HARNESSING VALUES TO PROMOTE MOTIVATION IN EDUCATION

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ABSTRACT

Purpose – *We review the interventions that promote motivation in academic contexts, with a focus on two primary questions: How can we motivate students to take more STEM courses? Once in those STEM courses, how can we keep students motivated and promote their academic achievement?*

Design/methodology/approach – *We have approached these two motivational questions from several perspectives, examining the theoretical issues with basic laboratory research, conducting longitudinal questionnaire studies in classrooms, and developing interventions implemented in different STEM contexts. Our research is grounded in three theories that we believe are complementary: expectancy-value theory (Eccles & Wigfield, 2002), interest theory (Hidi & Renninger, 2006), and self-affirmation theory (Steele, 1988). As social psychologists, we have focused on motivational theory and used experimental methods, with an*

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emphasis on values – students' perceptions of the value of academic tasks and students' personal values that shape their experiences in academic contexts.

Findings – *We review the experimental field studies in high-school science and college psychology classes, in which utility-value interventions promoted interest and performance for high-school students in science classes and for undergraduate students in psychology courses. We also review a randomized intervention in which parents received information about the utility value of math and science for their teens in high school; this intervention led students to take nearly one semester more of science and mathematics, compared with the control group. Finally, we review an experimental study of values affirmation in a college biology course and found that the intervention improved performance and retention for first-generation college students, closing the social-class achievement gap by 50%. We conclude by discussing the mechanisms through which these interventions work.*

Originality/value – *These interventions are exciting for their broad applicability in improving students' academic choices and performance, they are also exciting regarding their potential for contributions to basic science. The combination of laboratory experiments and field experiments is advancing our understanding of the motivational principles and almost certainly will continue to do so. At the same time, interventions may benefit from becoming increasingly targeted at specific motivational processes that are effective with particular groups or in particular contexts.*

Keywords: Interest; motivational interventions; parents; STEM education; values affirmation; achievement gaps

Many high-school students in the United States opt out of taking advanced mathematics and science courses. For example, only 35% of high-school graduates have taken precalculus and only 39% have taken physics (National Science Foundation, 2012). These low enrollment rates may be one reason that the United States has fallen behind 29 other countries in math and 22 countries in science according to a recent report (Program for International Student Assessment or PISA) (OECD, 2012). Of course, this is not a new trend. Since the publication of "A Nation at Risk" in 1983

(National Commission on Excellence in Education, 1983), reinvigorating interest in science, technology, engineering and mathematics (STEM) subjects has been part of the national agenda. It has become abundantly clear that if the United States wants to compete in a global market, it is imperative that more students pursue STEM careers. In fact, as recently as April 2013, the Obama administration committed \$3.1 billion to improve STEM education nationwide, with \$450 million being directed toward developing programs to inspire students to pursue STEM careers. Given the importance of expanding the pipeline of students who go onto STEM careers, it is critically important to develop interventions that promote enrollment in STEM courses.

If the problem is one of course enrollment and choices about course-taking and careers, it is a motivational question that demands a psychological analysis. Two distinct questions have guided our own work in this area: How can we motivate students to take more STEM courses? Once in those STEM courses, how can we keep students motivated and promote their academic achievement? In our work, we have approached these questions from several perspectives, examining the theoretical issues with basic laboratory research, conducting longitudinal questionnaire studies in classrooms, and developing interventions implemented in different STEM contexts. As social psychologists, we have focused on motivational theory and used experimental methods, with an emphasis on values – students' perceptions of the value of academic tasks and students' personal values that shape their experiences in academic contexts.

One strand of our research has focused on the psychological experience of interest, because interest is a powerful predictor of important achievement choices such as future course enrollment and choice of major (Harackiewicz, Barron, Tauer, & Elliot, 2002; Harackiewicz, Durik, Barron, Linnenbrink-Garcia, & Tauer, 2008) as well as academic performance (Ainley, Hidi, & Berndorff, 2002; Hidi & Harackiewicz, 2000; Schiefele, 1991). Interventions that prove successful in promoting STEM interest are particularly important to develop, especially in light of marked declines in students' pursuit of STEM majors when compared to other academic fields (National Center for Education Statistics, 2011).

Interest stems from the interaction between a person and a particular content, and values play an important role in this process. The potential for interest and motivation lies within the person, but the content and environment influence the strength and direction of interest as well as its continued development (Hidi & Renninger, 2006; Renninger & Hidi, 2011). The fact that a person's interest is influenced by the content and the context of a situation suggests that interventions have the potential to both trigger interest and support its maintenance over time and varied contexts. We hypothesize that the perception of value is critical to the development of interest over time. In other words, students will choose courses and persist in them when they perceive them to be personally important and valuable. Interventions that help students find value in STEM topics may be particularly effective in promoting interest and motivation.

THEORETICAL FRAMEWORK AND MODELS

In this paper, we discuss several successful social psychological interventions that have focused on the students' values to promote interest and, in some instances, academic performance in STEM courses (see Table 1 for an overview of our intervention studies). We conceptualize interest in *developmental* terms, and in multiple ways: students' interest in a topic *develops* over time; increasing students' perception of the value of a course may lead them to *develop* interest in it; *developmentally*, there may be key times to implement interest-promoting interventions. At its core, education involves developmental processes. Because of our recognition of the importance of development, we emphasize not only experimental designs, but also longitudinal designs. Notably, all of these interventions are based on theory and we review the relevant theories first, before describing the interventions themselves.

Our research is grounded in three theories that we believe are complementary: expectancy-value theory (Eccles & Wigfield, 2002), interest theory (Hidi & Renninger, 2006), and self-affirmation theory (Steele, 1988). According to Eccles's *expectancy-value theory*, a person chooses to take on a challenging task – such as persisting in a high-school physics course or choosing to become a biology major – if the person (1) values the task and (2) expects that he or she can succeed at the task (based on self-beliefs). Beliefs about the self and beliefs about the value of the task are both critically important in predicting course choices, persistence, and choice of a major. We believe that educators and parents may be able to influence students' perceptions of value in mathematical and scientific topics and thereby promote interest and STEM motivation.

Moreover, task values can play an important role in the development of interest. According to *interest theory* (Hidi & Renninger, 2006), being interested in an activity motivates us to pursue the activity when possible.

Table 1. Summary of Our Intervention Studies.

