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Making Connections: Replicating and Extending the Utility Value Intervention in the Classroom

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We replicated and extended prior research investigating a theoretically guided intervention based on expectancy-value theory designed to enhance student learning outcomes (e.g., Hulleman & Harackiewicz, 2009). First, we replicated prior work by demonstrating that the utility value intervention, which manipulated whether students made connections between the course material and their lives, increased both interest and performance of low-performing students in a college general education course. Second, we extended prior research by both measuring and manipulating one possible pathway of intervention effects: the frequency with which students make connections between the material and their lives. In Study 1, we measured connection frequency and found that making more connections was positively related to expecting to do well in the course, valuing the course material, and continuing interest. In Study 2, we manipulated connection frequency by developing an enhanced utility value intervention designed to increase the frequency with which students made connections. The results indicated that students randomly assigned to either utility value intervention, compared with the control condition, subsequently became more confident that they could learn the material, which led to increased course performance. The utility value interventions were particularly effective for the lowest-performing students. Compared with those in the control condition who showed a steady decline in performance across the semester, low-performing male students randomly assigned to the utility value conditions increased their performance across the semester. The difference between the utility value and control conditions for low-performing male students was strongest on the final exam ($d = .76$).

Keywords: academic motivation, educational intervention, expectancy-value motivation, gender, utility value

Supplemental materials: <http://dx.doi.org/10.1037/edu0000146.supp>

Optimizing student motivation and learning in the classroom is a goal shared by most educators. However, there is no consensus on the best methods. Rewarding students for classroom behavior or performance, or threatening punishment, are strategies conventionally believed to increase motivation and engagement (Ash, 2008; Kohn, 1999; Newby, 1991). Such strategies presume that learning tasks are not inherently rewarding and, therefore, extrinsic reasons

for task engagement must be introduced. In contrast, tapping into more intrinsic sources of motivation (Ames, 1992), such as fostering individual interest in specific topics (Hidi & Renninger, 2006), self-determined motivation (Deci & Ryan, 1985), and self-directed task involvement (Csikszentmihalyi, 1990), are strategies more likely to be recommended by educational psychologists (Boekaerts, 2002). By focusing on student perceptions and beliefs about the value of the learning activity, contemporary models of expectancy-value motivation highlight this more intrinsic source of motivation (e.g., Brophy, 1999; Eccles et al., 1983). Although the research generated by the expectancy-value framework has been largely correlational (Wigfield & Cambria, 2010), recent classroom studies reveal that interventions designed to enhance perceptions of value can increase both interest and course performance (e.g., Hulleman & Harackiewicz, 2009; Hulleman, Godes, Hendricks, & Harackiewicz, 2010). The research presented herein replicates and extends this prior work by further investigating a theory-based intervention designed to enhance student motivation and performance.

The Expectancy-Value Framework

Originally adapted from classic models of expectancy-value motivation (e.g., Atkinson, 1957; Vroom, 1964), Eccles and her colleagues (1983) proposed that motivation in educational contexts

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is determined most proximally by an individual's expectancy beliefs and subjective task values. Expectancy beliefs are defined as the belief that one can succeed at an activity, and have been correlated with achievement outcomes and achievement choices, such as continued persistence and course taking (for reviews see Richardson, Abraham, & Bond, 2012; Robbins et al., 2004). Subjective task values are defined as the perceived importance of a task or activity, and four facets were originally proposed by Eccles and colleagues (1983): intrinsic (enjoyment), utility (usefulness for proximal or distal goals), attainment (importance for one's sense of self), and cost (psychological barriers to, and negative consequences of, task engagement). A wealth of prior research has demonstrated that task values are positively correlated with continued persistence and ongoing motivation in an activity (for reviews see Wigfield & Cambria, 2010), except cost which is negatively related (e.g., Conley, 2012; Flake, Barron, Hulleman, McCoach, & Welsh, 2015). Consistent with more recent conceptualizations of the expectancy-value framework (e.g., Barron & Hulleman, 2015), we consider cost to be a unique construct independent of expectancy and value.

In particular, students' perceptions of utility value have been associated with achievement outcomes in longitudinal field studies (e.g., Bong, 2001; Durik, Vida, & Eccles, 2006; Hulleman et al., 2008). Originally defined as "the value a task acquires because it is instrumental in reaching a variety of long- and short-range goals (Eccles & Wigfield, 1995, p. 216)," measures of utility value have captured the relationship between students' current (e.g., classes, hobbies) and future goals (e.g., college major, career). For example, one of the original scales measuring utility value (1995) included items that tapped students' future plans ("How useful is learning advanced high school math for what you want to do after graduation?") and current goals ("How useful is what you learn in advanced high school math for your daily life outside school?"). Recent measures of utility value have mirrored this connection to both current and future goals (e.g., Hulleman et al., 2008). Furthermore, because some goals are more personally important than others, utility value has been conceptualized as having elements of both intrinsic and extrinsic motivation (Hulleman et al., 2008; Simons, Vansteenkiste, Lens, & Lacante, 2004).

Despite extensive correlational support, limited research has tested the effectiveness of interventions based on expectancy-value models. Our review of the current literature revealed only a handful of published papers investigating interventions based on the expectancy-value framework in an educational context, all focused on utility value (Acee & Weinstein, 2010; Brown, Smith, Thoman, Allen, & Muragishi, 2015; Harackiewicz, Canning, Tibbetts, Prinski, & Hyde, 2015; Harackiewicz, Rozek, Hulleman, & Hyde, 2012; Hulleman & Harackiewicz, 2009; Hulleman et al., 2010; Johnson & Sinatra, 2013). To provide stronger claims about both internal and external validity, three of the studies were conducted as double-blind, randomized classroom experiments (Harackiewicz et al., 2015; Hulleman & Harackiewicz, 2009; Hulleman et al., 2010, Study 2). Hulleman and colleagues evaluated a utility value intervention that encouraged students to discover the relevance of the material they were studying to their lives. Utility value was manipulated through a writing prompt given to high school science (Hulleman & Harackiewicz, 2009) and college psychology (Hulleman et al., 2010) students as part of their regularly assigned coursework. Students were randomly assigned to

either write about the relevance and usefulness of the course material in their own lives (relevance condition) or a summary of the material they were currently studying (control condition). In the high school sample, students completed writing assignments every three to four weeks of a 20-week semester. Students averaged about five essays throughout the semester. In the college sample, students were given writing assignments in the 8th and 12th weeks of a 15-week semester. The key dependent variables in both studies were end-of-semester interest in the course topic and course grades. The researchers provided teachers with information regarding whether students had completed the essays, but teachers were blind to condition throughout the semester. Because students wrote about course-related topics in both the relevance and control conditions, knowledge activation was controlled (i.e., summarization; see Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). The conditions thereby differed only in terms of the activation of utility value.

In these studies, the results indicated that the intervention was more effective for students with lower perceived or actual competence. In college psychology, students who performed more poorly on initial course exams were more interested in the course if they were in the relevance condition than the control condition. In high school science, the interaction effect was replicated on both science interest and grades for students who entered the course with lower performance expectations. In fact, the effect on end-of-semester GPA for students with low performance expectations resulted in an increase in .80 GPA points. In both studies, the intervention increased students' perceptions of utility value, and these increased perceptions led to improved performance and interest. Furthermore, this pattern of intervention effectiveness was also replicated with (a) undergraduate students who learned a mental math technique in the laboratory (Hulleman et al., 2010, Study 1), (b) first-generation college students enrolled in introductory science classes (Harackiewicz et al., 2015), and (c) high school students whose parents received an intervention on how to talk to their teenager about the value of math and science coursework (Rozek, Hyde, Svoboda, Hulleman, & Harackiewicz, 2015).

Learning Why the Utility Value Intervention Works

Together, these initial studies demonstrated that interventions designed to increase subjective task value subsequently increased interest and performance. However, these studies also demonstrated that the intervention effects were not the same for everyone (for reviews see Durik, Hulleman, & Harackiewicz, 2015; Harackiewicz, Tibbetts, Canning, & Hyde, 2014). Given these intervention effects, we sought to understand what might explain the underlying mechanisms, as well as develop future interventions that might work for all students regardless of their success expectancies and performance history.

Although Hulleman and colleagues (2009, 2010; Harackiewicz et al., 2015) have generally used relevance and utility value interchangeably in describing their intervention, there is a potentially important distinction to be made. Whereas utility value refers to usefulness to a proximal or distal goal, *relevance* simply refers to the presence of a relationship between one topic or idea and another topic or idea, which could include a goal but also includes a broader set of relationships (Kosovich & Hulleman, 2016). For example, math could be useful because it will help me in a future

job (*utility value*), or it could relate to my life because store cashiers need it even if I do not (*relevance*). Because the utility value intervention is one type of relevance intervention, one possible mechanism for utility value intervention effects is that encouraging students to find a connection allows them to notice relationships that they previously had not. Seeing such connections may allow individuals to view new information from a different perspective, and develop a more in-depth integration of their knowledge (Bransford & Schwartz, 1999). In addition, simply referencing the self when learning new material can lead to learning gains (e.g., Barney, 2007; for a review see Symons & Johnson, 1997). Consistent with this hypothesis is the finding that instructing individuals to find connections between learning situations can increase the likelihood of adapting a skill from one situation to another (i.e., cognitive transfer; Burke & Hutchins, 2007; Gentner, Loewenstein, & Thompson, 2003; Gick & Holyoak, 1980). As hypothesized in the early work of learning theorists (e.g., Thorndike & Woodworth, 1901), making a connection may enhance learning by instigating a set of processes that engenders a different approach to studying that may increase learning. For example, if a student finds a personal connection during a psychology lecture, the student may be more interested in the assigned reading and to discuss the material with friends. In general, the student may be more motivated to actively process the material during lecture and later when reading the book. Establishing relationships between new knowledge and old ideas may create a richer cognitive architecture which the student can draw upon when studying. As a result, students who make more connections between course material and existing knowledge may be more likely to find usefulness in the course, which may enhance motivation.

