrollment (*b* and *c'* paths)		
	OR	*Z*	*P*	*OR*	*Z*	*P*	*OR*	*Z*	*P*
Any intervention	1.95	2.46	0.014	1.45	1.88	0.061	1.35	1.49	0.137
Non-problematic levels of social and academic risk	-	-	-	-	-	-	2.68	3.60	0
SAT score	1.00	3.40	0.001	1.00	5.38	0.000	1.00	5.01	0.000
High school class rank	1.01	1.50	0.134	0.98	-2.35	0.019	0.98	-2.56	0.010
N	677			677			677		
R^2	.06			.03			.08		

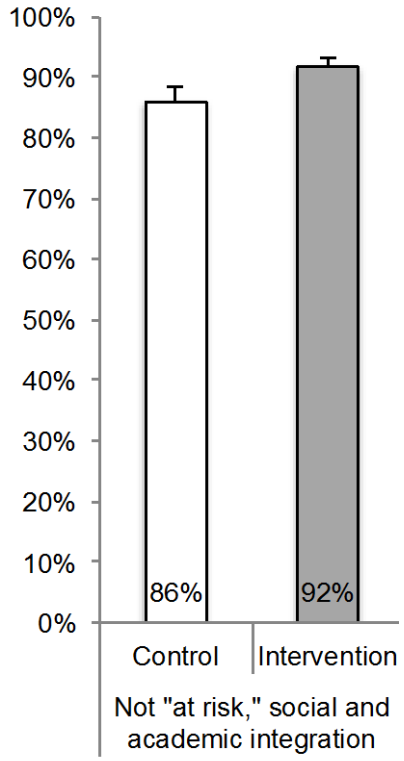
***Note**: Continuous full-time enrollment variable: 1=earned 12+ credits in the fall and spring semesters, 0=did not. Social and academic risk=designation as "green" level of risk across a variety of self-reports regarding using academic support services, joining extracurricular activities, making friends, and feeling comfortable in a dorm; OR=Odds Ratio. Models use robust standard errors. Results limited to the sub-sample of first-generation and racial minority (African American or Latino) students who completed the optional fall survey in October of students' first year. The indirect (mediated) effect was significant, unstandardized b=.01 [.0007, .03], P=0.04.*

Table S14. Percent Completing Fall Semester Full-time Enrolled in Experiment 2, by Year.

	Advantaged Students	Disadvantaged Students
2011: No Intervention (N=6,896)	90%	81%
2012: Randomized Control (N=2,062)	90%	82%
2012: Randomized Intervention (N=5,356)	90%	86%***
2013: No Intervention (N=6,719)	88%	81%
2014: Nonrandomized Intervention (N=6,244)	90%	84%***

Note: *** significantly different (p<0.001) from disadvantaged students who did not receive the intervention.

Figure S3. Effect of lay theories interventions on social and academic integration: Percent "not at risk" on composite.



Appendix 4 for:

Teaching a Lay Theory Before College Narrows Achievement Gaps at Scale

Outline of Supplementary Information for Experiment 3

This appendix includes the following information pertaining to Experiment 3, conducted with incoming first-year students at a selective private university:

- Information about the participants and university context
- Analyses of historical data to inform the designation of advantaged and disadvantaged status
- Information about experimental procedures
    - Overview
    - Data collection and intervention
- Effectiveness of random assignment to condition (Table S15)
- Customization of intervention materials
    - Creating the culture intervention (Table S16)
    - Creating the critical feedback intervention (Table S17)
    - Customizing the control condition
- Experimental effects on manipulation check items (Table S18)
- Pre-random-assignment survey measures used to evaluate the efficacy of random assignment
- Information about how the primary outcome was obtained and calculated.
- Results for primary outcomes:
    - Treatment effects separately for each condition (Table S19)
    - Treatment effects were not moderated by individual differences (Table S20)
    - Treatment effects of all interventions combined as compared to historical data (Table S21)
    - A figure showing treatment effects on class rank, for disadvantaged students (Figure S2) and advantaged students (Figure S3).
- Social integration measures;
    - Description of measures to assess social integration in the fall term
    - Analyses of treatment effects on social integration (Figure S6)

Participants and University Context

A total of 1,762 first-time college students entered the private, selective university in the fall of 2012. Of these, 1,623 students started the online module with intervention materials; 99% of them (n=1,607) could be matched to institutional grade data and 99% (n=1,608) had sufficient institutional or self-report race and parental education data to identify them as advantaged or as disadvantaged. (For 10 students, the reason they could not be matched to institutional data was because they specifically requested not to participate in that aspect of the research.) There were no differences by condition in whether students could be matched to institutional grade data or classified as advantaged or disadvantaged. This left a final sample for analysis of 1,592 students, 90.4% of the first-year class.

Student body composition. There is moderate racial and ethnic diversity at the university. Of the students in our sample, 52% said that they were White or European American, 25% said that they were Asian or Asian American, 11% said they were Latino or Hispanic, 7% said that they were Black or African American, and 5% said they were Pacific Islander, American Indian, or Alaskan Native. There is less socioeconomic diversity at this university than at the university in Experiment 2: 87% of students had at least one parent or legal guardian who had earned a post-secondary degree, classifying them as continuing-generation students. The remaining 13% of students were first-generation students.

Selecting the outcome of interest. Unlike the samples in Experiments 1 and 2, achievement gaps at this institution manifest in grades rather than in enrollment and persistence. The university has a very high retention rate. Only 11 students out of the total 1,623 in our sample were identified as having left the university by the end of their first year—a retention rate of over 99%. However, there were meaningful achievement gaps in grade point average (GPA) by race and first-generation status, as described below.