Study	Sample	Setting	Theoretical Approach	Summary of Intervention	Summary of Results
Durik and Harackiewicz (2007)	College students	Laboratory	Interest theory	A mental math technique was presented with either "catch" features (colorful fonts and pictures) or utility-value information (how the technique could be useful in everyday life).	Interest was increased with a catch manipulation for students with low initial interest, whereas utility value increased interest for students with high initial interest.
Hulleman et al. (2010), Study 1	College students	Laboratory	Expectancy-value theory	Students either wrote about the utility of a mental math technique or described pictures on the wall in the control condition.	Self-generated utility value increased interest for students with low performance expectations.
Hulleman et al. (2010), Study 2	College students	Introductory psychology classroom	Expectancy-value theory	Students either wrote about the utility of a topic in their class or wrote a summary of the topic in the control condition.	Self-generated utility value increased interest for students with low actual performance.
Hulleman and Harackiewicz (2009)	9th-grade students	High-school science classrooms	Expectancy-value theory	Students either wrote about the utility of a topic in their class or wrote a summary of the topic in the control condition.	Self-generated utility value improved interest and increased performance by two thirds of a letter grade for students with low performance expectations.
Harackiewicz et al. (2012)	Parent–teen pairs	Wisconsin study of families and work	Expectancy-value theory	Two brochures were mailed to parents that emphasized the utility value of various STEM disciplines (or not, in control conditions).	Students whose parents received the intervention enrolled in more math and science courses in high school compared with the control group.
Harackiewicz et al. (2013)	College students	Introductory biology classrooms	Self-affirmation theory	In two brief writing assignments, students either wrote about values that were important to them or wrote about values that were not important to them but might matter to someone else (control condition).	Values affirmation increased course grades, semester grade-point average (GPA), and retention for first-generation college students.

Interest may be triggered by interventions that emphasize the value of a task, and then further developed as the individual experiences positive feelings and comes to value an activity even more. Well-developed interests can motivate continued engagement with the activity; for example, Harackiewicz, Barron, Tauer, Carter, and Elliot (2000) and Harackiewicz et al. (2002) found that interest developed in introductory psychology courses predicted subsequent course-taking over four years, as well as students' eventual choice of academic major. Thus, interest theory suggests that task values may lead to deepened interest, which can then influence subsequent course-taking decisions.

A third theoretical model is particularly relevant once students are actually enrolled in STEM courses. *Self-affirmation theory* (Steele, 1988) addresses the achievement barriers faced by certain groups in certain domains, such as African-Americans, Latinos, and women in science. In school domains in which a group has been negatively stereotyped, those who want to succeed in the domain face the barrier of stereotype threat, the fear that they will confirm negative stereotypes about their group. For example, research shows that when talented African-American students are reminded of their ethnicity, this brings to mind the negative stereotypes associated with their ethnicity, and their performance on tests is depressed compared with the white students and African-American students in a control condition (Steele, 1997). Moreover, stereotype threat can cause misidentification with school. When stereotyped students perform more poorly in school relative to their peers, they may disengage from academic domains as a way of maintaining their self-concept. This theory is particularly relevant to understanding the experience of students in classes, and we will discuss this theory in greater detail in the later sections of this paper.

APPLICATIONS OF THE EXPECTANCY-VALUE MODEL FOR INTERVENTIONS

What students learn in school does not always seem relevant to their own lives. When students encounter subjects that do not seem important or useful, they may become disengaged, lacking the motivation that educators and parents hope to inspire in their students and children. However, researchers have recently begun to develop interventions that may address these motivational problems by increasing students' interest in academic disciplines. Interventions designed to promote interest can take many approaches. For example, a teacher might try to make an academic task more interesting by changing the features of the task, assigning group projects, or embedding learning activities in games (Bergin, 1999; Hidi & Baird, 1988; Lepper & Henderlong, 2000; Wigfield & Cambria, 2010). However, it is not always possible to change the nature of a task or activity. A parent or teacher cannot change the fundamental principles of mathematics or science, but they may be able to change the way students think about these subjects. For example, a parent might be able to promote interest in an academic topic by relating it to their child's recreational interests or career goals. By changing the perception of the activity (i.e., helping students perceive tasks as personally important), it may be possible to influence interest.

It is therefore important to distinguish interventions that change the structure of an activity (Lepper & Cordova, 1992; Schraw & Dennison, 1994) from those that change an individual's perceptions of an activity (Iyengar & Lepper, 1999). Task-based interventions typically vary collative variables (e.g., complexity, incongruity, novelty, and variability) to stimulate attention, arousal, and task engagement (Berlyne, 1960; Durik & Harackiewicz, 2007), whereas task-value interventions focus on individuals' perceptions and development of subjective task values (Harackiewicz & Hulleman, 2010).

As noted earlier, according to Eccles's model, perceived expectancies for success and subjective task values together determine motivation and performance on achievement tasks. Accordingly, one way to inspire interest and motivation is to increase the perceived expectancy of success, and a large research literature has examined the role of self-efficacy and performance expectations in promoting interest and performance (Harter, 2006; Pajares, 1996). It can be difficult to intervene with respect to students' performance expectations, however, and in this paper, we concentrate on the interventions focused around task values.

Indeed, it may prove more feasible to influence students' subjective task values than their self-efficacy for academic tasks. Eccles (Eccles, 2009; Eccles et al., 1983) argued that it is important to consider how individuals perceive and value a task, and identified four types of subjective task values: *intrinsic value* – the perceived importance of a task because of its inherent enjoyment or interest; *attainment value* – the perceived importance of a task for an individual's identity and self-worth; *utility value* – the perceived importance or usefulness of a task for accomplishing future goals relevant to an individual's life; and *cost value* – the negative aspects of engaging in a task (e.g., time consumption, performance anxiety). Her expectancy-value model posits that an increase in intrinsic, attainment, or utility value will lead to greater motivation toward an academic task.

Of these four task values, Eccles and colleagues consider utility value to be the most "extrinsic" because it extends beyond the task itself to connections between that task and other tasks, activities, or goals (Wigfield & Eccles, 1992). A person finds utility value in a task if they believe it is useful and relevant beyond the immediate situation for other tasks or aspects of a person's life. For example, when students encounter evolution in their biology class, the content may not seem immediately valuable or applicable to their lives. Learning about natural selection may not seem to have obvious practical or personal implications. However, if a health-conscious student comes to realize that plant breeders have been selecting for lettuce that tastes better but has far fewer nutrients, they may become more invested in biology and engage more with the content. These types of external connections to content distinguish utility value from the other more internally regulated task values.

Whereas intrinsic and attainment value are based on the inherent enjoyment of the task itself and the importance of the task for an individual's identity, respectively, utility value is predicated on perceiving connections between the immediate task and a future task or activity. Accordingly, some researchers have claimed that utility value is more "externally regulated" than other task values (Simons, Vansteenkiste, Lens, & Lacante, 2004). Extrinsic factors (e.g., rewards, prizes, and competitions) have historically been at the heart of controversy in the motivation literature with many researchers arguing against the use of external motivation to promote task motivation (Harackiewicz, 1979; Harackiewicz & Sansone, 1991; Harackiewicz & Tauer, 2006; Lepper, Greene, & Nisbett, 1973). In fact, some motivation theorists have argued that extrinsic motivation is antithetical to the development of interest (Deci & Ryan, 1985). However, when an individual perceives utility value in a task, they may connect the task to important personal goals and outcomes in an intrinsically regulated way that promotes the development of interest (Vansteenkiste, Lens, & Deci, 2006). Thus, utility value may have a more positive potential than originally thought (Hidi & Harackiewicz, 2000).