What is the best way to investigate the frequency of connections as a key pathway through which the utility value intervention impacts outcomes? One approach is to measure the proposed mechanism and conduct path analyses (e.g., Hulleman et al., 2010). This approach is appealing because it is relatively simple and falls within the range of most statistical packages (e.g., Tofighi & MacKinnon, 2011). The limitation of this approach is that it is correlational, and it does not account for other key variables that may explain the effects of the intervention but have not been measured. In contrast, the second approach, which is far less common but more powerful, is to manipulate the mechanism (see Baron & Kenny, 1986; Sigall & Mills, 1998). This approach allows the researcher to randomly assign participants to different levels of the variable to establish a cause-and-effect relationship. The con to this approach, which is inherent to all intervention studies, is that the effect of a manipulated variable may not be the same as the effect of the measured variable (cf. Barron & Harackiewicz, 2001). Rather than choosing one method, both approaches to enhancing learning outcomes will be investigated in this paper.

Interest as an Educational Outcome

Academic performance is a widely accepted educational outcome and grades play a pivotal role in a student's long-term educational opportunities. A less-acknowledged but equally important outcome is interest (Hidi & Harackiewicz, 2000; Hulleman et al., 2008). In a longitudinal study, Harackiewicz, Barron, Tauer, and Elliot (2002) found that interest predicted course choice and

college major selection over six years, whereas prior performance and college GPA did not. Interest can be thought of as two different types (Hidi & Renninger, 2006). *Situational interest* is the experience of engagement or attention during a task (Schraw & Lehman, 2001). *Individual interest* is an enduring proclivity for the task or behavior (Renninger & Wozniak, 1985). In the current study, we focused on situational interest because it is a precursor for the development of individual interest (Hidi & Renninger, 2006), which predicts long-term academic and career choices (e.g., Peters & Daly, 2013; Pike & Dunne, 2011), and is heavily influenced by the learning context and therefore amenable to change via short-term interventions (e.g., Durik & Harackiewicz, 2007; Hulleman et al., 2010).

Current Studies

In Study 1, students' perceptions of how often they connected the material to their lives was measured and used to predict student learning outcomes over the course of a semester. In Study 2, connection frequency was manipulated through an experimental intervention delivered as part of course embedded assignments. Although we hypothesized that both measured and manipulated connection frequencies will have similar effects on learning outcomes, it is possible that measured and manipulated variables capture different aspects of the same phenomena. Thus, it is crucial to examine both types of effects when investigating the role of connection frequency.

The utility value interventions utilized in the current studies were based on the self-generated utility value interventions used by Hulleman and colleagues (e.g., Hulleman et al., 2010; Hulleman & Harackiewicz, 2009). In addition to replicating this prior research, we extend it in five ways. First, we used an online course management system to deliver the intervention, instead of paper-and-pencil writing assignments used in prior studies, which was seamlessly embedded within the course as a regular course assignment. Second, we tested the mechanism of the utility value intervention by measuring the self-reported frequency with which students made connections between the material and their lives throughout the semester (e.g., connection frequency). Third, we further examined the mechanism of the utility value intervention by manipulating one hypothesized mechanism—connection frequency. Fourth, we examined the effects of the intervention on students' expectancies and perceived costs in the course. The theoretical model hypothesizes that the utility value intervention effects are driven through increased perceptions of value, particularly utility value. However, it is also possible that writing about the relevance of course material could increase students' expectancies that they can learn the material and perform well in the course, or decrease their perceived cost for learning. Fifth, because prior research found differential intervention effects based on key demographics, such as gender and initial performance, we also examined whether the intervention was more effective for students at-risk for poor performance. In the case of a college general education course, students who initially perform poorly in the course are most at-risk, as are male students (Voyer & Voyer, 2014).

Study Samples

The samples for both studies in this paper came from students who were enrolled in two sections of a 15-week introductory psychology course at a midsized university in the southeastern United States. Both sections were taught by the same instructor. Of the 589 students who were enrolled in the course, 501 students (85%) completed the initial consent form and were eligible to participate in our research. Of these students, 113 were randomly selected to participate in Study 1 and 388 were randomly selected for Study 2.

Study 1: A Longitudinal, Correlational Investigation

In Study 1, we explored a potential pathway for utility value effects found in prior research. Specifically, we developed a new measure that asked students to report on the frequency with which they made connections between the material and their lives while listening to lectures, studying for exams, and socializing with friends. As a method for providing initial validity evidence for both the idea and the measure, we examined whether students' self-reports of connection frequency provided a pathway through which utility value was related to student learning outcomes during a semester-long undergraduate psychology course.

Method

Participants. Of 113 eligible introductory psychology students, the final sample included 97 students who were over the age of 18 and participated in the surveys. Students received extra credit in the course for completing both surveys. The sample was 70% female, 84% white (4% African American, 4% Asian), 86% non-psychology majors, and 55% freshman (28% sophomore, 12% junior, 3% senior). The mean age of participants was 18.7 years.

Self-reports of expectancy-value-cost motivation. Students completed self-report surveys at three time points during the semester: Time 1 measures were taken during the 2nd week, Time

2 measures were taken during the 8th week, and Time 3 measures were taken during the 14th week of the semester. Measures of expectancy, utility value, and cost were collected at Time 1 and 3, and have been previously validated with students in middle school (Kosovich, Hulleman, Barron, & Getty, 2015), high school (Hulleman & Harackiewicz, 2009), and college (Grays, 2013; Hulleman et al., 2008). Expectancy was measured using a 4-item scale (e.g., "I expect to do well in this class," $\alpha = .92$ and $.93$). Utility Value was measured using a 6-item scale (e.g., "I can apply what we're learning in this class to the real world," "The course material is relevant to my future career plans," $\alpha = .93$ and $.92$). Cost was measured using a 6-item scale (e.g., "Doing well in this class isn't worth all the things that I have to give up," $\alpha = .81$ and $.87$). All self-report items used an 8-point Likert-type scale that ranged from 1 (*completely disagree*) to 8 (*completely agree*; see Appendix A in the Supplemental Online Material for complete list of items, and Table 1 for descriptive information including reliabilities).

Connection frequency. To capture the number of connections between students' lives and the course material, a 3-item measure of connection frequency was included at Time 2, just after the second course exam (e.g., "When reading a chapter from the textbook/During a regular class period or lecture/When studying for quizzes and exams, how often do you connect the class material to your life?"; $\alpha = .87$). These items used a 6-point Likert-type scale ranging from 1 (*never*) to 6 (*all of the time*).

Learning outcomes. Two major learning outcomes were collected: academic performance and interest in the course. Students' academic performance was measured using class exam scores. There were 4 noncumulative exams, each covering four chapters in the textbook, and administered during the 4th, 8th, 12th, and 16th weeks of the course. There were 80 multiple-choice questions on the first three exams, and 100 multiple-choice questions on the fourth and final exam. Each question was worth one point. Students completed the exams using Scantron answer sheets and the exams were machine-scored. The grades were never curved and the grading scale was: 90% to 100% A, 80% to 89% B, 70% to

Table 1
Descriptive Statistics for Major Variables in Study 1

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Time 1 interest											
2. Time 1 expectancy	.34										
3. Time 1 utility value	.79	.31									
4. Time 1 cost	-.37	-.20	-.30								
5. Initial exam	.00	.23	.04	-.12							
6. Time 2 connections	.33	.33	.25	-.14	.14						
7. Time 3 interest	.75	.34	.62	-.35	.11	.46					
8. Time 3 expectancy	.33	.60	.32	-.39	.50	.34	.54				
9. Time 3 utility value	.61	.32	.69	-.29	.06	.41	.77	.45			
10. Time 3 cost	-.33	-.13	-.18	.66	-.19	-.30	-.37	-.50	-.29		
11. Final exam	.01	.06	.13	.08	.60	.05	.03	.27	.02	.02	
12. Female	.19	-.03	.18	-.07	.10	-.01	.16	.08	.21	-.08	.20
Observed min.	3.00	4.50	2.33	1.83	31.00	2.00	3.33	4.00	2.00	1.67	35.00
Observed max.	8.00	8.00	8.00	6.00	75.00	6.00	8.00	8.00	8.00	8.00	98.00
Mean	6.00	6.50	6.09	3.60	63.16	3.88	6.14	6.48	6.01	3.96	81.85
SD	1.08	.86	1.11	.93	7.19	.91	1.19	.97	1.15	1.23	9.28
α	.92	.92	.93	.81	.83	.87	.92	.93	.92	.87	.87

Note. $N = 97$. Female is a dummy-coded variable: 0 = male, 1 = female. Correlations greater than |.20| are significant at $p < .05$. Correlations greater than |.29| are significant at $p < .01$.

79% C, 60% to 69% D, and below 60% F. Point biserial information for each test revealed no bad questions. Further information regarding the exams can be obtained from the authors upon request.

In addition to performance, we also collected a measure of students' interest in the course material using a 9-item scale (e.g., "I think the field of psychology is very interesting," "I really enjoy this class," "I plan on taking more courses in psychology," $\alpha = .92$ and $.92$). This measure of interest has been used in prior research (Harackiewicz, Durik, Barron, Linnenbrink-Garcia, & Tauer, 2008; Hulleman et al., 2010), and is designed to capture students' emerging interest in psychology (Renninger & Hidi, 2011). Although this measure of interest was collected at the same time as the Time 3 measures of motivation, we used interest as an outcome in our analyses because, conceptually, interest is one of our key academic outcomes. Theoretical models of interest development (e.g., Hidi & Renninger, 2006) and empirical research (Harackiewicz et al., 2008) demonstrate that perceptions of competence and value are key antecedents of interest.

Procedure. The Time 1 survey was administered via an online survey during the second week of the semester. Students had a week to complete the survey, which included all Time 1 motivation items. During the 4th week of the semester, students took the first exam. During the 8th week of the semester, students completed the connection-frequency items (Time 2). During the 14th week of the semester, participants completed the Time 3 measures. In the 16th week, participants completed the final exam. Students earned course credit for completed surveys.

Results

Descriptive analyses. Our primary research question was whether the newly developed measure of connection frequency was related to self-reports of student motivation and course outcomes. Our hypothesis was that greater endorsement of the connection frequency items would be related to end-of-semester motivation, interest, and exam scores. Further, we examined whether connection frequency during midsemester provided an indirect pathway between initial motivation and final course outcomes.