Determining Advantaged or Disadvantaged Designation with Theory and Historical Data

It is crucial to note that we do not see racial or ethnic groups as "disadvantaged" in their essence; rather, groups face group-based threats based on social context. Therefore we analyzed historical data and consulted psychological theory to understand disadvantages in context.

Historical data obtained. We obtained data on first-year cumulative grade point averages (GPAs) from the university registrar for the previous two cohorts of first-year students at the university. GPA is reported on a scale that ranges from 0 to 4.3, with 4.3 corresponding to the highest grade (A+). Here we report raw GPA as well as GPA adjusted for the sample mean of gender, SAT or SAT equivalence, and high school class rank. All of the analyses reported here were re-conducted with the randomized control group in the intervention cohort, as shown later.

Racial/ethnic gaps. In the two pre-intervention cohorts at this university, Asian/Asian American students and White/European American students had higher cumulative first-year GPAs (M=3.53, M_{adj}=3.49, SD=0.33) than did Black/African American students, Latino/Hispanic students, Native American students, and Pacific Islander students (M=3.32, M_{adj}=3.41, SD=0.41). In the raw data, this corresponded to a roughly 0.58 standard deviation difference comparing the former group to the latter. Group differences were highly significant with and without covariates (gender, SAT scores, and high school class rank), $t(3025)=14.73$ and $t(3021)=6.24$, respectively, Ps<0.001.

First generation student gaps. Similarly, continuing-generation students (students with at least one parent having earned a post-secondary degree) had higher first-year cumulative GPAs (M=3.50, M_{adj}=3.49, SD=0.36) than did first-generation students (M=3.30, M_{adj}=3.40, SD=0.41). In the raw data, this corresponded a 0.57 standard deviation difference between the groups. Group differences were highly significant with and without covariates, $t(3353)=11.78$ and $t(3325)=5.51$, respectively, Ps<0.001. (There are students included in this analysis than in the race analysis because first-generation data were available for more students than were race data.)

Further examination showed that, within racial/ethnic group, the differences in GPA by first-generation status were significant for Latino and Native students, marginally significant for

European American students, and non-significant for Asian, African American, and Pacific Islander students

- Asian or Asian-American: M=3.59, M_{adj}=3.49 continuing-generation vs. M=3.43, M_{adj}=3.45 first-generation, P=0.18;
- African American: M=3.32, M_{adj}=3.44 vs. M=3.19, M_{adj}=3.39, P=0.27;
- Hispanic/Latino: M=3.46, M_{adj}=3.46 vs. M=3.26, M_{adj}=3.37, P=0.002;
- Native: M=3.06, M_{adj}=3.31 vs. M=2.69, M_{adj}=3.08, P=0.01;
- European American: M=3.52, M_{adj}=3.51 vs. M=3.35, M_{adj}=3.44, P=0.07;
- Pacific Islander: M=3.34, M_{adj}=3.37 vs. M=3.35, M_{adj}=3.47, P=0.24).

This was consistent with the intervention cohort data, in which Asian students did not differ in academic performance by first-generation status (M=3.65, M_{adj}=3.57 continuing-generation vs. M=3.58, M_{adj}=3.60 first-generation).

Therefore, first-generation Asian students were not considered "disadvantaged." Note this is different from Experiment 2, where Asian students showed the largest social-class achievement gaps.

Final disadvantaged status designation. In sum, based on historical data as well as theory about the psychological threats to social relationships or academic ability that racial and ethnic minority and first-generation students may face in college, we classified all Asian students and all continuing-generation European American students as not facing group-based disadvantages (i.e. "advantaged") and all African American, Latino, Native, Pacific Islander, and first-generation European American students as facing group-based disadvantages ("disadvantaged").

Future research seeking to make predictions about the groups that would or would not show benefits from a lay theories intervention will benefit from continuing to develop methods for first identifying *contextual* disadvantages, and then attempting remedies (psychological and otherwise) for those.

Procedure

Overview. This was a four-cell experiment with the primary (social-belonging) control condition and three different intervention conditions: the *social-belonging* intervention (akin to that tested in Experiment 2); a *culture intervention* that emphasized ways to maintain interdependent relationships with home communities while joining new communities in college; and a *critical-feedback intervention* that emphasized that critical feedback from college instructors reflects instructors' high standards and confidence students can meet those standards, not bias or a negative judgment.

Similar to Experiment 2, students self-administered the study via a one-time approximately 30-minute web-based experience during the summer before the first year of college. Effects on grades over the first year of college were assessed via data collected from the university institutional research office.

Using data obtained from the admissions office, strata were created for random assignment. Students were randomized to condition within race/ethnicity and gender strata. The sample() function in R was used to conduct random assignment. Random assignment was effective. See Table S15.

Delivery procedure. As in Experiment 2, the entire intervention needed to be contained in one brief, self-contained experience. It was not possible to conduct a separate baseline survey during another session or to ask questions before students began the survey.

Creation and Customization of Intervention Materials

Social-belonging intervention. The social-belonging intervention was nearly identical to that used in Experiment 2.

Culture intervention. The *culture* intervention was novel and developed specifically for this study. Past research shows that first-generation (and many racial or ethnic minority) college students experience a cultural mismatch in higher education (1, 2). These students tend to come from more interdependent cultural backgrounds that emphasize the embeddedness of the self in communities with others; by contrast, colleges and universities tend to emphasize independent ways of being (e.g., "follow your own star"; "customize your major").

This mismatch is thought to undermine a sense of belonging in college among minority and first-generation students. To bolster students' sense of fit in college, the culture intervention emphasized ways students learned to maintain interdependent relationships with friends and family at home while developing interdependent relationships in college. The materials were developed from surveys and focus groups with first-generation and international students at the university. See Table S16 for a sample of the 6 stories from upper-year students used in the intervention.