Moreover, given that utility value is based on the perceptions of the usefulness of a task for other goals and applications, it may prove to be the task value most amenable to external intervention. A teacher or parent can point out the possible connections, or help students appreciate the relevance of a topic for their future goals. For this reason, we have focused on developing interventions that promote the perception of utility value in laboratory and classroom settings. By integrating expectancy-value and interest theories, we propose two ways that utility value can influence motivation and persistence in STEM fields. First, perceiving utility value in mathematics and science can directly influence subsequent course enrollment choices because of the importance of these courses for future goals (e.g., going to college and becoming a doctor). Second, perceiving utility value in courses can influence subsequent course choices and career decisions through the process of interest development. That is, perceiving value in mathematics and science courses can promote deeper interest in those fields, and interest may be a proximal motivator of career decisions. Thus, interest may be a pathway through which interventions influence motivation and preparedness for STEM majors and careers. To explore how changes in perceived utility value impact interest and motivation, however, it is important to understand how interest develops over time, as well as distinguish interventions that trigger the initial development of interest from those that promote the maintenance or deepening of interest (Hidi & Harackiewicz, 2000).

INTEREST THEORY

Hidi and Renninger (2006) advanced a four-phase model of interest development that charts the transition from situationally based interest to individual interest. The two earlier phases of interest are characterized as varying degrees of "situational interest." In the first phase, a trigger is necessary (provided by the content or the environment) to spark a temporary affective and cognitive change that results in a short-term increase in interest. If this triggered situational interest is further supported, typically by external sources, it can develop into a more maintained situational interest (phase 2). The latter two phases are characterized by a predisposition to seek repeated engagement with the content. In order to develop emerging individual interest (phase 3) and well-maintained individual interest (phase 4), the individual must play a more active role in their own interest development. Interest in the latter phases is therefore more self-generated and does not necessarily require external support to develop, suggesting that interventions may be most effective in the early stages of interest development either by aiding the development of situational interest, or by supporting or promoting the transition to a more internalized interest.

Hidi and Renninger (2006) also hypothesized that increasing the perception of the value of a task is critical for progressing from situational to individual phases of interest. An increase in the perceived value of a task motivates individuals to continue engaging in content or an activity. Thus, both the expectancy-value model and interest theory predict that increasing perceived task value is a viable way to promote interest and motivation. With these theoretical frameworks in mind, we have explored the relationship between interest, motivation, and the task value most amenable to outside intervention: utility value.

Correlational studies conducted in classes have found that the perceived instrumentality of studying was positively correlated with students' persistence and academic performance (De Volder & Lens, 1982; Husman, Derryberry, Crowson, & Lomax, 2004; Husman & Lens, 1999; Van Calster, Lens, & Nuttin, 1987). Malka and Covington (2005) showed that students' perception of the relevance of their schoolwork to their future goals predicted academic performance. Many other correlational studies have found that when students perceive value in course topics, they develop more interest, take more advanced courses in those academic disciplines, and perform better (Harackiewicz et al., 2000; Harackiewicz et al., 2008; Wigfield, 1994). For example, Hulleman, Durik, Schweigert, and Harackiewicz (2008) measured perceived utility value by asking students in an introductory psychology class to report, early in the semester, the extent to which they found class material to be useful to their everyday life and future career. They then examined the relationship between perceived utility value and interest, measured at the end of the course, as well as course grades, and found that utility value was a significant predictor of both interest and grades in the course, controlling for initial interest.

INTERVENTIONS TO INCREASE INTEREST

In an experimental laboratory study, Durik and Harackiewicz (2007) measured students' baseline interest in mathematics and then taught them a mental math technique, varying both the collative features of the task and the availability of utility-value information in a crossed experimental design. "Catch" features (designed to trigger interest) were varied by presenting the math technique with colorful fonts and pictures in the catch condition, compared to a plain black-and-white control condition. To vary utility-value information, some students received information about how the technique could be useful in everyday life (e.g., "You might use mental math to figure out tips at restaurants or to manage your bank transactions") whereas no utility-value information was presented in the control condition. The "catch" manipulation was effective in promoting interest for students who were low in initial interest, whereas the utility-value intervention increased interest for students who were already high in initial interest. Durik and Harackiewicz argued that situational triggers, in the form of enhanced collative features of the task, were necessary to initiate interest development for students low in initial interest, but that the utility-value intervention helped high-interest participants develop a more maintained interest. Thus, a task-based intervention appeared to trigger interest for low-interest participants, but the utility-value intervention was effective in supporting interest for high-interest students.

Hulleman, Godes, Hendricks, and Harackiewicz (2010) tested a different type of utility-value intervention: one in which students actively generated the utility value of a topic. In two experiments – a laboratory study and a randomized trial in a college class – utility value was manipulated with a writing intervention in which participants were asked to explain how the topic being learned (math in the laboratory study and psychology in the college class) was relevant to their lives. In other words, participants were asked to generate their own connections and discover utility value themselves through writing about the task. In the control condition, students wrote a summary of the material. In both experiments, the utility-value intervention increased interest, especially for participants who were low in expected (laboratory study) or actual (classroom study) performance, indicating the importance of both utility value and performance expectations in predicting interest. If students do not expect to perform well, the process of generating personal connections to an academic discipline may be particularly important for triggering interest and promoting engagement in the task. Students who expect to do well may already be aware of the utility value of the activity. This possibility was supported by the mediation analyses showing that the intervention worked for low-expectancy students by promoting perceptions of utility (measured via questionnaire) (Hulleman et al., 2010). In other words, the intervention increased perceptions of utility for these low-expectancy students, and perceived utility value was a positive predictor of subsequent interest in the task for all students.