The measure of connection frequency was normally distributed (skewness = $-.11$; kurtosis = $.43$), and the overall scale mean was just above the scale midpoint of 3.5 ($M = 3.9$ out of 6), which reflects making connections between 'sometimes' and 'often.' And 95% of the scores fell between 2.33 and 5.33 (see Figure S1). When inspecting the zero-order correlations (see Table 1), students' Time 2 self-reports of the frequency with which they connected the course material with their lives was moderately and positively correlated with Time 3 utility value ($r = .41$), expectancy ($r = .34$), and interest ($r = .46$), and negatively correlated with cost ($r = -.30$). Connection frequency was unrelated to final exam scores ($r = .05$). Thus, the measure of connection frequency is correlated in ways we would expect with other self-reported motivation variables, and had a sufficiently normal distribution and variance to warrant continuing to explore its role in the development of motivation during the semester.

Regression analyses. While the pattern of correlations provided preliminary evidence that connection frequency may contribute to learning outcomes, we ran a series of OLS regressions to investigate the unique pattern of relationships between Time 2

connection frequency and Time 3 outcomes, controlling for Time 1 covariates (measures of motivation, interest, exam 1 score, and gender). As shown in Table S1, connection frequency was a unique and significant predictor of utility value ($\beta = .25$, $sr^2 = .05$), cost ($\beta = -.21$, $sr^2 = .04$), and Time 3 interest ($\beta = .22$, $sr^2 = .04$). However, connection frequency was not a significant predictor of Time 3 expectancy or final exam score. We next tested whether Time 2 connection frequency served as an indirect pathway (ω) through which initial motivation could be related to course outcomes. Using the method outlined by Tofighi and MacKinnon (2011), we first regressed Time 2 connection frequency on the Time 1 covariates and found that Time 1 expectancy was the only significant predictor ($\beta = .24$, $sr^2 = .11$). Next, we utilized the prior regression equations to determine that Time 2 connection frequency served as an indirect pathway for Time 1 expectancy to contribute to changes in Time 3 utility value ($\omega = .08$, 95% CI [0.001, 0.20]), cost ($\omega = -.07$, 95% CI [-0.15 , -0.01]), and Time 3 interest ($\omega = .08$, 95% CI [0.001, 0.19]). Finally, we examined whether connection frequency contributed to learning outcomes through its relationships with Time 3 motivation. This path model is displayed in Figure 1, and revealed that the relationship between connection frequency and interest could be explained by the increases in Time 3 utility value ($\omega = .15$, 95% CI [0.043, 0.287]).

Study 1 Discussion

Study 1 demonstrated initial validity evidence for our measure of the frequency with which students made connections between the course material and their lives. The measure was normally distributed, correlated with other self-reported motivation variables as expected, and contributed to students' motivation and learning outcomes. Consistent with this hypothesis, our measure of connection frequency was uniquely related to increases in expectancy, utility value, and interest, and decreases in cost, when controlling for prior measures of those variables. In addition, we found that connection frequency led to increased interest in psychology by increasing students' perceived utility value in the course. Although connection frequency did not operate as an indirect pathway between utility value and outcomes, as we had hypothesized, it did provide an indirect pathway between initial expectancy and outcomes. As a result, in Study 2 we examined whether the utility value intervention operates through success expectancies.

We also found in Study 1 that women outperformed men in the course. This replicates an emerging finding that women earn higher grades in school than men (e.g., Duckworth & Seligman, 2006; Voyer & Voyer, 2014). Our prior classroom-based intervention research demonstrates that the utility value intervention works better for low-performing students (Hulleman et al., 2010). Other interventions designed to promote perceptions of utility value for math and science found that the intervention differed depending upon students' gender and school performance (Rozek et al., 2015). These three findings set up the need to examine whether the intervention works differently for students based on demographics associated with being at-risk for poor performance (e.g., gender, initial performance levels), and experimental condition. We tested this possibility in Study 2.

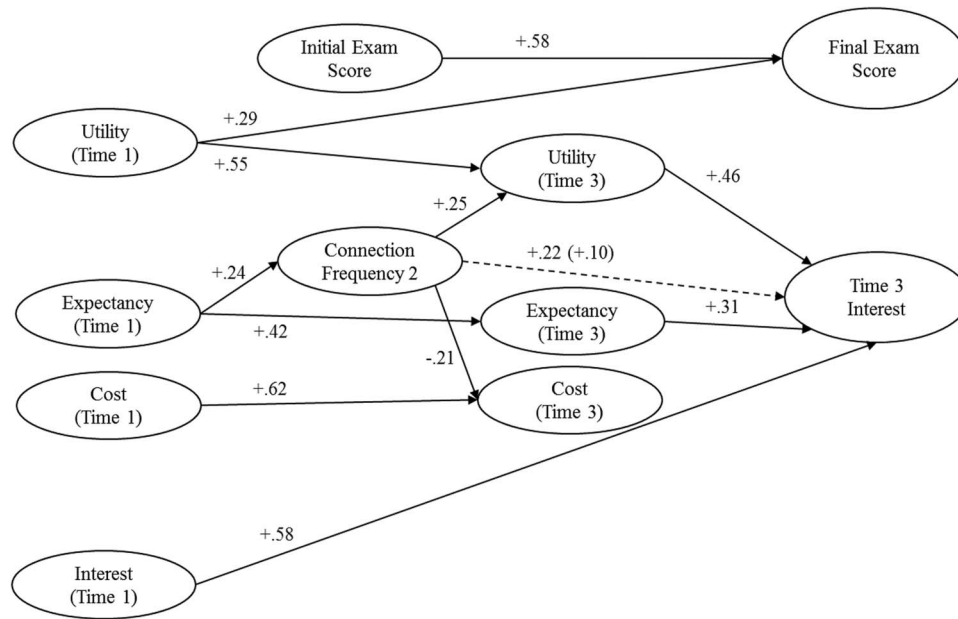


Figure 1. Path model of the relationships between connection frequency and learning outcomes in Study 1. $N = 97$. Values are standardized OLS regression coefficients that were statistically significant ($p < .05$). Only significant paths are shown. Regression equations also controlled for gender (see Table S1 and text for details). The direct effect of connection frequency on Time 3 Interest ($\beta = .22, p < .01$) was reduced to nonsignificant ($\beta = .10, p = .11$) when the Time 3 motivation measures were included in the model.

Study 2: A Longitudinal, Experimental Investigation

In Study 2, we conducted a double-blind, randomized classroom experiment that manipulated connection frequency by designing an enhanced utility value intervention that encouraged students to make more frequent connections between the course material and their lives. The goal of this enhanced utility value intervention was to increase the strength of the original utility value intervention by adding a new element. Although we hypothesized that connection frequency operated in the original utility value intervention, we wondered whether spontaneous connections may be uncommon or difficult to make (Bransford & Schwartz, 1999). We therefore utilized a related line of research on implementation intentions (e.g., Gollwitzer, 1999; Gollwitzer & Brandstatter, 1997), with the goal of increasing the connections students make between the material and their lives outside of the intervention.

When an individual forms an implementation intention, he or she specifies the when, where, and how an intended behavior will occur to promote goal attainment (Gollwitzer, 1999). The setting of these intentions provides a salient anchor for when a specific behavior should occur. In a study by Gollwitzer and Brandstatter (1997), participants were randomly assigned to either adopt implementation intentions for the completion of a self-reflection essay assigned over winter break, or were simply given the goal of turning in the essay. Students in the implementation intention condition were far more likely to complete the essay on time, and in less time, than a group of participants who were just given the goal to complete the essay.

We integrated the implementation intentions framework into the design of our enhanced utility value intervention. The enhanced condition included an opportunity for students to set implementa-

tion intentions to make connections between their lives and the course material on a routine basis during the semester (e.g., in class, while studying, when socializing). By adopting implementation intentions to make connections between the course material and their lives, we hypothesize that students will be more likely to actively seek connections in the specific situations that they identify. An increase in connections should promote deeper processing and engagement in learning, which in turn should enhance utility value, interest, and course performance. Because spontaneous connection-seeking does not always happen (Gentner et al., 2003), setting implementation intentions may nudge individuals toward this behavior.

Finally, we endeavored to make the interventions as easy to implement as possible. Both utility value interventions were designed so that they could be delivered via an online course management system used by the instructor and students. This allowed us, as researchers, to keep the instructor blind to students' experimental condition, and enabled students to participate in the intervention by using a familiar system. Although there was considerable set-up of the intervention required by the researchers, including randomizing of groups, the delivery of such an intervention to an entire class by a single instructor was done via an assignment through the online course management system. This approach is one solution for testing and scaling up psychological interventions in classrooms (Harackiewicz & Borman, 2014; Paunesku et al., 2015).

Method

Participants. Students in Study 2 were part of a separate subsample of students enrolled in the same two sections of intro-

ductory psychology used in Study 1. Of the original 589 students enrolled in the two sections, 388 were randomly selected to participate in Study 2. The final sample included 357 students who were over the age of 18, completed the final exam, and participated in the interventions. Similar to Study 1, the Study 2 sample was 70% female, 84% white (6% African American, 4% Asian), 84% nonpsychology majors, and 61% freshman (21% sophomore, 13% junior, 4% senior). The mean age of participants was 18.6 years.

Measures. All self-report and performance measures were identical to Study 1. Descriptive information on the scales, including reliabilities, can be found in Table 2.

Procedure. The procedures were nearly identical to Study 1, with two exceptions. First, the intervention prompts were delivered after the first and second exams. Second, instead of being measured at Time 2 (after the second exam), connection frequency was measured at the same time as the other motivation measures: Time 1 was the 2nd week of the semester and Time 3 was the 14th week. This allowed us to examine whether the intervention worked by increasing the frequency with which students connected the material to their lives. As in Study 1, students received course credit for completing the surveys and intervention prompts. Importantly, neither the instructor nor teaching assistants knew the specific content of the intervention, nor which students were assigned to which condition.

Intervention #1. Following the first exam, students were reminded in class to participate in the first intervention assignment and were given three days from the time that the links were available to complete the activity. Students then received web links to the intervention via email. The links were also posted in students' respective online group pages by the researchers. Upon clicking the web-link, participants were randomly assigned to one of three conditions: the control condition, the utility value condition, or the enhanced utility value condition. Thus, both the instructor and students were kept blinded to which students were in which conditions.

In the control condition ($n = 119$), participants received the following prompt: "Below is a list of the units covered in GPSYC 101 so far. For each topic, summarize what you know in about 1 or 2 sentences. We are not asking you to elaborate on the material, just to summarize the information that you can recall." Underneath the prompt were four text boxes labeled for each class unit (i.e., History, Careers, & Connections; Research; Biology & Behavior; and Memory).