Critical-feedback intervention. The *critical-feedback* intervention was designed to help students understand critical feedback in a way that would sustain their motivation in the face of criticism and encourage them to use feedback to learn and grow rather than to see criticism as evidence of a lack of belonging. Critical feedback is often ambiguous in meaning, and students can wonder whether criticism reflects a fair judgment of their work and ways to improve or a negative evaluation or even bias on the part of the instructor (3, 4). This ambiguity looms especially large for students who contend with negative stereotypes in school, who face the reality that others could view them through the lens of a negative stereotype.

As a consequence, past research shows that disambiguating the meaning of critical feedback—telling students that instructors give critical feedback when they believe the student can reach a higher standard—can increase students' motivation in the face of critical feedback for instance to revise their work, and do so especially so among negatively-stereotyped students (3, 4).

Adapting materials from past critical feedback interventions with adolescents (4) and from past social-belonging interventions (5), the intervention materials described critical feedback as reflecting the high standards held by instructors as well as instructors' belief in students' ability to meet those standards. See Table S16 for a sample of the 7 stories from upper-year students used in the intervention.

Control condition. The control condition materials were based on the social belonging materials described in the overview. As in Experiments 1 and 2, a number of idiosyncratic changes were made in order to make the materials appropriate for this setting (e.g., mentioning

specific campus landmarks, mentioning the bike-friendly ethos of the university, etc.), but the form, themes, and structure were the same.

Again, we believe this is a conservative control condition in that it shares some information about the transition to college that could be helpful to students. Indeed, a final question on the survey asked if students had learned anything from completing the activity, and more than half of the students in the control condition (52%) said that they had.

Experiment 3 Intervention Effects on Manipulation Checks

As in Experiments 1 and 2, we assessed a number of self-reported measures immediately following the interventions to examine whether students' beliefs about college had changed as expected based on theory. Items were written to be sensitive to each intervention condition.

Table S17 reports data for all of the approximately 1,450 participants who completed these measures (sample size varies slightly by question).

Immediate effects intervention-general beliefs. We predicted that all three interventions would increase students' understanding that the transition to college could be difficult, but would not decrease their overall optimism about college.

Understanding that the transition to college could be difficult at first		α=0.87
Scale:	*1=Not at all* … *7=Extremely much*	
1. To what extent do you think that the transition to [school name] could be difficult at first? 2. To what extent do you think you will experience difficulties and challenges at first in the transition to [school name]?		

Excitement and optimism about college		α=0.82
Scale:	*1=Not at all* … *7=Extremely much*	
1. How excited are you about coming to [school name]? 2. How much do you think you'll enjoy your time at [school name]? 3. How much fun do you think you'll have at [school name]?		

Immediate effects on intervention-specific self-reports.

Social-belonging intervention manipulation checks. As in Experiments 1 and 2, three questions asked students the extent to which they expected they would feel as though they belonged in college *when they first arrived on campus in the fall* and, as in Experiment 1, how much they thought they would feel they belonged *at the end of sophomore year*. We expected that all three interventions would make students' estimates of their initial belonging lower and more reasonable and would also increase students' expectations of growth in their belonging over the first two years. However, we predicted that this would be most the case in the social-belonging intervention because it addresses students' beliefs about belonging most directly.

Expected initial feelings of belonging		α=0.85
Scale:	*1=Not at all* …	

	7=Extremely much
1. To what extent do you think you will feel you fit in at [school name] when you arrive on campus this fall? 2. To what extent do you think you will feel you belong at [school name] when you arrive on campus this fall? 3. To what extent do you think you will feel at home at [school name] when you arrive on campus this fall?	

Expected feelings of belonging at the end of sophomore year	α=0.92
Scale:	*1=Not at all* … *7=Extremely much*
Think ahead to the end of your sophomore year at [school name]. 1. At that time, to what extent do you think you will feel you fit in at [school name]? 2. At that time, to what extent do you think you will feel you belong at [school name]? 3. At that time, to what extent do you think you will feel at home at [school name]?	

Culture intervention manipulation check. As a manipulation check for the *culture* intervention, two questions asked students the extent to which the university offered students opportunities to fulfill interdependent motives (i.e., "Join communities of people on campus with shared values and perspectives" and "Give back to their community") and a third item asked to what extent students expected that being away from home might cause negative feelings. We expected that these measures would be most sensitive to the culture condition, as it was the only one to address issues of interdependence and relationships with family and friends back home directly and to discuss that being away from home might cause negative emotions or stress. The composite was calculated by computing a simple mean of the three items.

Manipulation check: Culture condition	
Scale:	*1=Not at all* … *7=Extremely much*
To what extent do you think [school name] provides students with the opportunity to: 1. Join communities of people on campus with shared values and perspectives 2. Give back to their community To what extent do you anticipate that each of these could, sometimes, be a source of <u>stress or negative feelings</u> for you at [school name]? 1. Being away from home	

Critical feedback intervention manipulation check. As a manipulation check for the *critical-feedback* intervention, two questions asked students the extent to which college instructors give students critical feedback "to help students improve and grow" and "to distinguish between students with more and less academic potential." We expected these items would be sensitive to the critical-feedback intervention, as it specifically conveys that instructors give criticism because they have high standards and believe students can reach them. A logical inference from that information is that instructors do *not* give feedback to distinguish between students with more and less potential.

Manipulation check: Critical feedback condition	
Scale:	*1=Not at all* … *7=Extremely much*
Sometimes at [school name] professors and teaching assistants (TAs) give students critical feedback. To what extent	

do you think they do so:

1. To help students improve and grow
2. To distinguish between students with more and less academic potential

Results. Table S17 shows that these predictions were generally supported: the interventions changed the relevant general measures, and the specific interventions changed the specific measures. Furthermore, overall optimism about the upcoming transition was unaffected.