Hulleman and Harackiewicz (2009) tested a similar experimental intervention with high-school science students. Students enrolled in 9th-grade biology classes were randomly assigned to utility value or control writing conditions at the beginning of the semester, within classrooms. Teachers were told that the research concerned the effectiveness of writing assignments, but were blind to the hypothesis and experimental condition. Students' success expectancies and initial interest in science were measured at the beginning of the semester. At the end of each unit (about every 2–3 weeks), students either wrote about how the material they were studying applied to their own lives (utility-value condition) or wrote a summary of the same material (control condition). Students' interest in science and future plans for science-related careers were measured at the end of the semester, and course grades were obtained from school records. Results indicated that the intervention was particularly effective for students with low performance expectations in the class: these students reported more interest and obtained higher grades. Given that students who do not believe they can do well are especially at risk for poor performance and decreased academic interest (Eccles et al., 1983; Renninger, 2000), these are the students most in need of help. The utility-value intervention improved performance for these at-risk students by nearly two thirds of a letter grade and promoted their interest in science. Moreover, Hulleman and Harackiewicz (2009) showed that interest predicted students' science-related career plans, suggesting that utility-value interventions might have long-term effects. These results suggest that this simple intervention aimed at promoting the perception of utility value was powerful in promoting important academic outcomes.

It is interesting to note that in the Durik and Harackiewicz (2007) study, in which students were presented with utility-value information from an outside source, the utility-value intervention was most effective for highly interested students, yet in the Hulleman studies (Hulleman et al., 2010; Hulleman & Harackiewicz, 2009), in which students generated their own utility-value connections, the utility-value intervention was more powerful for less-confident students. This highlights the fact that learners approach tasks with different backgrounds (i.e., varying levels of interest and performance expectations) and that utility-value interventions may have differing effects depending on an individual's background (Durik, Hulleman, & Harackiewicz, in press; Durik, Shechter, Noh, Rozek, & Harackiewicz, 2014).

For example, the fact that externally presented utility-value information (i.e., telling students why a task might be important for them) was particularly effective for high-interest students in the Durik and Harackiewicz (2007) study suggests that for students who are already interested in a topic, utility-value information may serve as another meaningful way to connect to content and deepen interest. Thus, utility-value information may act as an additional motivator for students to continue pursuing a task. The fact that the self-generated utility-value intervention in the Hulleman and Harackiewicz (2009) and Hulleman et al. (2010) study was most effective for students with low success expectancies suggests that the act of identifying personal utility-value connections (i.e., writing essays about how the content is personally relevant) may be especially important for triggering interest among students who might otherwise become disengaged with the task. For these students with low success expectancies, discovering how a particular content or task relates to their life may be a powerful mechanism for initiating the development of interest. Considered together, these results suggest that there may be different routes to the promotion of perceived utility value and interest for students.

PARENTS: AN UNTAPPED RESOURCE

Given the impressive potential of utility-value interventions for promoting important academic outcomes in classroom settings, our more recent research has investigated whether it is possible to influence students' perceptions of utility value in other ways. According to Eccles's expectancy-value model, parents play a pivotal role in influencing their children's motivational beliefs (Jacobs & Eccles, 2000). Correlational and longitudinal studies support this idea, showing that parents' beliefs in educational domains are closely linked to the beliefs and behaviors of their children. Furthermore, studies show that parental involvement is a strong predictor of students' attitudes, values, and academic choices (Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001; Simpkins, Fredricks, & Eccles, 2012). On the basis of these studies, we investigated experimentally whether parents could influence their children's perceptions of utility value and thereby promote interest and motivation.

Specifically, we tested an intervention designed to influence high-school students' perceptions of utility value and STEM course-taking by intervening with parents in a randomized field study (Harackiewicz, Rozek, Hulleman, & Hyde, 2012). We tested whether an intervention targeted at parents could be an effective way of promoting both parents' and students' perceptions of utility value. We hypothesized that an intervention that increased parents' perceptions of the utility value of math and science would promote their children's perceptions of utility value, resulting in increased enrollment in mathematics and science courses. The intervention consisted of two brochures mailed to parents and a dedicated, password-protected website that provided information about STEM fields and careers, and emphasized the utility value of mathematics and the sciences. The intervention directly targeted parents, with the intention that they would then talk with their teens about the importance of math and science. This was an indirect intervention in the sense that we predicted that an intervention aimed at parents would influence teens' perceptions of utility value and subsequent course-taking. The effectiveness of this intervention was therefore predicated on parents being able to effectively communicate to their children the utility-value information they received via the brochures and website.

We followed 188 adolescents (88 girls and 100 boys) and their parents through the high-school years in this randomized experiment. The first brochure, titled "Making Connections: Helping Your Teen Find Value in School" was mailed to parents in October of the 10th grade. The brochure provided information about the usefulness of mathematics and science in daily life and for various careers (e.g., how math is important for managing one's personal finances and chemistry is important for doctors, nurses, and pharmacists). In addition to the utility-value information, the brochure included advice for parents about how to talk with their children about the relevance of mathematics and science to their children's lives. For instance, the brochure suggested that instead of telling teens how important math and science are to their lives and their futures, parents should encourage teens to discover the connections that are most personally meaningful to them. The brochure also suggested that many teens resist such conversations and recommended enlisting other trusted resources such as mentors, teachers, and coaches.

The second brochure, titled "Making Connections: Helping Your Teen with the Choices Ahead" was sent to each parent separately in January of the 11th grade and included information about a password-protected website titled "Choices Ahead." Like the first brochure, this one emphasized the ways in which mathematics and science connect to people's lives as well as the importance of conveying these connections to students. The second brochure was different from the first in that it placed an increased emphasis on the relevance of STEM courses for preparing students for college and future careers. The website contained clickable links to a number of different resources about STEM fields and careers, in addition to interesting science sites that illustrated the relevance of STEM topics to everyday life. It also presented excerpts of interviews with current college students who explained the importance of their high-school mathematics and science courses for their college preparation. Thus, parents who visited the website were provided with examples of college students who recognized the utility value of their high-school STEM courses. Parents were also given the option of e-mailing specific links from the website to their teens, to present them with relevant examples highlighting the importance of a STEM education. Parents in the control group did not receive either of the brochures or access to the website.

Parents reported their perceptions of the utility of mathematics and science for their teens (e.g., "Math and science are important for my teen's life") at two points in time: once when the students were in the 9th grade (prior to the intervention) and once when the students were in the 11th grade (after the intervention materials were delivered). Following 12th grade, students and parents each completed questionnaires assessing the extent to which parents and teens had engaged in conversations about the importance of mathematics and science. Teens also indicated their perceptions of the utility value of mathematics and science. In addition, we collected high-school transcripts following the students' graduation and coded the transcripts for multiple features, including the number of math and science courses taken each year. The primary hypothesis was that students whose parents had received the intervention would enroll in more advanced mathematics and science courses.

We found that students whose parents received the intervention enrolled in significantly more mathematics and science courses in the 11th and 12th grades than teens whose parents were in the control group. The difference was equivalent to nearly an extra semester of mathematics or science over a two-year period. For the majority of students, these extra courses consisted of advanced, elective courses in mathematics and science. Consistent with the previous findings (Jodl et al., 2001; Simpkins, Davis-Kean, & Eccles, 2006), we also found that parental education was a significant predictor of STEM course-taking in high school. The two effects were independent, and the size of the intervention effect ($\beta = .16$) was comparable to the effect of parental education ($\beta = .17$) (see Fig. 1).