Both the utility value ($n = 116$) and enhanced utility value ($n = 122$) conditions received the following prompt:

In the space below, we would like you to write 1 to 2 paragraphs about how the material that you have been studying in GPSYC 101 relates to your life. We are not asking you to summarize the material, just to elaborate on its relevance to your life. So far, you have covered the following units in your class: History, Careers, & Connections; Research; Biology & Behavior; and Memory.

Below the prompt was a text-box for participants to type their short essays. This prompt was adapted from Hulleman and colleagues prior intervention prompts (Hulleman et al., 2010; Hulleman & Harackiewicz, 2009).

In addition, enhanced utility value participants were then sent to a new page featuring three additional prompts (see Appendix B in the Supplemental Online Material). The first prompt asked participants to identify the time and place where they might be able to think about the relevance of class material to their own lives. The second prompt asked participants to identify obstacles that might prevent finding the relevance of class material. The third prompt asked participants to identify strategies to overcome the obstacles identified in the second prompt.

Intervention #2. Following the 2nd exam, students in the control condition were given a pair of prompts in succession: "Choose one of the specific topics from above. In 1 to 2 paragraphs (75 to 125 words), summarize the details of the topic as best you can."

Table 2
Descriptive Statistics for Major Variables in Study 2

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Time 1 expectancy												
2. Time 1 utility value	.27											
3. Time 1 cost	-.38	-.36										
4. Time 1 connections	.30	.50	-.26									
5. Time 1 interest	.27	.79	-.38	.44								
6. Initial exam	.11	.01	-.05	.00	.03							
7. Time 3 expectancy	.40	.20	-.26	.16	.24	.34						
8. Time 3 utility value	.18	.67	-.33	.30	.65	.06	.43					
9. Time 3 cost	-.17	-.33	.54	-.15	-.42	-.27	-.42	-.44				
10. Time 3 connections	.19	.38	-.27	.47	.39	.10	.34	.51	-.34			
11. Time 3 interest	.07	.62	-.32	.30	.78	.10	.33	.75	-.50	.49		
12. Final exam	.09	.06	-.10	.00	.08	.63	.40	.11	-.31	.15	.13	
13. Female	.08	.33	-.19	.17	.33	.07	.12	.28	-.30	.21	.33	.12
Observed min.	4.75	2.17	1.67	1.00	1.44	35.00	1.50	1.00	1.83	1.50	1.67	39.00
Observed max.	8.00	8.00	7.00	6.00	8.00	76.00	8.00	8.00	8.00	6.00	6.00	100.00
Mean	6.46	6.12	3.52	3.77	6.11	61.62	6.34	6.47	5.97	3.99	3.99	79.48
SD	.81	1.07	.87	.84	1.14	7.15	1.01	1.08	1.13	.88	.88	9.40
α	.90	.92	.80	.88	.93	—	.93	.93	.86	.89	.93	—

Note. $N = 357$. Female is a dummy-coded variable: 0 = male, 1 = female. Correlations greater than |.10| are significant at $p < .05$. Correlations greater than |.15| are significant at $p < .01$.

Participants in the utility value and enhanced utility value conditions were given a pair of prompts about relevance: (a) “Choose a topic from above that is personally useful and meaningful to you. In 1 to 2 paragraphs (75 to 125 words), describe how learning about this topic is useful *to your life right now*” and, (b)

Choose a topic from above that is personally useful and meaningful to you (it may be the same topic as before). In 1 to 2 paragraphs (75 to 125 words), describe how learning about this topic will be beneficial *to you in the future* (e.g., education, career, daily life).

Enhanced utility value participants were also given several items prompting reflection on their implementation intentions (see Appendix B in the Supplemental Online Materials). The reflection items asked students to recall what implementation intentions they had discussed in the previous intervention and to reflect on ways they could improve their strategies.

Results

Analytic plan. Our primary research question involved examining whether the intervention conditions would promote learning outcomes compared with the control condition (see Primary analyses). Our main hypothesis was that the utility value interventions would promote interest and achievement at the end of the semester compared with the control condition. We also hypothesized that the enhanced utility value condition would have an additional effect above and beyond the utility value condition. This first set of questions led us to conduct intent-to-treat, OLS regression analyses on the outcomes (interest, exam scores) as a function of the experimental conditions using hierarchical multiple regression. Second, we tested whether the intervention was more effective for students most at-risk for poor performance (see At-risk student analyses). This involved adding interaction terms between initial exam scores, gender, and the experimental conditions to the OLS regression models used in the primary analyses. Third, we tested whether the effects of the utility value interventions could be explained, at least partially, by increased motivation (i.e., expectancy, utility value, cost) and connection frequency. This would demonstrate that both motivation and connection frequency were indirect pathways through which the intervention impacted outcomes. This question was examined using path modeling and indirect effects analyses (see Indirect effects analyses). Finally, we conducted a fidelity analysis to examine whether students responded to the utility value writing prompts as expected (see Intervention fidelity analyses).

Descriptive analyses. A comparison of the unadjusted raw means in Table S2 reveals no significant difference on the Time 1 covariates (all F s < 2.7, all p s > .10), indicating balanced randomization across the three conditions. Second, students successfully responded to the intervention prompts. There were no differences in the number of words written in the control ($M = 178.0$, $SD = 57.1$) or utility value conditions ($M = 182.8$, $SD = 57.7$; $d = .06$; $p = .57$), indicating students committed a similar level of effort and thinking in each condition. Example essays can be found in the Supplemental Online Materials (see Appendix C). In addition, the connection frequency variable was again normally distributed at both Time 1 (skewness = .19, kurtosis = .08) and Time 3 (skewness = .06, kurtosis = $-.28$), with a mean near the midpoint of the scale at both Time 1 ($M = 3.77$ of 6, $SD = .83$)

and Time 3 ($M = 3.99$, $SD = .88$). However, as expected, there were small, raw mean differences in favor of the utility value intervention conditions compared with the control condition on Time 3 measures of interest ($d = .24$), expectancy ($d = .23$), utility value ($d = .24$), and final exam scores ($d = .23$), but not on cost or connection frequencies.

The pattern of correlations (see Table 2) was similar to Study 1 and revealed positive relationships between Time 1 connection frequency and Time 3 expectancy ($r = .16$) and utility value ($r = .30$), and a negative relationship with cost ($r = -.15$). Time 3 connection frequency was positively related to interest ($r = .49$) and final exam scores ($r = .15$).

Primary analyses. Did the utility value intervention conditions enhance academic outcomes compared with the control group? To answer this question, we used hierarchical, OLS regression to examine the effects of the interventions on interest in psychology and final exam scores. Regression allows us to examine unique relationships among the predictors of interest. We first examined intervention differences using an intent-to-treat model (Model 1) that included only the contrast codes for the experimental conditions. The utility value code compared whether both utility conditions were better than the control (control = -2 , utility = $+1$, enhanced utility = $+1$), and the enhanced utility value code compared whether the enhanced utility value condition was better than the utility value condition (utility value = -1 , enhanced utility value = $+1$). We did not include the covariates in Model 1 because there were no differences between experimental groups on the covariates, which meant that we could avoid the additional assumptions required when including covariates (Rosenbaum et al., 2002). However, adding the Time 1 motivation covariates (expectancy, value, cost) and connection frequency to the regression models predicting final exam scores and Time 3 interest did not alter the pattern of effects or statistical significance on either final exam scores or interest (see Model 3 in Tables S3 and S4).

Second, to examine whether the intervention was more effective for students at-risk of poor performance, we tested interactions between the intervention contrast codes and initial exam scores and gender in Model 2. Based on prior research (e.g., Hulleman & Harackiewicz, 2009; Hulleman et al., 2010) and Study 1, we identified male students who performed poorly on the first exam as most at-risk. Therefore, we added initial exam scores (mean-centered) as a continuous variable, gender (0 = male, 1 = female), four two-way interaction terms (utility contrast by gender, utility contrast by initial exams, enhanced contrast by gender, enhanced contrast by initial exams), and two three-way interaction terms to our model (utility contrast by gender by initial exams, enhanced contrast by gender by initial exams). This became Model 2.

Using the methods outlined by Aiken and West (1991), we probed significant interactions in three ways. First, we calculated predicted values at one standard deviation above and below the continuous moderator (in this case initial exam scores) by using the regression equation that contains the continuous variable. Second, we calculated simple slopes at one standard deviation above and below the continuous moderator to test for significant differences. Third, we calculated standardized mean differences between conditions at one standard deviation above and below the continuous predictor by estimating a regression equation with standardized predictors and standardized outcomes. Finally, to aid

interpretation of predicted values, we standardized the dependent variable when calculating predicted values so that they can be interpreted on a standardized metric.

Intent-to-treat analyses on learning outcomes. The analyses of Model 1 (see Tables S3 and S4) revealed a significant effect of the utility contrast on both final exam scores ($\beta = .12$, $sr^2 = .01$, $p = .03$) and interest ($\beta = .11$, $sr^2 = .01$, $p = .04$). Students randomly assigned to either utility condition performed better on the final exam ($M = 80.3$) and were more interested in psychology at the end of the course ($M = 6.14$) compared with students in the control condition ($M_{\text{Exam}} = 77.96$, $d = .25$; $M_{\text{Interest}} = 5.85$, $d = .24$). The difference between the utility and enhanced utility condition was not significant for either performance or interest.

At-risk student analyses. The analyses of Model 2 (see Tables S3 and S4) revealed a significant utility value contrast by initial exam interaction on both final exam scores ($\beta = -.22$, $sr^2 = .02$, $p = .01$) and interest ($\beta = 1.11$, $sr^2 = .01$, $p = .03$). As presented in Figure 2, when compared with students in the control condition, low-performing students in the utility value conditions performed better on the final exam ($d = .82$) and were more

interested in the course material at the end of the semester ($d = .13$). Initial exam scores were also a significant predictor of final exam scores ($\beta = .60$, $sr^2 = .10$). Female students also reported more interest in psychology at the end of the semester than male students ($\beta = .32$, $sr^2 = .10$). Importantly, the enhanced utility value contrast was nonsignificant, indicating that there was no additional benefit of the enhanced utility value condition above and beyond the regular utility value condition (see Tables S3 and S4 for complete regression results).