Measures

Covariates. Student SAT scores or SAT equivalence (for those who took the ACT but not the SAT), student high school class rank, and student gender were obtained from the institutional research office.

As in the other two experiments, following best practices in randomized trials, missing data on these covariates were indicated with a dummy variable and a value of zero was imputed in the covariate variable. Both the dummy variable and the covariate with imputed value were included in models.

First-generation status and race/ethnicity. In determining students' first-generation status, institutional data were used. Self-reports of race and ethnicity followed the intervention materials. If a student reported multiple races/ethnicities, they were asked to indicate which they identified with most and the selected race/ethnicity was used as their primary race/ethnicity. For students who did not report their race/ethnicity, institutional data was used.

There was one exception. In our demographic questions, "Pacific Islander" was not listed as one of the race/ethnicity options. After the survey was disseminated, conversations with school administrators, as well as recent research, suggested that Pacific Islander students may also be a vulnerable population. Analysis of the historical data at the institution showed that, indeed, there was an achievement gap for Pacific Islander students. Therefore, any student who was identified as Pacific Islander in institutional data was considered Pacific Islander.

First year cumulative GPA. Students' cumulative first-year GPAs were obtained from the institutional research office. Grades range from 4.3 (A+) to 0.0 (No Pass). Grade points for a particular course are weighted by the unit value of a course (e.g., an A in a 5-unit course has a greater effect on a student's GPA than an A in a 3-unit course).

Class rank at end of first year. The cumulative first-year GPAs of all students participating in the intervention were rank-ordered to determine class rank and class percentile.

Experiment 3 Intervention Effects on Primary Academic Outcomes

All analyses were "intent-to-treat" —all students who began the intervention module were retained in analyses. Table S18 displays raw and adjusted means by intervention condition. As expected, there was no effect of the intervention on advantaged students' first-year grades. However, the intervention significantly raised first-year grades for disadvantaged students. The reduction in the achievement gap between advantaged students and disadvantaged students receiving any intervention was 31% comparing raw means and 47% comparing covariate-adjusted means.

Moderation. Intervention effects were not significantly moderated by gender, SAT score, or high school class rank. See Table S19.

Comparison to historical data. As an additional comparison group, we obtained de-identified data on the two cohorts of first-year students immediately prior to the intervention year (incoming students in years 2010 and 2011) from the university institutional research office. See Table S20 for raw and adjusted means of students in the historical samples.

First-year GPA among disadvantaged students in the intervention cohort control condition and disadvantaged students in the two prior cohorts do not differ; thus these historical samples are reasonable comparison groups for intervention effects among disadvantaged students. As Table S20 shows, providing further confidence in the intervention effects among disadvantaged students, disadvantaged students in the intervention conditions performed better not only than disadvantaged students in the randomized intervention control condition but also disadvantaged students in the two previous cohorts.

In contrast to this pattern among disadvantaged students, among advantaged students, those in the intervention cohort control condition and those in the two prior cohorts *do* differ: Advantaged students in the two prior cohorts performed somewhat worse than randomized control-condition advantaged students. Thus we do not use the historical samples as a comparison group for advantaged students.[1]

Intervention effects on class rank. The interventions increased disadvantaged students' relative position within the college class, reducing the percentage of disadvantaged students in the bottom quartile of their class. Figures S2 and S3 depict class rank information in 5-percentile increments for both disadvantaged and advantaged students.

Experiment 3 Coding of Open-ended Responses.

Because coding of open-ended responses of the quality of students intervention essays did not meaningfully relate to intervention outcomes in Experiments 1 and 2, coding was not conducted for Experiment 3.

Experiment 3 Effects on Spring Quarter Social and Academic Integration in College

A survey was conducted in the spring of students' first year of college to examine their academic and social integration at the university.

Survey sub-sample. Participation in the spring survey did not differ between advantaged (31%) and disadvantaged (29%) students, $\chi^2(1)<1$. Though slightly more intervention-condition students took part (32%) than control-condition students did (27%), $\chi^2(1)=3.96$, $P=0.05$, this did not differ by disadvantaged status. In addition, analysis of cumulative first-year GPA yielded no interaction between survey completion status and either sub-group or experimental condition,

[1] While beyond the scope of this paper—and not a threat to the primary inferences in the paper—we can speculate about several possible explanations for the cohort effect among advantaged students. First, the university instituted a new freshman year curriculum in the summer between the two cohorts, changing the nature and length of a first-year humanities program. Perhaps this interacted with advantaged status in a way not fully understood, leading to higher grades for advantaged students but not for disadvantaged students.

*F*s<1. Among disadvantaged students, the intervention effect on grades among both students who did not take part in the spring survey and those who did was similar, $t(1580)=1.64$, $P=0.10$, $d=0.22$, and $t(1580)=1.70$, $P=0.09$, $d=0.38$, respectively. At least along this metric, respondents seemed reasonably representative of participating students as a whole.

Overview of outcomes. The primary outcome of interest was students' reported social and academic integration in college—students' reports of relevant relationships that they had formed and behaviors they had engaged in. The survey also assessed other constructs (e.g., psychological measures), which are not our focus here.

There were four primary indices of social and academic integration: the degree to which students had (1) formed close friends on campus, (2) developed a mentor relationship, (3) accessed academic support services, and (4) become involved in extracurricular groups. These constructs correlated weakly with one another. We combined them into a single composite (i.e., standardized and averaged them) for theoretical reasons. See below for the individual items that composed each construct.

See Table S21 for effects by condition on these constructs individually and when combined as a composite.

Close friends. Two different metrics assessed the degree to which students had developed close friends in college. First, three items directly asked students about their friendships in general. Second, students were asked to list up to 7 of their closest friends at the university. They then rated the closeness of the relationship with each friend. We computed the average closeness of these friends. These two metrics were reasonably correlated, $r(404)=.46$, $P<0.001$. They were averaged to create a single "close friends" index.