Additional analyses revealed that the intervention significantly increased the mothers' perceptions of the utility value of STEM topics for their teens, as well as the students' reports of conversations with their parents about the importance of mathematics and science. Thus, the intervention was effective in changing the parental perceptions of utility value and was also effective in promoting conversations with teens about the value of STEM disciplines. Process analyses indicated that the direct effects of the intervention on mothers' perceptions of STEM utility value and students' reports

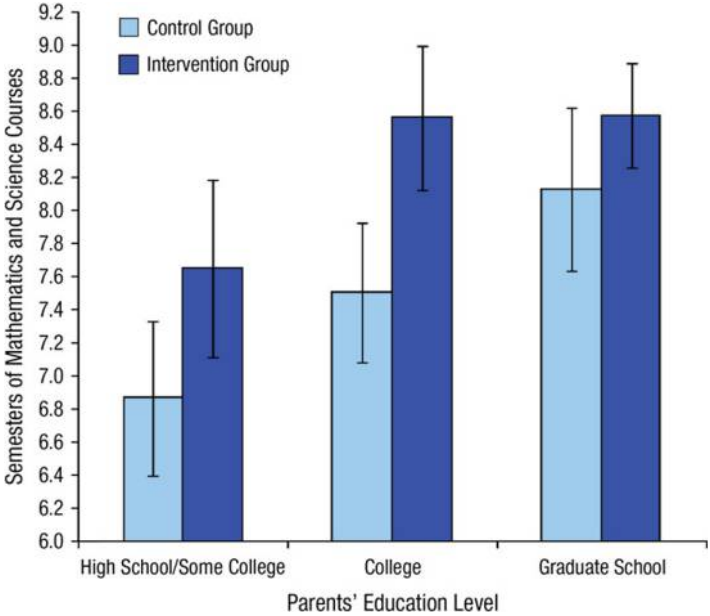

Fig. 1. Effects of the Utility-Value Intervention and Parents' Educational Level on the Number of Semesters of High-School Math and Science Classes in Which Students Enrolled.

of conversations with their parents were associated with students' perceptions of STEM utility value after graduation. Overall, these results suggest that an intervention targeting parents can influence their children's perceptions of the utility value of mathematics and science courses as well as their STEM course-taking in high school.

The results of this randomized intervention study suggest that parents, a largely untapped resource, can and should be viewed as powerful agents in the promotion of students' STEM-related motivation. However, more research is needed to investigate how to guide parents most effectively to help their children discover the utility value of STEM disciplines. For example, future research might elucidate the dynamics involved in parent–teen conversations and their impact on course-taking. Parent–teen relationship quality, parental background in math and science, and gender (of both teens and parents) could each influence the quality and content of parent–teen conversations (Rozek, Hyde, Svoboda, Hulleman, & Harackiewicz, 2013). The intervention effects reported here might be stronger for some groups than others, and it will be important to explore such moderators in future research. Overall, however, given that this relatively simple intervention had such dramatic effects, these findings are extremely promising and bode well for future interventions that target parents. Indeed, these results suggest that parents are willing and able to influence their children's motivation in STEM courses – they just need the support and information resources to do so.

Given that parents can have such a profound effect on their children's education, it is important to investigate which parents are most effective at helping their children successfully navigate academia. Researchers have long been interested in the effects of social class on educational trajectories (e.g., Gamoran, 2001), and parental education is an essential component of social class. Not surprisingly, a parent's educational level carries meaningful consequences for their children. For example, when considering factors such as family income, birth weight, and elementary school quality, the best predictor of 10-year-olds' mathematics performance is mother's education (Melhuish et al., 2008). These effects likely occur for several reasons. One is that parents with more education are more familiar with the skill-set required to succeed in school and are better able to support their children's schooling. In addition, parents with more education are more likely to themselves have taken more math and science courses, and may therefore appreciate the utility value of them. Indeed, the effect of parental education was evident in our intervention study with parents (Harackiewicz et al., 2012); as shown in Fig. 1, teens with more highly educated parents took more semesters of mathematics and science in high school.

FIRST-GENERATION (FG) COLLEGE STUDENTS

The importance of parental education becomes even clearer when examining the academic performance of FG college students. FG college students are those for whom neither parent received a four-year degree, and they comprise roughly 15–20% of students in American universities (Bowen, Kurzweil, & Tobin, 2005; Saenz, Hurtado, Barrera, Wolf, & Yeung, 2007). Not only do FG students perform worse academically than their continuing-generation (CG) college peers, but they have a significantly higher drop-out rate as well, and this discrepancy has been referred to as the social-class achievement gap (Snibbe & Markus, 2005). When one considers that the income achievement gap has increased by 30–40% in the last 25 years (Reardon, 2011), the plight of FG students in college takes on newfound significance. If a college education is the best vehicle for upward social mobility, it is critical to ensure that we give FG students the best chance at successfully completing a college degree.

Research suggests that FG students face far more economic and social barriers in college compared with their peers, and that these barriers may have been in place from birth. The literature on parenting practices indicates that FG students are brought up in homes where the quality and quantity of time spent with parents differs substantially from more educated parents (Philips, 2011). College-educated mothers spend between four and six more hours per week caring for their children than their less-educated counterparts (Ramey & Ramey, 2010), and a greater proportion of parent–child time is spent on educational activities (Leibowitz, 1977).

In addition, CG students have parents whose own college experiences enable them to assist their teens with the adjustment from high school to college. In contrast, the parents of FG students may not be as helpful with college planning, preparation, and experiences in college, because of their own lack of such experiences. Parents typically overestimate the cost of college (Grodsky & Jones, 2007; Horn, Chen, & Chapman, 2003), and many eligible high-school graduates are unaware of available financial resources (e.g., Pell grants) directed at helping lower income families (American Council on Education, 2004). Compared with parents who are college graduates, a parent who is unfamiliar with the college application process is unlikely to be as helpful when filling out applications for financial aid, and may not be aware of the benefits of doing so. With fewer supports in place, FG students may go into college less well prepared than their CG peers, and may be unsure about whether they really belong in college (Ostrove & Long, 2007).

Recent work by Stephens, Fryberg, Markus, Johnson, and Covarrubias (2012a) suggests that FG students have different goals for attending college than their CG peers, and that this puts FG students at a competitive disadvantage in college. Stephens and colleagues proposed a *cultural mismatch theory* that describes how the interdependent motivation of FG students for attending college is at odds with the independent norms of traditional American universities, resulting in a "cultural mismatch" that undermines the performance of FG students.