The two-way interaction between the utility value contrast and initial performance on final exam performance was qualified by a significant three-way interaction between gender, initial performance, and the utility value contrast ($\beta = .19$, $sr^2 = .01$). As presented in Figure 3, the benefits of the utility value intervention appeared for low-performing male students who increased their exam performance by over three-quarters of a standard deviation in the utility value conditions compared with the control condition ($d = .76$). By the final exam, male students in the utility value conditions were performing as well as female students in the control conditions, which was equivalent to going from a C to a B

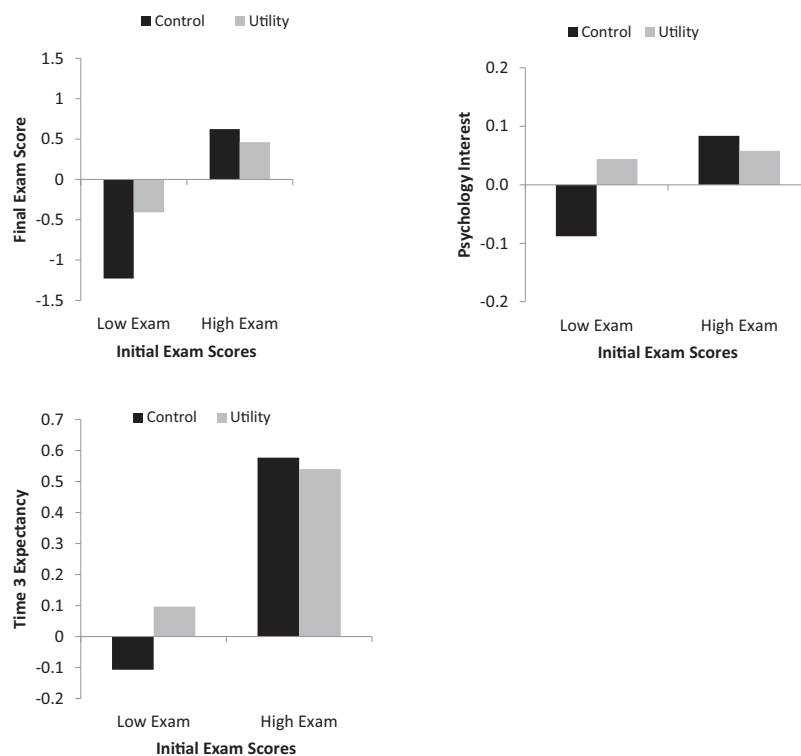


Figure 2. Interaction between the utility value interventions and initial exam scores on final exam scores, Time 3 interest in psychology, and Time 3 success expectancies in Study 2. $N = 357$. Predicted values for Low and High Exam were computed based on estimates for one standard deviation below (Low Exam) and above the mean (High Exam) on Initial Exam Scores (Aiken & West, 1991). We calculated standardized mean differences between the utility value and control conditions by using predicted values from a regression equation in which the outcome variables were standardized. Doing so results in predicted values that are in standardized units of both the predictor and the criterion (Cohen, Cohen, West, & Aiken, 2002). For example, in the upper left panel of this Figure, students with low expectancies in the control group had a predicted value of -1.22 on final exam scores, whereas low expectancy students in the combined utility value conditions had a predicted value of -0.41 on final exam scores. These values produce an adjusted, standardized mean difference of $d = 0.82$. See Model 2 in Tables S3 and S4 for complete details.

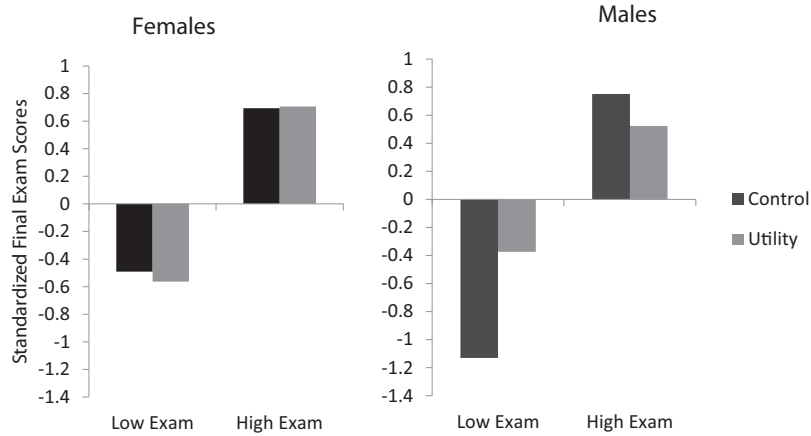


Figure 3. Three-way interaction between gender, initial exam scores, and utility conditions on final exam scores in Study 2. $N = 357$. Predicted values for Low and High Exam were computed based on estimates for one standard deviation below (Low Exam) and above the mean (High Exam) on First Exam scores (Aiken & West, 1991). See Model 2 in Tables S3 and S4 for complete details.

(see Figure 4). In other words, the students who traditionally perform most poorly in general education courses, males who initially struggle in the course, benefitted the most from the intervention. Importantly, the inclusion of the motivation covariates did not change the results (see Model 3 in Tables S3 and S4). The utility value conditions did not significantly affect high-performing students' exam scores, regardless of whether they were males or females, or low-performing females.

Indirect effects analyses. We also examined whether changes in connection frequency and expectancy-value-cost motivation were induced by the utility value interventions, and whether these changes contributed to further motivation and learning in the course. We also hypothesized that expectancy and perceptions of utility value might contribute to learning outcomes. We used path modeling within a multiple regression framework for two reasons. First, it matches the regression framework we used to analyze the intent-to-treat effects. Second, this was the same technique used in

Study 1, with two exceptions. First, because we measured connection frequency at two time points, we first examined whether the interventions increased students' reports of connection frequency by regressing Time 3 connection frequency on the contrast codes, gender, initial exam scores, initial interest, and initial motivation (see Table S5 for regression results). Second, to test whether the motivation measures were pathways for the intervention effects, we included Time 3 measures of expectancy, value, cost, and connection frequency in the regression models predicting interest and final exam scores (see Model 4 in Tables S3 and S4).

Regressing Time 3 connection frequency on the Time 1 covariates and contrast codes for conditions revealed that initial interest in psychology ($\beta = .17, sr^2 = .01$), Time 1 connection frequency ($\beta = .35, sr^2 = .09$), and initial exam scores ($\beta = .10, sr^2 = .01$) were the only significant predictors. In terms of motivation, although the utility value interventions did not impact utility value or cost, they did impact students' success expectancies. When predicting Time 3 expectancies, there was a significant interaction between the utility value contrast and initial exam scores ($\beta = -.11, sr^2 = .01$). As presented in Figure 2, the utility value conditions increased low-performing students' expectancies compared with the control condition ($d = .20$), whereas there was no effect for high-performing students ($d = -.04$). Time 3 expectancy in turn was a significant predictor of final exam scores ($\beta = .21, p < .01, sr^2 = .02$). As presented in the top panel of Figure 5, low-performing male students in the utility conditions had higher exam scores than their counterparts in the control condition ($d = .76$), which was partially explained by an increase in expectancy for students who performed poorly on the first exam ($\omega = .15, 95\% \text{ CI } [0.019, 0.322]$). Importantly, these interaction effects were unaffected by the inclusion of expectancy in the regression model predicting final exam scores.

Although perceived utility value, cost, and connection frequency could not provide indirect pathways for the intervention effect (because they were not predicted by the intervention), the motivation variables were significant predictors of outcomes. Because we controlled for Time 1 measures of motivation and inter-

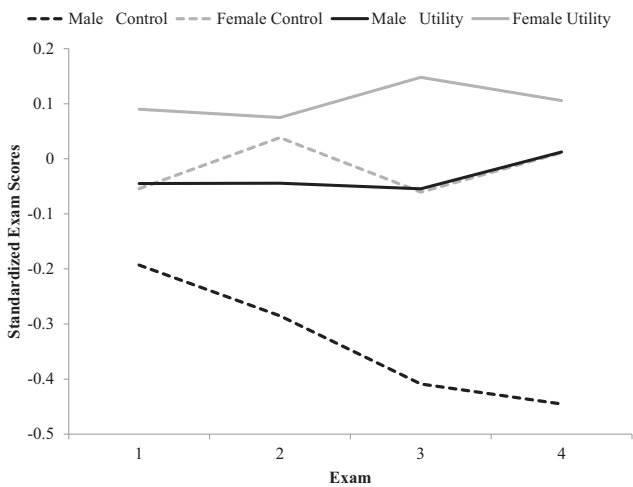


Figure 4. Unadjusted final exam scores by experimental condition and gender in Study 2. $N = 357$.

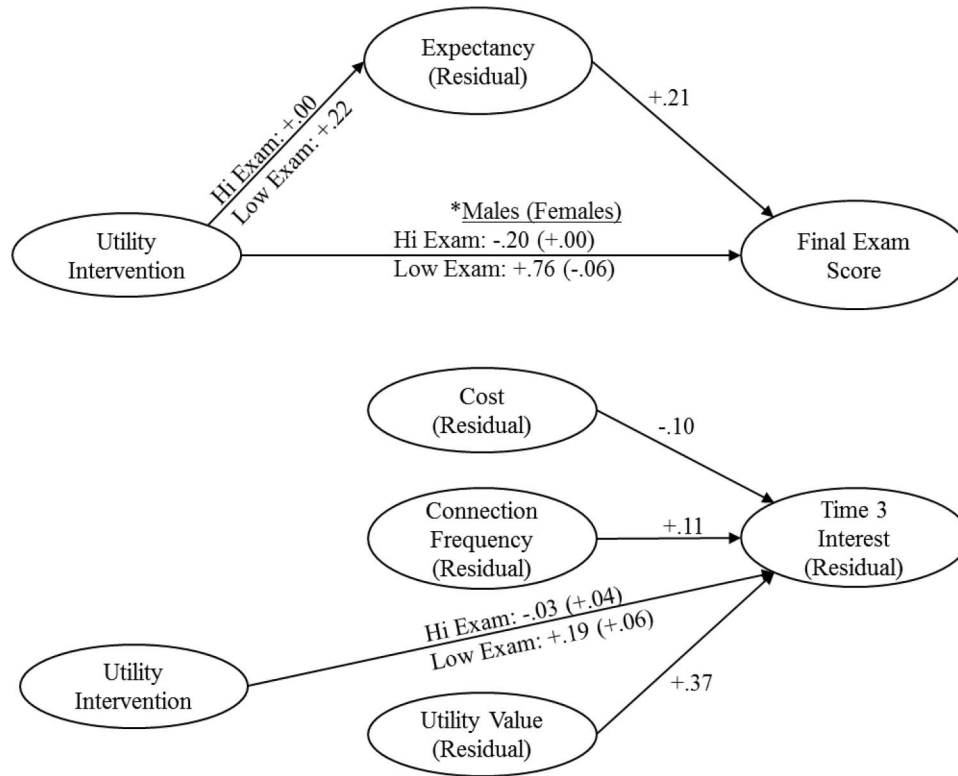


Figure 5. Path model of intervention effects on final exam scores (top) and interest (bottom) in Study 2. $N = 357$. Values are standardized OLS regression coefficients that were statistically significant ($p < .05$). Ovals with “(Residual)” in them are residual values having controlled for Time 1 measures. Other control variables included: Time 1 motivation (expectancy, utility value, cost, interest), gender, and initial exam scores. See text for details. The two-way interaction between the utility intervention and initial exam scores on interest was significant for students with low exam scores ($\beta = .19$), and reduced to nonsignificant ($\beta = .06$) when the motivation measures were included in the model. Predicted values for Low and High Exam were computed based on estimates for one standard deviation below (Low Exam) and above the mean (High Exam) on First Exam scores (Aiken & West, 1991). *The significant three-way interaction between the utility intervention, initial exam scores, and gender on final exam scores ($\beta = .19$, $sr^2 = .01$) revealed that low-performing males benefitted the most from the intervention ($d = .76$).