Close friends and social support	α=0.82
Scale:	*1=Strongly disagree* *2=Disagree* *3= Somewhat disagree* *4=Neither agree nor disagree* *5=Somewhat agree* *6=Disagree* *7=Strongly agree*
1. Thinking back on this past academic year, I feel that I have made some close friends at [school name]. 2. I feel that there is no one at [school name] I can share my personal worries and fears with. (reverse-coded) 3. When I need suggestions on how to deal with a personal problem, I know someone at [school name] to turn to.	

Average closeness of friends	
Scale:	*1=Not very close* … *7=Very close*
We would like to know about your closest friends at [school name]. We have provided space for up to 7 friends below but many students do not use all of these spaces. Please just list the close friends you have at [school name]. [For each friend listed:] How close of a friend is this person?	

Mentor. One binary (yes/no) question assessed whether students had developed a relationship with a mentor during their first year in college.

Relationship with mentor	
Scale:	*0=No*

	1=Yes
Thinking back on this past academic year, has anyone associated with [school name] taken a special interest in you and your personal and academic development? (e.g., faculty mentor, graduate student, an older undergraduate, etc.)	

Use of academic support services. Three questions assessed whether students had accessed academic support services available to all students. An average of these three items was computed. (The scale reliability among these three items was not expected to be particularly high because each item assessed whether students used a *different* source of academic support.)

Use of academic support services		α= 0.48
Scale:	*1= Never* *2=Once* *3=2-3 times* *4=4-6 times* *5=7 or more times*	
So far this quarter, how often have you... 1. Met with a professor or TA outside of class? 2. Met with your pre-major advisor or major advisor? 3. Sought academic tutoring? (e.g, by going to the [name] Writing Center, a departmental or class tutoring center, etc.)		

Involvement in extracurricular activities. Students were asked to list up to three groups they joined or participated in at the school. For each group listed, students were how involved they had been with the group. A continuous metric of involvement was calculated by summing the involvement scores of the groups listed, yielding a maximum score of 15. If no groups were listed but other data were complete, the involvement score was counted as zero.

Involvement in extracurricular activities	
Scale:	For each group: *1=Not very involved* *2=Somewhat involved* *3=Moderately involved* *4=Quite involved* *5=Very involved* Overall involvement score ranged from 0 to 15.
Please list up to three groups or extracurricular organizations you have joined or participated in at [school name]. You can think of volunteer groups, social groups, ethnic groups, religious groups, art or cultural groups, clubs, teams or other student groups at [school name]. [For each group listed:] How involved have you been with this group?	

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Table S15: Effectiveness of Random Assignment in Experiment 3.

	Control		All interventions			
	M or %	*SD*	*M or %*	*SD*	Test statistic (*t* or χ^2)	*P*
SAT score	1450.71	105.68	1452.15	110.36	0.23	0.82
High school percentile rank	10.74	11.05	11.76	13.60	1.37	0.17
Disadvantaged (minority or first-generation European American student)	25.37%		25.80%		0.03	0.86
Female	47.54%		47.39%		<0.01	0.96

Table S16. Sample Stories From Upper-Year Students in the Culture and Critical-Feedback Intervention Conditions in Experiment 3.

Culture Intervention	Critical Feedback Intervention
"I was so excited to come to [school name]. I looked forward to living on my own, meeting new people, and taking classes I was interested in. At first, though it was hard. I knew my family missed me at home and I missed them too. Sometimes I felt disconnected at [school name]. I didn't have my family with me, and it seemed like you were just supposed to do things on your own here. But as I spent more time at [school name] I realized that [school name] is about more than pursuing your own path. Everybody who comes to [school name] is excited to learn new things. But everyone also stays tied to their family back home. And with time, you become part of the community at [school name] too—you meet people who share your interests and backgrounds, perspectives and values, and you become close. It took time, but I learned to stay connected with my family at home even as I made new relationships at [school name]."	"Writing the first paper for my freshman writing class really opened my eyes. I worked incredibly hard on the paper. Lots of late nights at [library name]. Lots of clever insights. By the time I turned it in, I thought it was a masterpiece. A few days later, I got it back…covered in critical comments. I was beyond upset. In high school I had gotten lots of positive feedback on my writing, and I was convinced this paper was better. So I went to talk to the TA. He told me something I'll never forget: 'We love it when a student gives us a paper worth criticizing.' He said that when you get critical feedback at [school name]—even a lot of it—it means the teacher believes in you, sees potential in your ideas, and wants to help you bring them out. It's funny, because I'd always assumed the opposite—that criticism meant the teacher didn't believe in me. Now I see that people work hard to give critical feedback when you show them you can reach a higher standard. Now I always try to make my work worth criticizing, so I can benefit from that criticism and create something truly great."
"Sometimes I still can't believe I'm so lucky to be at [school name]. It's like a dream come true. But it wasn't easy at first. Fall quarter freshman year I worried a lot about my family and friends who relied on me back home. I felt selfish for not being there to keep up the yard for my mom or to help coach my little brother's soccer team. My mom called after one of my brother's games, and I told her how I was feeling. She set me straight. She told me that [school name] was exactly where I should be and that working hard in class and meeting people and making friends was just what I should be doing. She reminded me that being a student at [school name] is a realization of so many dreams in my family—not just my own. I try to keep her words in mind when I feel overwhelmed with a problem set or even when I'm just hanging out with people in my dorm. It makes me feel connected to my family and helps me understand why being at [school name] is so important to me even though I'm far from home."	"Faculty at [school name] are world class, and many really enjoy working with students. But they are also busy. That means that if they take the time to give you feedback on your work—especially detailed, critical feedback—they do so for a reason. It shows they care about you and your ideas. My parents used to tell me that every criticism is like a treasure. That's even more true when the person giving you criticism is at the top of their field. Not all professors give you this kind of criticism, and there are plenty of times when I've had long stretches of just getting grades without many comments. But when you do get good criticism, it's like gold."