To test this hypothesis, Stephens et al. (2012a) first surveyed administrators at 60 colleges and universities across the United States about the skills they felt were most important for their students to develop. Half of the survey items reflected independent skills (e.g., learning to work independently) and half represented interdependent skills (e.g., learning to work together with others). Fully 84% of the college administrators characterized their school culture as more independent than interdependent. To test whether incoming students were striving to attain the same skill-set that these universities were emphasizing, Stephens et al. (2012a) surveyed over 1400 college freshmen about their motivation for attending college. They found that FG students have more interdependent motives for attending college (e.g., "helping out my family after college is a very important reason for completing my college degree") and fewer independent motives for attending college (e.g., "learning to be an independent thinker is a very important reason for completing my college degree") than their CG peers. They then examined the relations between these different motivation orientations and academic performance, and found that students who endorsed more independent motives (consistent with the skills universities were promoting) attained higher grades, but conversely, students who endorsed more interdependent motives (and who thus would have experienced a mismatch with the types of skills promoted by universities) received significantly lower grades.

In separate studies, Stephens and her colleagues went on to show that FG students experience significantly more stress (indexed by cortisol levels) on an academic task after their school was presented as having independent as opposed to interdependent cultural norms (Stephens, Townsend, Markus, & Phillips, 2012b) and that FG performance gaps could be reduced when a university environment was presented as being more interdependent in nature (consistent with FG student motivations) than independent (Stephens et al., 2012a).

It might also be the case that FG students are subjected to a psychological threat that undermines their academic performance. As noted earlier in our discussion of the theories that guide our research, Steele (1997) coined the phrase "stereotype threat" to describe the apprehension and discomfort that afflicts individuals from stigmatized groups when they become concerned about confirming negative stereotypes about their group. Reminders of negative stereotypes about one's group cue uncertainty for the individual and mental searches that one might be confirming the stereotype (Schmader, 2010; Schmader, Johns, & Forbes, 2008). The process of monitoring for failure and suppressing negative thoughts saps the very cognitive process – working memory – that is essential for success on complicated math problems or other difficult cognitive tasks. This phenomenon has led to an abundance of research aimed at both explaining and alleviating the effects of stereotype threat.

More than 300 laboratory and field studies, ranging from studies of minority students in middle school to women in math classes, have demonstrated that stereotyped group members perform more poorly when stereotypes about their group are made salient, relative to controls in which stereotypes are not invoked (Aronson & Inzlicht, 2004; Aronson et al., 1999; Steele & Aronson, 1995; Steele, Spencer, & Aronson, 2002; for a meta-analysis, see Walton & Spencer, 2009). Several studies examining stereotype threat and social class suggest that low socioeconomic status (SES) college students do in fact perform more poorly when tested in an evaluative environment that makes SES salient (Croizet & Claire, 1998; Croizet & Dutrévis, 2004; Harrison, Stevens, Monty, & Coakley, 2006; Spencer & Castano, 2007). These studies suggest that FG students may be vulnerable to the harmful effects of stereotype threat.

To combat the effects of stereotype threat, social psychologists have developed interventions designed to inoculate stigmatized students from perceived threats. One intervention, based on Steele's (1988) theory of self-affirmation, discussed earlier, has proven to be particularly effective, and is called values affirmation. Self-affirmation theory posits that when individuals from stereotyped groups affirm their personal values, it bolsters them against the perceived threats that stem from negative stereotypes about their group (Steele, 1988). The affirmation occurs via a writing task in which individuals are instructed to write about their most important values; this exercise has been shown to help students from stigmatized groups cope with identity threat (Fein & Spencer, 1997; Sherman, Nelson, & Steele, 2000). By affirming core personal values in threatening contexts, stereotyped individuals can reestablish a sense of personal integrity and self-worth, thus supporting them in stressful and evaluative environments (see McQueen & Klein, 2006; Sherman & Cohen, 2006 for review).

In recent years, researchers have implemented the values affirmation intervention in randomized field studies to test its effectiveness in improving the academic performance of traditionally stereotyped groups. The results have been promising. Cohen, Garcia, Apfel, and Master (2006) demonstrated that a values affirmation intervention significantly reduced the existing achievement gap between African-American and European American middle-school students by 40%. Similarly, Sherman et al. (2013) found that a values affirmation intervention reduced the achievement gap between Latino American and White middle-school students by 24.5%. This brief writing intervention, conducted in middle-school classes, changed academic trajectories for disadvantaged students. Values affirmation has also proven to be effective in higher education.

Women have been stereotyped as being worse at math and science than men. In order to counteract the effects of a gender stereotype threat, Miyake et al. (2010) implemented a values affirmation intervention in a college physics class where gender gaps in performance had been documented. The intervention was successful in reducing the gender gap in the class by 61%. Furthermore, the intervention was most effective for women who endorsed the gender stereotype (i.e., women who believed men perform better than women in physics). Whereas even a moderate level of the gender stereotype endorsement negatively predicted the academic performance of women in the control condition, no such relationship existed for the affirmed women, suggesting that their identities were buffered from the debilitating effects of stereotype threat.

USING A VALUES AFFIRMATION INTERVENTION TO HELP FG STUDENTS

Given the impressive history of values affirmation interventions for promoting important academic outcomes for other stereotyped groups, we implemented a values affirmation intervention in an attempt to close the social-class achievement gap that existed in a college biology course (Harackiewicz et al., 2014). We hypothesized that a values affirmation intervention could effectively aid the performance of FG students by buffering them against perceived identity threats due to stereotypes about their group (Croizet & Claire, 1998) or by buffering them against the mismatch between individual motives and institutional norms (Stephens et al., 2012a). Both stereotype threat theory and cultural mismatch theory suggest that FG students experience college as more stressful than their CG peers, and we hypothesized that focusing on important personal values may help FG students cope with this stress and lead to better academic performance.

We tested a values affirmation intervention in a randomized control study in the context of an introductory university biology course where FG students chronically performed worse than CGs. This course functions as a gateway course to all biology majors and therefore to careers in the biological and medical sciences. A total of 798 students (320 men and 478 women; 644 CG students and 154 FG students) participated in the field study. The intervention was administered twice: once during the third week of classes (time 1), and once during the eighth week of classes (time 2). The intervention itself was a brief writing assignment (modeled after the one used by Miyake et al., 2010) that required students to select two or three values from a list of 12: *being good at art; creativity; relationships with family and friends; government or politics; independence; learning and gaining knowledge; athletic ability; belonging to a social group (such as your community, racial group, or school club); music; career; spiritual or religious values; and sense of humor*. Written instructions in the affirmation condition directed students to circle two or three values that were *most* important to them and then write an essay describing why their selected values were important. Instructions in the control condition directed students to circle two or three values that were *least* important to them and then write an essay describing why those values might be important to someone else.