est, the Time 3 measures could be considered residual (or change) scores. As presented in the bottom panel of Figure 5, increases in perceived cost during the semester were associated with declines in interest during the semester ($\beta = -.10$, $sr^2 = .01$), whereas increases in perceptions of utility value ($\beta = .37$, $sr^2 = .05$) and connection frequency ($\beta = .11$, $sr^2 = .01$) were associated with increases in interest.

Intervention fidelity analyses. Although connection frequency was predictive of later interest, we did not increase connection frequency through our enhanced utility value manipulation. Because there were no differences between the utility and the enhanced utility conditions, this meant that the additional elements to the enhanced utility condition had no effect on outcomes above and beyond the utility writing. To further understand the effects of the intervention, we analyzed the extent to which participants responded to the intervention prompts as intended (i.e., intervention fidelity; see O’Donnell, 2008). To capture intervention fidelity, we identified three core components of the intervention prompts (Nelson et al., 2012): (a) the degree to which individuals

provided satisfactory responses to their requisite prompts in all three conditions (indicating general compliance to the prompts across conditions); (b) the degree to which essays contained personalized connections between the material and their lives (indicating responsiveness to the utility value prompts); and (c) the degree to which individuals specified implementation intentions (indicating responsiveness to the enhanced utility value prompts). For the purposes of assessing intervention fidelity to the essay prompts, independent raters were trained on a brief rubric that contained three elements: writing quality (expected to be equal across conditions), personalization of connections (expected to be higher in the utility value conditions than in the control), and implementation intentions (expected to be higher in the enhanced utility condition compared with the control and utility condition).

Writing quality. To assess common elements of writing quality across all conditions, raters coded essays on a four-point rating scale that included 0 (*Less than a sentence*), 1 (*Typed incoherent thoughts or thoughts unrelated to the topic*), 2 (*A series of clear, unrelated sentences addressing the same topic*), 3 (*Groups of*

clear, related sentences addressing the same topic). Raters were allowed to use half points. Rater reliability was assessed using adjacent percent agreement, or the degree to which independent ratings were less than one point away on a rating scale (e.g., a rating of 2 and 2.5 would be considered agreement). In the case of disagreements, scores were averaged to compute the final rating. A score of 2 or higher on the writing quality scale was considered to be adequate fidelity. For writing quality, raters demonstrated 83% adjacent agreement across all interventions. The results indicated that the control group produced slightly lower quality essays during the first intervention ($M_{\text{control}} = 2.21$, $SD = 0.62$; $M_{\text{Utility}} = 2.56$, $SD = 0.49$; $M_{\text{Enhanced}} = 2.57$, $SD = 0.47$), whereas the utility value condition was slightly lower during the second intervention ($M_{\text{control}} = 2.92$, $SD = 0.35$; $M_{\text{Utility}} = 2.66$, $SD = 0.64$; $M_{\text{Enhanced}} = 2.85$, $SD = 0.39$). Despite the minor differences in writing quality, we note that all three groups received higher average ratings for the second set of essays, and all three group averages were between the highest points on the rating rubric. On average, 95% of essays were rated as having adequate fidelity, and only the control condition during first intervention (85%) was below 94%. These results suggested that students tended to write acceptable essays that addressed the prompted topics.

Personalized connections. To assess the degree to which personalization was present in both the utility and control essays, raters coded essays on a four-point rating scale that included 0 (*Essay is not focused on the self or a significant other*), 1 (*Essay implies or suggests personal importance, but does not say how*), 2 (*Essay references personal relevance rather than general*), 3 (*Essay references personal relevance and provides a strong example of why*). Essays were scored in the same manner as for writing quality. Raters demonstrated 92% adjacent agreement across all interventions. The results indicated that the control group displayed substantially lower personalization in their essays during the first intervention ($M_{\text{control}} = 0.04$, $SD = 0.34$; $M_{\text{Utility}} = 2.24$, $SD = 0.67$; $M_{\text{Enhanced}} = 2.21$, $SD = 0.69$; $d = 3.7$ between the control and combined utility value conditions), as well as during the second intervention ($M_{\text{control}} = 0.02$, $SD = 0.15$; $M_{\text{Utility}} = 2.34$, $SD = 0.74$; $M_{\text{Enhanced}} = 2.50$, $SD = 0.55$; $d = 3.8$ between the control and combined utility value conditions). On average, essays were rated as having adequate fidelity 89% of the time in the utility groups. The control essays were rated as being personalized 0.8% of the time, as would be expected. These differences suggest that the hypothesized driving feature of the intervention was present in the utility conditions, but not the control condition.

Implementation intentions. The enhanced utility value condition was created by including elements of implementation intention interventions. To that end, students were asked to respond to prompts about specific times to think about connections, about obstacles that might prevent them from thinking about connections, and about solutions to overcoming those obstacles. To measure fidelity of student responses in these cases, we used word counts for each individual prompt. Raters were asked to flag sentences that used language that could be used to answer any one of the three implementation intention prompts (i.e., times, obstacles, solutions; Rater Agreement = 100%). This approach was used because our initial analyses indicated that the presence (vs. absence) of implementation intentions was highly correlated with elaboration. Neither the control group nor the utility value group were coded as including implementation intentions (all mean word

counts < 1.55 words, median and mode word counts were 0 in both conditions at both time points). In contrast, the enhanced utility value prompts induced substantially more writing about implementation intentions during the first intervention ($M_{\text{Times}} = 33.19$, $SD = 25.27$; $M_{\text{Obstacles}} = 31.26$, $SD = 23.61$; $M_{\text{Solutions}} = 37.53$, $SD = 18.68$), and slightly more during the second intervention ($M_{\text{Times}} = 10.16$, $SD = 9.01$; $M_{\text{Obstacles}} = 9.62$, $SD = 8.01$; $M_{\text{Solutions}} = 10.37$, $SD = 7.97$). To have adequate fidelity, students need to have indicated at least one time, one obstacle, and one solution. On average, control and utility essays were rated as having adequate fidelity 1% of the time, whereas essays in the enhanced utility condition were rated as having adequate fidelity 50% of the time.

Fidelity results summary. These results suggested that students generally demonstrated reasonable fidelity to the implementation intention prompts, although fidelity to the implementation intentions aspect of the enhanced utility condition was not quite as strong as fidelity to the personalization aspect of the regular utility condition. See Tables S6 and S7 for more details.

Study 2 Discussion

The results of Study 2 partially replicated prior research demonstrating that a theoretically guided intervention based on the expectancy-value framework could enhance student learning outcomes (Hulleman & Harackiewicz, 2009; Hulleman et al., 2010). As found in prior research, the utility value intervention worked best for students who were at-risk for poor overall course performance. On both interest in psychology and performance, the interaction between initial exam performance and the utility value intervention revealed positive effects for low performers and null effects for high performers. Furthermore, the three-way interaction on performance revealed that male students who had performed poorly on the first exam especially benefitted from the utility value intervention. We also replicated the effects of Study 1, which demonstrated that a new measure of connection frequency was a pathway through which students developed interest in psychology over the course of the semester. This directly supports our hypothesis that an important aspect of finding value in a topic, and eventually developing interest, is for students to make connections between the course content and their lives.

In addition to the utility value intervention used in prior research, we developed an additional intervention intended to increase connection frequency. The enhanced utility value intervention encouraged students to make more connections between the psychology they were learning and their lives during their daily routines. Unfortunately, our analyses did not reveal an additional benefit of the enhanced condition above and beyond the utility value condition. However, our investigation led to a surprising finding: instead of further bolstering students' utility value, as found in prior research (e.g., Hulleman et al., 2010), the utility value conditions increased students' expectancies for success. This was surprising because our theory and prior research had focused on perceptions of utility value as the primary mechanism of intervention effects. We consider these surprising findings in turn below.

What happened in the enhanced utility value condition? Our qualitative examination of the written responses to our intervention prompt indicated that students had, for the most part,

engaged in the intervention how we had intended. Students were prompted to make an implementation intention about when they would make connections, identify obstacles to making connections, and identify strategies to overcome those obstacles. These aspects of creating an intention to perform a specific behavior are aligned with the research literature in this area (e.g., Gollwitzer, 1999). So, what are we to conclude about the enhanced intervention? First, because this was our first attempt at creating this type of intervention, it is possible that our manipulation did not adequately activate behavioral commitment. The lack of effects on self-reported connection frequency seem to support this concern. One implication is to revise the intervention by including more aspects intended to activate behavioral commitment. However, instead of being an implementation issue, it is possible that our focus is on the wrong variable. Although our connection frequency measure may correlate with positive outcomes, it could be that when students are prompted to make connections on their own, that the quality of that connection also matters. Unfortunately, both our enhanced intervention prompts and connection frequency measures were solely focused on frequency and not quality. A second implication is to develop a different intervention that encourages students to make more high quality connections, similar to the types of connections that they are making when instructed to write about relevance, and to develop a measure that captures both quantity and quality of connections.