Table S17. Experiment 3: Intervention Effects on Immediate Self-Reported Manipulation Checks.

Dependent variable	Control	Social-Belonging Intervention	Culture Intervention	Critical Feedback Intervention
Belief that the transition to college is difficult at first				
Raw mean	4.60	5.16	4.88	5.08
SD	1.34	1.23	1.32	1.20
d for comparison to control	-	0.45	0.22	0.38
P-value for comparison to control	-	< 0.001	0.003	< 0.001
Excitement and optimism about college				
Raw mean	6.45	6.40	6.42	6.37
SD	0.69	0.74	0.70	0.77
d for comparison to control	-	0.07	0.04	0.11
P-value for comparison to control	-	0.33	0.59	0.15
Anticipated feelings of belonging in fall of freshman year				
Raw mean	5.07	4.65	4.95	4.91
SD	1.10	1.20	1.12	1.14
d for comparison to control	-	0.37	0.10	0.14
P-value for comparison to control	-	< 0.001	0.16	0.07
Expected *increase* in sense of belonging from beginning of college to the end of sophomore year				
Raw mean	1.34	1.62	1.40	1.39
SD	0.97	1.08	1.04	0.90
d for comparison to control	-	0.29	0.07	0.06
P-value for comparison to control	-	< 0.001	0.36	0.44
Belief that college offers ways to fulfill interdependent motives and that being away from home may initially cause negative feelings				
Raw mean	5.40	5.48	5.59	5.41
SD	0.78	0.80	0.76	0.78
d for comparison to control	-	0.10	0.25	0
P-value for comparison to control	-	0.19	< 0.001	1.00
Belief that instructors give critical feedback to help students learn and grow and not to distinguish between students of low and high potential				
Raw mean	5.13	5.13	5.29	5.36
SD	1.00	0.97	0.95	0.90
d for comparison to control	-	0.001	0.17	0.24
P-value for comparison to control	-	0.99	0.02	0.002

Note: *All outcomes assessed on 1-7 scales. Values are raw and unadjusted. d=Cohen's d effect size. P-values are from OLS regressions controlling for SAT scores, high school class rank, and gender.*

Table S18: Experiment 3: Effects on Cumulative First-Year GPA By Condition.

	Control	Social-Belonging Intervention	Culture Intervention	Critical Feedback Intervention	Any Intervention
First-year cumulative raw GPA					
All Asian-American students and continuing-generation European-American students (*n*=1,183)					
Raw mean	3.62	3.60	3.62	3.62	3.61
SD	0.34	0.37	0.35	0.35	0.35
P-value for comparison to control	-	0.58	0.94	0.93	0.77
All African American, Hispanic/Latino, Native American, Pacific Islander, and first-generation European American students (*n*=409)					
Raw mean	3.33	3.39	3.47	3.39	3.42
SD	0.44	0.42	0.36	0.38	0.39
P-value for comparison to control	-	0.20	0.01	0.22	0.03
Achievement gap	-	0.20	0.15	0.22	0.19
(% reduction)	-	(23%)	(49%)	(22%)	(31%)
First-year cumulative GPA, controlling for SAT scores, high school class rank, and gender					
All Asian-American students and continuing-generation European-American students (*n*=1,183)					
Adjusted mean	3.59	3.58	3.59	3.59	3.59
P-value for comparison to control	-	0.52	1.00	0.91	0.76
All African American, Hispanic/Latino, Native American, Pacific Islander, and first-generation European American students (*n*=409)					
Adjusted mean	3.39	3.48	3.52	3.48	3.49
P-value for comparison to control	-	0.10	0.01	0.10	0.02
Achievement gap	-	0.09	0.08	0.11	0.09
(% reduction)	-	(41%)	(61%)	(40%)	(47%)

Table S19: Experiment 3: Results from Separate Regressions Testing for Moderation of the Interventions by Demographics.

Moderator tested	*B*	*t*	*P*
SAT score	0.000	0.68	0.50
High school class rank	-0.005	-1.48	0.14
Gender	0.015	0.17	0.87

***Note**: Analyses were conducted only among the sub-group of 409 students considered "disadvantaged" and theoretically expected to benefit most from the intervention—ethnic minority students and European-American first-generation students. Each row represents the test of an Any Intervention × Moderator interaction in a separate OLS regression model that also includes in it the condition variable, the moderator, and the other covariates (gender, SAT score, or high school class rank). All moderators were mean-centered. The high school class rank analysis was computed using only the students who had institutional data for this variable (n=218). Results were similar (but slightly less significant) using analyses that multiply imputed the missing values.*

Table S20. Experiment 3: Effect of All Interventions on First-Year GPA.