The assignment was framed as a practice writing exercise, and students received credit as long as they completed the assignment. However, students were told that the writing exercise was confidential and would not be read by their instructors or teaching assistants (TAs). They were told that they would not be graded for spelling or grammar and that an independent group, not affiliated with the biology course, would check for thoughtful completion of the assignment. These procedures ensured that students took the assignment seriously, but would feel more comfortable writing about their personal values. In accordance with previous values affirmation interventions (Cohen et al., 2006; Miyake et al., 2010), all instructors (including biology faculty and TAs) remained blind to the study's purpose, hypotheses, and experimental conditions. This marked the first time that a values affirmation intervention was implemented on such a large scale in a college course (i.e., across hundreds of students with multiple instructors and numerous laboratory and discussion sections).

Students completed baseline and post-intervention questionnaires assessing confidence about their performance in the class (measured with three items: "I am confident that I will do well in Introductory Biology," "I expect to get a good grade in this course," "I am confident that I can obtain a final grade of B or better in this course"), and their concern about their background (measured with the item: "I am not sure I have the right background for this course"). These brief measures were intended to assess their experiences in the class.

We examined the effects of values affirmation on three primary academic outcomes: (1) grade in the biology course, (2) semester GPA across all courses (excluding the biology course), and (3) continuation to the second course in the biology sequence. We hypothesized that values affirmation would benefit FG students such that FG students in the treatment condition would receive higher grades and be more likely to continue on to the next course in the biology sequence when compared to FG students in the control condition. Results supported these hypotheses (Fig. 2).

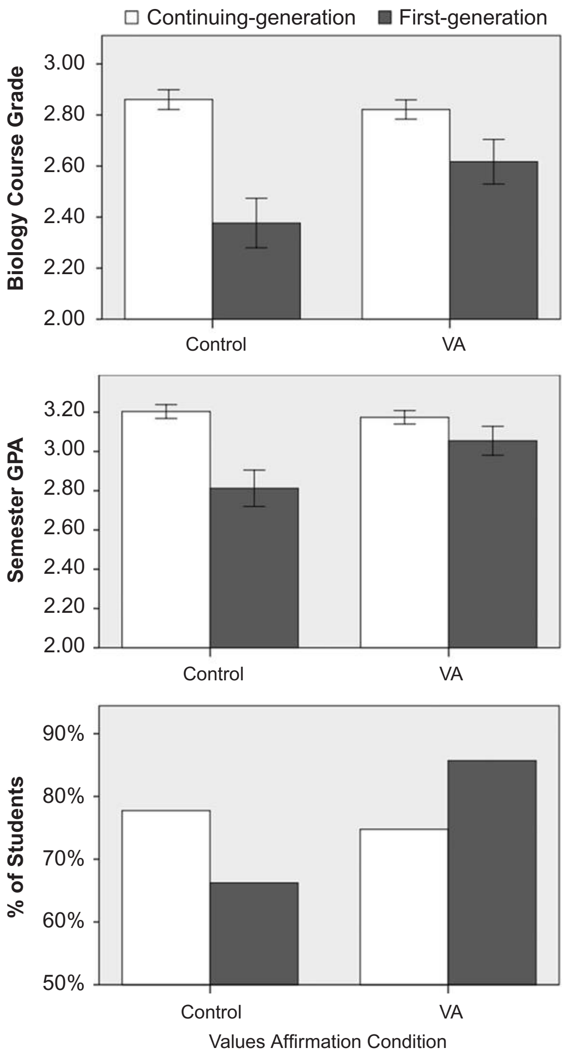

Fig. 2. Performance in the Biology Course, Semester GPA, and Percentage of University Students Who Enrolled in the Second Semester of Biology as a Function of Generational Status (Parents' Education) and Treatment Condition (Control vs. Values Affirmation).

Results for the academic performance measures (course grades and semester GPA) indicate that FG students in the values affirmation condition outperformed FG students in the control condition by an average of 0.24 grade points, resulting in a 50% reduction in the social-class achievement gap. Furthermore, whereas 85.7% of FG students in the values affirmation condition enrolled in the second half of the biology sequence, only 66.3% of the FG students in the control condition did so. These results suggest that the values affirmation intervention was powerful in promoting academic performance and continuing motivation in the class.

Process analyses based on the baseline and postintervention questionnaires revealed that FG and CG students did not differ in terms of confidence or concern about their background at the beginning of the course, but that FG students in the control condition became significantly more concerned about their background as the course progressed. In contrast, no such pattern existed for FG students in the treatment condition, suggesting that values affirmation offset these mounting concerns. Although the process measures were limited in this study, they do suggest that FG students have a different experience, and that values affirmation may work to make them feel more comfortable in the course.

To explore the experience of FG students in the introductory biology class, we also conducted a study of students in another section of the course. In addition to measuring students' concerns about their background for the course, we also examined whether students worried about "fitting in" more generally, and if students experienced discrepancies between their motives for attending college on the one hand, and university norms on the other (Stephens et al., 2012a). We administered a series of questionnaires to 772 students at the end of the semester (318 men, 454 women; 613 CG and 159 FG students). These included Sherman, Bunyan, Creswell, and Jaremka's (2009) measure of academic and social concerns (sample item: "In college I sometimes worry that people will dislike me"), Walton and Cohen's (2007) measure of belonging uncertainty, and level of belonging (sample item: "Sometimes I feel like I belong at University X, and sometimes I feel that I don't belong at University X"). We also constructed a measure of Academic Belonging ($\alpha = 0.78$; sample item: "I belong at University X"). In addition to these measures, we administered a shortened, 10-item version of Stephens and colleagues' (Stephens et al., 2012a) scale assessing students' motives for attending college. Half the items referred to independent motives reflecting traditional American university values (e.g., becoming an independent thinker), whereas the other half reflected interdependent motives more commonly associated with working-class values (e.g., giving back to my community, helping the family out after completing college).

Relative to CG students, FG students scored higher on the academic and social concerns scale as well as the belonging uncertainty measure (i.e., they were more concerned and uncertain about fitting in as college students) and significantly lower on our new Academic Belonging scale (i.e., they reported feeling less like they belonged in college). Consistent with Stephens and colleagues' (Stephens et al., 2012a) findings, FG students in our sample also reported significantly more interdependent motives and significantly fewer independent motives for attending college than their CG peers. Considered together, these findings suggest that FG students are more concerned about their status as college students, feel less like they belong in a college or university setting, and may experience a mismatch between their motives for attending college and university norms. These may all be contributing factors to the social-class achievement gap and could provide insight into how the values affirmation intervention was effective at promoting FG students' academic performance.