Why did the intervention boost success expectancies and not utility value? One obvious reason why we found effects on success expectancies not found in prior research is that success expectancies had not been previously hypothesized as a pathway of intervention effects, and thus had not been measured or analyzed in this way. However, mediation by success expectancies seems quite plausible. Several studies of the utility value intervention in both classroom-based field experiments and laboratories have found that the version of the utility value intervention used in this study, where students write about the connections they see as relevant to them, is most effective in boosting performance and interest for students with poor performance histories or low expectations (Durik et al., 2015). Thus, even though utility value was found to be a mediator in previous studies, it is quite plausible that the utility value intervention was working as a proxy for success expectancies. Conventional wisdom suggests that people like what they are good at and do better at what they like. This adage is supported by the finding that expectancies and values, when measured via self-reports, are positively correlated (Robbins et al., 2004). We found this to be true in both of our studies, with expectancy and utility value being moderately correlated (r s from .27 to .45). If this adage is true, it may be that the utility value interventions have been affecting expectancies and utility value, ultimately increasing both interest and performance. Yet prior investigations did not examine whether expectancies helped explain the intervention effects.

In addition to the surprising expectancy effect, it was also surprising that we did not find mediation of the intervention effect attributable to utility value in Study 2. Prior laboratory and field studies of the utility value intervention by Hulleman and colleagues (Hulleman et al., 2010; Hulleman & Harackiewicz, 2009) revealed that the effects of the intervention on outcomes could be explained, at least partially, by increases in perceptions of utility value. In our case there are at least three possibilities why our

study might be different. First, this study was the first to manipulate utility value via an online assignment, so it may be that this difference changes how the intervention affects the mediating motivational mechanisms. In prior classroom studies, students either hand-wrote their responses to the intervention prompt in notebooks (2009), or had several weeks to hand-write or type a two to three page paper (2010, Study 2). In fact, there is some research to suggest that the physical act of writing activates different areas of the brain than typing the same text (Mueller & Oppenheimer, 2014). Further work is needed to examine this possible explanation.

Second, contextual differences in course instructor, instructional practices, or student characteristics could be responsible. The small sample of contexts (this is only the third published test of this intervention in the field) makes the influence of such contextual differences difficult to discern. However, there are important contextual aspects of this study worth noting. The instructor teaching the course is known for being highly motivating, and has received national teaching awards from The Princeton Review (2012) and the American Psychological Association (2012). Perhaps even more importantly for these particular findings, the student body at his university voted him as the best professor during 2013 (Jacobs, 2013). Evidence of his teaching prowess is also apparent in our survey data. Students reported making more frequent connections to psychology at the end of the semester than at the beginning. In fact, the change in connection frequency from the fourth to the thirteenth week was over a quarter of a standard deviation in the control conditions ($d = .25$) and combined utility value conditions ($d = 0.27$). As a point of reference, this change was much larger than for either expectancy or value, which both slightly decreased over the semester (both d s = $-.13$). These contextual differences could change the way the intervention affects motivational dynamics. For example, with such a strong base for value and making connections being provided by the context, the measure of utility value may have reached a ceiling which could not be adjusted by the intervention. In this strong value context, the utility value intervention may have emboldened students to believe they could succeed because they trusted the teacher to make the content not only interesting, but also learnable. As demonstrated in K through 12 settings, trust in school is an important predictor of increased achievement scores (Bill & Melinda Gates Foundation, 2010; Bryk & Schneider, 2002), and future research could investigate trust in relation to the utility value intervention.

Third, it can be difficult to capture mediation for many reasons. There are examples of other interventions which are based on social psychological theory (e.g., growth mindsets, belonging uncertainty, values affirmation) that have effects on outcomes but do not always capture effects on measured variables. Self-reports are prone to biases, such as social desirability and reference bias, which are sensitive to context (Duckworth & Yeager, 2015). This is particularly true for utility value as students' responses are likely affected by the specific unit or topic that students are studying, which varies from week to week.

General Discussion

The results of Study 2 add to the growing body of literature that social psychological interventions in general can promote student

learning outcomes, and that utility value interventions in particular can be beneficial. In addition to replicating prior research on utility value, we extended this growing body of work in several ways. To further understand the mechanism of the utility value intervention effect, we both measured (Studies 1 and 2) and manipulated (Study 2) one process of the utility intervention effect. This method can provide additional validity evidence in support of the mediating mechanism (Baron & Kenny, 1986; Sigall & Mills, 1998). Specifically, we hypothesized that the frequency with which students made connections between the material and their lives throughout the semester might be one way that the utility value intervention increases motivation and performance. By continually making connections, students might be energizing their study behavior and integrating their knowledge in deeper ways (Bransford & Schwartz, 1999). Although we were unable to successfully manipulate this mechanism in Study 2, we found that making more connections between the material and students' lives was positively related to expecting to do well in the course, and valuing the course material. In addition, students who made more connections perceived fewer costs for learning the material. Because this was an exploratory investigation of this measure, future research is needed to further validate the measure and understand its relationship with motivational processes and learning outcomes.

Implications for Theory and Research

At a theoretical level, the current research lends additional support for understanding motivation and achievement in educational contexts using an expectancy-value framework. In particular, the role that expectancy and utility value both play in determining key academic outcomes within the context of interventions was further elucidated. Although prior theoretical work allowed for expectancies and values to be positively related, it was only through experimental research that we learned that a utility value intervention can actually increase expectations for success. We also uncovered an important proximal process, or mechanism, through which the utility value intervention has its effects: connection frequency. In both studies, students who reported more frequently seeing connections between the course material and their lives reported more interest in the material at the end of the semester. Further, in Study 1, this link between connection frequency and outcomes was explained by a concomitant increase in perceptions of utility value. Although this finding is correlational, it corroborates our inclination that the frequency of connections is an important aspect of finding value, and developing interest, in academic content. As in past research, encouraging students to make a connection at a single point in time through a utility value intervention boosted utility value and learning outcomes. In extending prior work, we demonstrated that making frequent connections between the material and students' lives also boosts utility value and learning outcomes.

Our findings are also consistent with models of interest development (Hidi & Renninger, 2006; Renninger & Hidi, 2011), which posit that perceiving value in a particular domain or activity is a crucial aspect of developing an enduring interest. In addition to providing support for the role of value in interest development through an intervention study, we also found a new pathway for interest development: connection frequency. Although not explicitly outlined in their four-phase model of interest, connection

frequency is likely related to two important factors in this model: perceived knowledge and value. By making more connections, students are building additional knowledge about how learning content relates to their lives, and also creating a foundation for perceiving personal value in a topic. Future work will need to further develop our understanding of connection frequency and quality in interest development. Importantly, this link to interest development, and in particular understanding which factors are amenable to manipulation within the classroom context, are especially important for educational practice.

Implications for Practice

On the surface, our effort to further explore the mechanisms of the utility value intervention is a theoretical question. Why should practitioners care why an intervention works so long as it works? However, our work uncovered a theoretically surprising finding related to this question: The utility value intervention, in this context, increased low performing students' outcomes by virtue of enhancing success expectancies. One interpretation of this finding is that an intervention designed to enhance value actually enhances students' expectancies. For practitioners, solving their local challenges involves aligning the sources of the problem (i.e., students with low expectancies) with an intervention that targets that source. This means looking beyond the surface features of the intervention to understand the mechanics of how the intervention works (Nelson, Cordray, Hulleman, Darrow, & Sommer, 2012).

In addition, this research is an example of designing an intervention in an online environment to facilitate achieving both research and practice goals. On the research end, the online delivery enabled us to randomize students behind the scenes so that both students and the instructor were blind to differences in intervention activities across students. Data entry and cleaning were minimized, and the data were immediately available to us. We were able to inform the instructor which students had completed the interventions and surveys so that he could assign course credit, and students had a common means of accessing the 'assignment' regardless of condition. On the practice end, the online environment minimized the impact on instructional time (students completed the intervention and surveys on their own time outside of class). An online environment is also a cost-effective means of scaling psychological interventions, as most undergraduate institutions use some version of course management software within which the intervention and surveys can be imbedded.

At-Risk Students and Academic Achievement

Students disengage from school, and eventually drop out, as a result of a number of factors, including lack of academic preparation, poor knowledge of effective learning strategies, and low motivation (e.g., Allensworth & Easton, 2007). Poor performance in introductory and general education courses, especially those taken early in students' academic career (e.g., middle school prealgebra or college-level general education courses), can have an especially salient impact on their academic trajectories (e.g., Casillas et al., 2012). Interestingly, one group that has consistently underperformed in school has been males. A recent meta-analysis demonstrated that females outperform males in school, and this performance gap cuts across grade-levels, subject areas, and pub-

lication year (Voyer & Voyer, 2014), indicating that this is not a recent phenomenon. A separate review indicated that gender differences in intelligence, personality, and motivation partially explained this performance gap (Spinath, Eckert, & Steinmayr, 2014). In particular, girls are more self-disciplined than boys, which leads to increased learning and academic achievement (Duckworth & Seligman, 2006).

The results from Study 2 are consistent with this emerging work, and provide additional evidence that the utility value intervention helps students at risk for underperformance. In both of our studies, male students performed more poorly than their female counterparts. In Study 2, the utility value intervention reduced this gap by over 75%. These results also align with other social psychological interventions that boost academic achievement of at-risk student groups (e.g., Aronson, Fried, & Good, 2002; Cohen, Garcia, Apfel, & Master, 2006; Walton & Cohen, 2011). For example, the utility value intervention has boosted the performance of students who initially doubted their ability to succeed in high school science (Hulleman & Harackiewicz, 2009) and undergraduate science (Hulleman, An, Hendricks, & Harackiewicz, 2007), first-generation under-represented minority students in college biology (Harackiewicz et al., 2015), and underperforming undergraduate psychology students (Hulleman et al., 2010). Further research will need to determine whether the gender effect was simply a proxy for identifying low-performing students, or whether it identified an important difference between male and female students in particular.