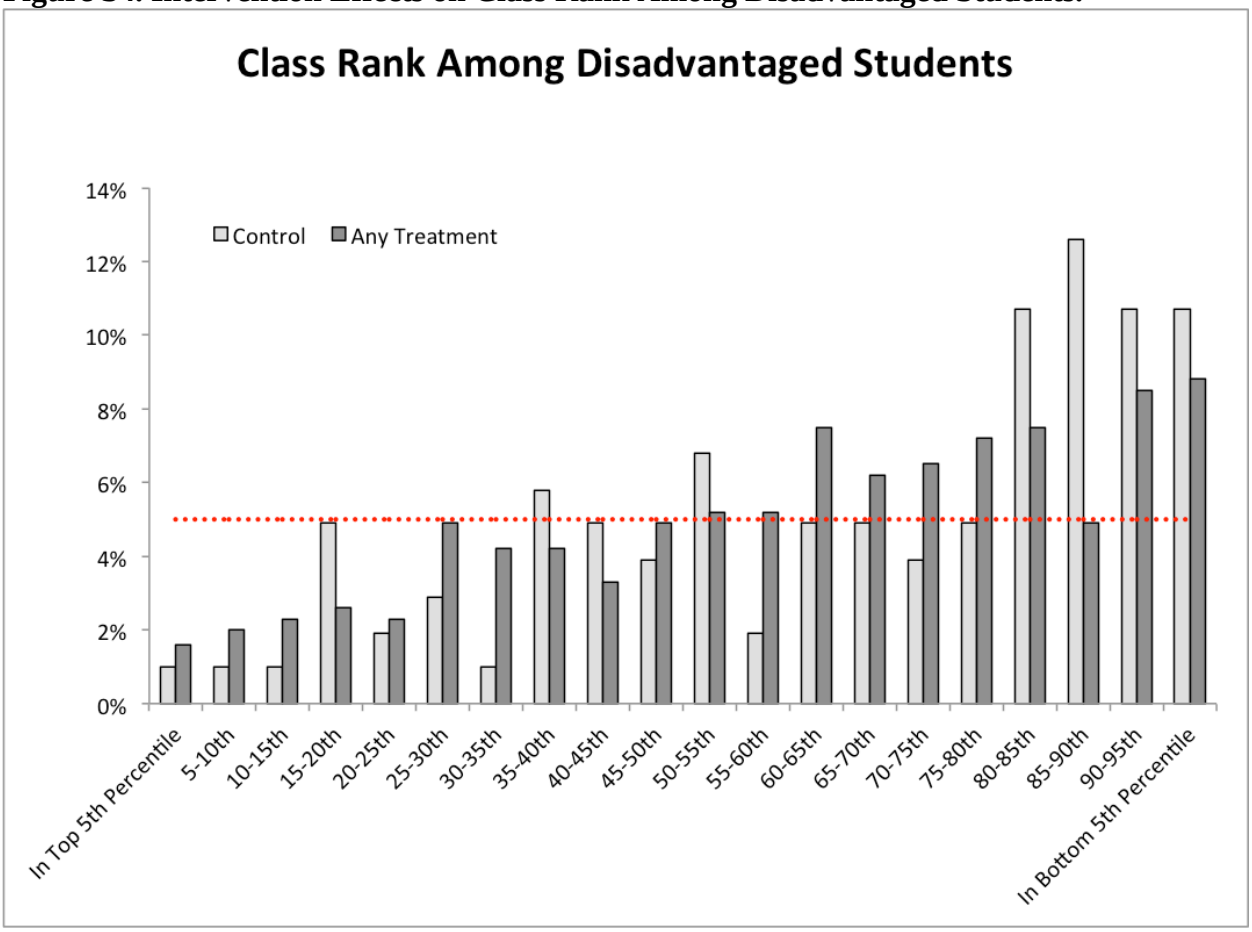
	Intervention Cohort: Control	Previous Untreated Cohorts: 2010 / 2011	Intervention Cohort: Any Intervention
First-year cumulative raw GPA			
All Asian-American students and continuing-generation European-American students			
Raw mean	3.62	3.53	3.61
SD	0.34	0.33	0.35
n	303	2061	880
P-value for comparison to intervention-cohort control	-	< 0.001	0.76
All African American, Hispanic/Latino, Native American, Pacific Islander, and first-generation European American students			
Raw mean	3.33	3.32	3.42
SD	0.44	0.41	0.39
n	103	968	306
P-value for comparison to intervention-cohort control	-	0.69	0.03
First-year cumulative GPA, controlling for SAT scores, high school class rank, and gender			
All Asian-American students and continuing-generation European-American students			
Adjusted mean	3.57	3.50	3.56
P-value for comparison to intervention-cohort control	-	< 0.001	0.69
All African American, Hispanic/Latino, Native American, Pacific Islander, and first-generation European American students			
Adjusted mean	3.40	3.42	3.49
P-value for comparison to intervention-cohort control	-	0.61	0.01

Table S21: Experiment 3: Social and Academic Integration in College, by Condition

	Control	Social-Belonging Intervention	Culture Intervention	Critical Feedback Intervention	Any Intervention
Have made close friends in college (1-7 scale)					
All Asian students and continuing-generation European-American students (*n*=357)					
Raw mean	5.52	5.55	5.79	5.76	5.70
SD	1.00	1.06	0.96	0.98	1.00
p-value for comparison to control	-	0.87	0.11	0.14	0.19
All African American, Hispanic/Latino, Native American, Pacific Islander, and first-generation European American students (*n*=116)					
Raw mean	5.22	6.12	5.71	5.42	5.75
SD	1.17	0.71	1.18	1.21	1.09
p-value for comparison to control	-	0.001	0.07	0.47	0.02
Use of academic support services (1-5 scale)					
All Asian students and continuing-generation European-American students (*n*=344)					
Raw mean	2.67	2.64	2.75	2.89	2.77
SD	0.88	0.89	0.88	0.83	0.87
p-value for comparison to control	-	0.91	0.63	0.12	0.41
All African American, Hispanic/Latino, Native American, Pacific Islander, and first-generation European American students (*n*=115)					
Raw mean	2.43	2.86	2.80	2.96	2.87
SD	0.62	0.88	0.90	0.84	0.87
p-value for comparison to control	-	0.06	0.10	0.02	0.02
Involvement in extracurricular activities (0-15 scale)					
All Asian students and continuing-generation European-American students (*n*=333)					
Raw mean	6.96	7.08	7.12	6.97	7.05
SD	4.40	4.45	4.61	4.11	4.36
p-value for comparison to control	-	0.85	1.00	0.79	0.97
All African American, Hispanic/Latino, Native American, Pacific Islander, and first-generation European American students (*n*=109)					
Raw mean	6.00	9.05	7.00	7.50	7.69
SD	4.82	3.80	4.22	4.24	4.16
p-value for comparison to control	-	0.01	0.34	0.20	0.06
Developed a mentor relationship (yes/no)					
All Asian students and continuing-generation European-American students (*n*=347)					
Percent "yes"	49.33%	57.65%	49.43%	49.00%	51.84%
p-value for comparison to control	-	0.30	0.98	0.95	0.71
All African American, Hispanic/Latino, Native American, Pacific Islander, and first-generation European American students (*n*=116)					
Percent "yes"	44.00%	67.86%	50.00%	59.26%	58.24%
p-value for comparison to control	-	0.13	.77	.30	0.28
Composite social and academic integration (average of standardized values of 1-4)					
All Asian students and continuing-generation European-American students (*n*=357)					
Raw mean	-0.10	-0.03	0.04	0.04	0.02
SD	0.69	0.57	0.60	0.55	0.57
p-value for comparison to control	-	0.42	0.18	0.16	0.15
All African American, Hispanic/Latino, Native American, Pacific Islander, and first-generation European American students (*n*=116)					
Raw mean	-0.30	0.34	0.01	0.06	0.13
SD	0.64	0.50	0.57	0.51	0.54
p-value for comparison to control	-	< 0.001	0.04	0.03	0.001