Future research should investigate the sources of FG students' belonging anxiety and examine whether and how it relates to the cultural mismatch that appears to undermine the performance of FG students. Does values affirmation somehow remedy the cultural mismatch (FG students' values of interdependence vs. college norms of independence) or alleviate the belonging concerns of FG students? If so, is it because it counteracts the effects of stereotype threat or is it because it gives FG students opportunities to discover a cultural match with university norms? Although the results of our randomized intervention study are promising, they have perhaps prompted as many questions as they have answered. Can values affirmation work to close social-class achievement gaps? Yes! Do we know exactly why that is? Partially. We now have a clearer picture of the psychological profile of FG students. We know that they may feel more out of place and less confident about their preparation. They value interdependence and connections to family more than CG students do. And they may feel that they are stereotyped as less academically capable. All of these are clues about what interventions will be most effective at retaining them in science.

Integrating interest theory, expectancy-value theory, and values affirmation theory may be productive in thinking about the retention of students in challenging university courses in mathematics and the sciences. In the case of the introductory biology course targeted in our intervention, it seems likely that both interest (e.g., "This is the topic that I find fascinating, and

I would like to study it in greater depth") and utility value (e.g., "I need this course to get into medical school") motivate students to enroll in the course. Researchers need to consider how, once students have enrolled in the course, we can keep them there, sustain their motivation, and motivate them to continue in the sequence of courses. Moreover, performance and motivation are closely intertwined. Enhancing the performance of FG students through values affirmation improved their retention in the second semester of the course. That is, final grade in the first semester of the course partially mediated the effect of the intervention on retention in the second semester of the course (Harackiewicz et al., 2014).

CONCLUSIONS

In this paper, we have reviewed a set of social psychological interventions designed to promote students' motivation and academic performance across an array of outcomes including interest, grades, choices of math and science courses, and persistence in science. These interventions, conducted both by us and by others, have in common a focus on values: utility value in some cases and core personal values in others. In addition, all are theory-based, rooted in expectancy-value theory, interest theory, self-affirmation theory, or cultural mismatch theory. Although these interventions may seem like "magic bullets" because they are so simple (Yeager & Walton, 2011), they are powerful because they focus on changing the mind-set of the students. As such, they can complement other educational interventions that focus on changing the learning environment (e.g., Deslauriers, Schelew, & Wieman, 2011; Haak, HilleRisLambers, Pitre, & Freeman, 2011). Progress in education may be maximized by considering both types of change. Moreover, utility-value and self-affirmation interventions are not mutually exclusive or antithetical to each other. In fact, used in combination, each might boost the effectiveness of the other. We are currently investigating this possibility.

One of the next challenges for researchers is scaling up these interventions so that they could be used, for example, in all biology classes in a school district or a large university. Our intervention in multiple sections of an introductory biology course at a large public university is a step in that direction, but there is much more to be done. Scaling up will require two components: (1) identification of the aspects of the intervention that are essential for it to be effective; and (2) identification of ways to maintain the fidelity of the intervention when it is implemented by multiple faculty who are not themselves researchers in social psychology (Hulleman & Cordray, 2009). For example, will values affirmation work if it is conducted using distance methods in which the writing assignment is emailed to students, they complete it, and deposit it in a course dropbox? Or does the exercise have to be administered in person in the classroom? Cohen, Purdie-Vaughns, and Garcia (2012) have argued that to be successful, a values-affirmation writing assignment must be seen by students as a course assignment coming from the instructor; it must be presented in class so that students see it as an integral part of the course (rather than being administered by outside researchers); and the students' writing must be confidential so that students can honestly write about their core values without worrying about their instructor seeing or judging their writing. In regard to utility-value interventions, must students write about the usefulness of course material for themselves, or is it equally effective if they have a choice to write about its usefulness to someone they know? And for either values affirmation or utility-value interventions, how many times across a semester should the exercise be repeated for maximum effectiveness?

Certainly, there have been occasional failures to replicate the effects of some of these interventions (Aronson & Dee, 2012), and it is important to monitor these failures and learn from them. We believe that many of these failures to replicate may be due to imprecise implementation of the intervention. Yet precise implementation will depend on the identification of the essential elements of the intervention, and this will require further research along the lines discussed.

Our review of interventions designed to close racial achievement gaps and interventions designed to close social-class achievement gaps raises additional questions: To what extent are racial achievement gaps actually social-class achievements gaps? And, depending on the answer to that question, can one or another intervention be more effective? For example, racial stereotypes may be more salient in academia than social-class stereotypes, creating stereotype threat for ethnic minority students, which can be counteracted by values affirmation. If social-class achievement gaps are rooted more in growing up with parents with less education, utility-value interventions with families may be most effective. In what situations might these two types of interventions be combined?

In this paper, we have emphasized a developmental approach. This approach raises an important question: At what age(s) are these interventions best implemented? For example, should we administer values affirmation interventions with first-grade girls in math class? Much of the existing thinking about developmental issues has been rooted in career development theories and research on the ages at which people make crucial decisions about future careers. For example, social cognitive career theory, which emphasizes self-efficacy, is widely applied (Lent, Brown, & Hackett, 1994). Research based in this approach finds that the first two semesters of college are especially important for career outcomes (Brown et al., 2008).

An alternative would be to consider children's cognitive development and the ages at which they develop cognitions such as a stable sense of self-efficacy or of the usefulness of material they are studying in school. Exemplifying this developmental approach, Aronson and Good (2003) have argued that, for math stereotype threat to occur in girls, they must (1) be aware of the content of gender stereotypes, (2) understand both the personal and societal implications of gender stereotypes, (3) have a well-developed concept of gender identity, and (4) have a firm concept of academic ability. Aronson and Good concluded that all of these are present by about age 11–12, that is, at the beginning of middle school. Clearly more research is needed on the ages at which youth acquire the multiple concepts that hinder achievement. Specific interventions can then be targeted to the most appropriate ages.

The developmental approach also highlights the importance of the sources of the stereotypes that contribute to stereotype threat and ideas that certain careers are inappropriate for one gender or one ethnic group. Although we have emphasized the idea that parents are an untapped resource for enhancing students' understanding of the utility value of mathematics and science courses, it is also true that teachers and parents are a major influence on the development of gender stereotypes about math (reviewed by Gunderson, Ramirez, Levine, & Beilock, 2012). This line of research leads to interventions not with students, but instead with parents and teachers.

Although these interventions are exciting for their broad applicability in improving students' academic choices and performance, they are also exciting in regard to their potential for contributions to basic science. The combination of laboratory experiments and field experiments is advancing our understanding of motivational principles and almost certainly will continue to do so. At the same time, interventions may benefit from becoming increasingly targeted at specific motivational processes that are effective with particular groups or in particular contexts.

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