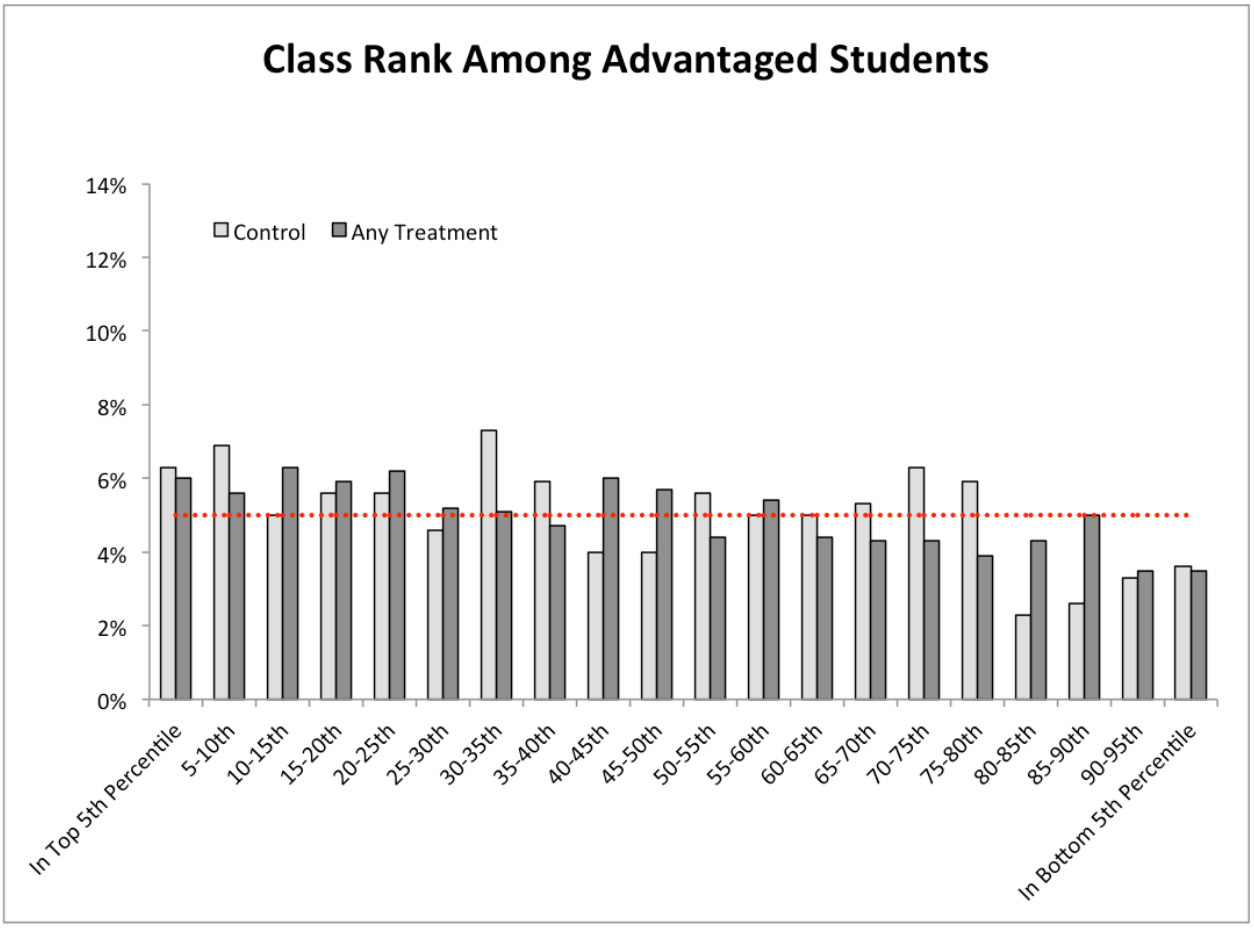
Note: *Values are raw and unadjusted. P-values are from regressions controlling for SAT scores, high school class rank, and gender. For the mentor variable, separate logistic regressions were run by at-risk status.*

Figure S4. Intervention Effects on Class Rank Among Disadvantaged Students.



Note: Red line is at 5%. Bars would be at the red line if there were no achievement gap.

Figure S5. Intervention Effects on Class Rank Among Advantaged Students



Note: Red line is at 5%. Bars would be at the red line if there were no achievement gap.

Figure S6. Effect of lay theories interventions on social and academic integration on end of year survey in Experiment 3.