Limitations and Future Directions

There are some important limitations to this study, including those that are common to field experiments, such as studying intervention effects within a single context, which necessarily constrains generalizations about effectiveness (cf. Shadish, Cook, & Campbell, 2002; Shavelson, Phillips, Towne, & Feuer, 2003). In our two studies, four limitations stand out as particularly important for future research. First, our measure of connection frequency, which was newly developed for this study and central to our research questions about the pathways of the utility value intervention effects, needs further validation. How does it correlate with other measures of motivation, and how sensitive is it to differences in teaching style or learning content? Furthermore, the measure does not capture the quality of connections that students make. It is highly likely that students who make high-quality connections will benefit more than students who make low-quality connections to their lives. There are at least two possible reasons for this. From a motivation perspective, making higher quality connections could deepen students' desire to digest the material and engage in learning. From a neuroscience perspective, research shows that new experiences can be associated with existing memories when these experiences are strongly activated (e.g., McGaugh, 2000). When two neural pathways are activated in tandem, the intensity in activation can trigger a process known as long term potentiation (Purves et al., 2001). Long-term potentiation leads to new synaptic connections between the two pathways, resulting in the two pathways being activated together in future experiences of either. This would mean that making a connection between course content and a common daily experience (e.g., working at a job) could then lead to the activation of that content whenever the daily

experience reoccurs. Regardless of the underlying reason, the importance of quantity and quality of connections could be examined in future research. For example, student essays in response to the utility value intervention prompts could be coded for quality of connections, and then linked to outcomes (e.g., Hulleman & Cordray, 2009). Alternatively, an accompanying student self-report measure of connection quality could be assessed so that the independent effects of connection quantity and quality could be examined.

The final three limitations are related to the possible reasons why the intervention effect sizes in our experimental study were not enhanced as we had hoped. Second, because of the potential influence of classroom contextual factors (e.g., instructor, instructional practices, peer norms), future research needs to be conducted within a wide variety of classrooms and instructional styles. Ideally, intervention effects would be examined in enough classrooms to examine between classroom differences in the effectiveness of the utility value intervention. Not every intervention will replicate in every context, whether due to implementation challenges or other issues (e.g., Dee, 2015). Thus, the need for independent replication work is necessary for the utility intervention just as it is for any other intervention in education contexts.

Third, this was the first time we used an online medium to deliver the intervention, and we adapted the intervention so as to reduce the time burden on students. As a result, intervention dosage, and quite possibly intervention strength, was reduced compared with prior studies of the utility value intervention. In this study, students were asked to write less text and to do it less frequently than prior versions of the utility value intervention. For example, in the previous college psychology study published by Hulleman et al. (2010), students completed two take-home essays of 1 to 2 pages, compared with two online essays of 2 to 3 paragraphs. Thus, both of these factors (highly motivating classroom context and intervention strength) may have conspired to mute the salience of the intervention on students' perceptions of utility value. However, despite these implementation changes, the overall effect sizes on learning outcomes in this study (*ds* from .23 to .24) were similar to other value interventions (Lazowski & Hulleman, 2015). Future research could systematically vary these implementation factors to identify necessary levels of dosage and frequency required to obtain utility value intervention effects.

Fourth, the control condition used in Study 2, as well as in the other published randomized field experiments of the utility value intervention (Harackiewicz et al., 2015; Hulleman & Harackiewicz, 2009; Hulleman et al., 2010), was not a do-nothing control group. Rather, the control condition consisted of asking students to summarize the material they had been learning recently in the course. In the research literature on the cognitive psychology of learning, this control condition is known as summarization and has been found to enhance learning (Dunlosky et al., 2013). Essentially, these studies (including ours) tested a motivation intervention in comparison to a cognitive intervention, and found that the motivation intervention produced better outcomes. This means that the effect size for the utility value intervention, both in the research presented here as well as prior published work, likely has been underestimated because the comparison group contained a cognitive intervention. To obtain a more pure effect size, future research could use a more inert comparison group.

Conclusion

The methods in this study demonstrate the value of experimental tests of psychological theories. Without such intervention studies, we would know very little about what happens in classrooms when we try to enhance student motivation (cf. Shavelson et al., 2003). Our combined longitudinal and experimental approach provides initial validity evidence for the role of connection frequency and motivation in explaining utility value intervention effects. More generally, this research contributes additional validity evidence to the growing body of research related to the impact of social-psychological interventions on educational outcomes (Lazowski & Hulleman, 2015; Yeager & Walton, 2011). When such theoretically guided interventions are thoughtfully implemented within academic contexts, surprisingly strong and consistent effects have been found on interest in academic topics, course performance, and persistence (Wilson, 2006). Importantly, this research demonstrates that these effects are not “magic,” but rather rely on targeted psychological mechanisms that can gain influence over time (Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2009; Garcia & Cohen, 2011). The hopeful message is that, by engineering the psychological situation, educational practitioners can significantly impact student learning and development.

References

- Acee, T. W., & Weinstein, C. E. (2010). Effects of a value-reappraisal intervention on statistics students' motivation and performance. *Journal of Experimental Education*, 78, 487–512. <http://dx.doi.org/10.1080/00220970903352753>
- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.
- Allensworth, E. M., & Easton, J. Q. (2007). *What matters for staying on track and graduating in Chicago Public High Schools*. Chicago, IL: Consortium on Chicago School Research. Retrieved December 17, 2007.
- American Psychological Association. (2012). *Psychology's top honors: Div. 2 (Society for Teaching of Psychology)*. Robert S. Daniel Teaching Excellence Award (four-year college): David B. Daniel, PhD. Retrieved from <http://www.apa.org/monitor/2012/09/top-honors.aspx>
- Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology*, 84, 261–271. <http://dx.doi.org/10.1037/0022-0663.84.3.261>
- Aronson, J., Fried, C. B., & Good, C. (2002). Reducing the effects of stereotype threat on African-American college students by shaping theories of intelligence. *Journal of Experimental Social Psychology*, 38, 113–125. <http://dx.doi.org/10.1006/jesp.2001.1491>
- Ash, K. (2008). Promises of money meant to heighten student motivation. *Education Week*. Retrieved on February, 14, 2008.
- Atkinson, J. W. (1957). Motivational determinants of risk-taking behavior. *Psychological Review*, 64, 359–372. <http://dx.doi.org/10.1037/h0043445>
- Barney, S. T. (2007). Capitalizing on the self-references effect in general psychology: A preliminary study. *Journal of Constructivist Psychology*, 20, 87–97. <http://dx.doi.org/10.1080/10720530600992915>
- Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51, 1173–1182. <http://dx.doi.org/10.1037/0022-3514.51.6.1173>
- Barron, K. E., & Harackiewicz, J. M. (2001). Achievement goals and optimal motivation: Testing multiple goal models. *Journal of Personality and Social Psychology*, 80, 706–722. <http://dx.doi.org/10.1037/0022-3514.80.5.706>
- Barron, K. E., & Hulleman, C. S. (2015). Expectancy-value-cost model of motivation. In J. D. Wright (Ed.), *International encyclopedia of the social & behavioral sciences* (2nd ed., Vol. 8, pp. 503–509). Oxford, UK: Elsevier Ltd. <http://dx.doi.org/10.1016/B978-0-08-097086-8.26099-6>
- Bill & Melinda Gates Foundation. (2010). *Learning about teaching: Initial findings from the Measures of Effective Teaching Project*. Research paper retrieved from http://www.metproject.org/downloads/Preliminary_Findings-Research_Paper.pdf
- Boekaerts, M. (2002). *Motivation to learn*. Educational Practice Series #10. International Bureau of Education. Bellegarde, France: SADAG. Retrieved from http://www.ibe.unesco.org/fileadmin/user_upload/archive/publications/EducationalPracticesSeriesPdf/prac10e.pdf
- Bong, M. (2001). Role of self-efficacy and task-value in predicting college students' course performance and future enrollment intentions. *Contemporary Educational Psychology*, 26, 553–570. <http://dx.doi.org/10.1006/ceps.2000.1048>
- Bransford, J. D., & Schwartz, D. L. (1999). Rethinking transfer: A simple proposal with multiple implications. *Review of Research in Education*, 24, 61–100.
- Brophy, J. (1999). Toward a model of the value aspects of motivation in education: Developing appreciation for particular learning domains and activities. *Educational Psychologist*, 34, 75–85. http://dx.doi.org/10.1207/s15326985ep3402_1
- Brown, E. R., Smith, J. L., Thoman, D. B., Allen, J. M., & Muragishi, G. (2015). From bench to bedside: A communal utility value intervention to enhance students' biomedical science motivation. *Journal of Educational Psychology*, 107, 1116–1135. <http://dx.doi.org/10.1037/edu0000033>
- Bryk, A., & Schneider, B. (2002). *Trust in schools: A core resource for improvement*. New York, NY: Russell Sage Foundation.
- Burke, L. A., & Hutchins, H. M. (2007). Training transfer: An integrative literature review. *Human Resource Development Review*, 6, 263–296. <http://dx.doi.org/10.1177/1534484307303035>
- Casillas, A., Robbins, S., Allen, J., Kuo, Y. L., Hanson, M. A., & Schmeiser, C. (2012). Predicting early academic failure in high school from prior academic achievement, psychosocial characteristics, and behavior. *Journal of Educational Psychology*, 104, 407–420. <http://dx.doi.org/10.1037/a0027180>
- Cohen, G. L., Garcia, J., Apfel, N., & Master, A. (2006). Reducing the racial achievement gap: A social-psychological intervention. *Science*, 313, 1307–1310. <http://dx.doi.org/10.1126/science.1128317>
- Cohen, G. L., Garcia, J., Purdie-Vaughns, V., Apfel, N., & Brzustoski, P. (2009). Recursive processes in self-affirmation: Intervening to close the minority achievement gap. *Science*, 324, 400–403. <http://dx.doi.org/10.1126/science.1170769>
- Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2002). *Applied multiple regression/correlation analyses for the behavioral sciences* (3rd ed.). London, UK: Routledge.
- Conley, A. M. (2012). Patterns of motivation beliefs: Combining achievement goal and expectancy-value perspectives. *Journal of Educational Psychology*, 104, 32–47. <http://dx.doi.org/10.1037/a0026042>
- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York, NY: Harper & Row.
- Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York, NY: Plenum Press. <http://dx.doi.org/10.1007/978-1-4899-2271-7>
- Dee, T. S. (2015). Social identity and achievement gaps: Evidence from an affirmation intervention. *Journal of Research on Educational Effectiveness*, 8, 149–168. <http://dx.doi.org/10.1080/19345747.2014.906009>
- Duckworth, A. L., & Seligman, M. E. (2006). Self-discipline gives girls the edge: Gender in self-discipline, grades, and achievement test scores. *Journal of Educational Psychology*, 98, 198–208. <http://dx.doi.org/10.1037/0022-0663.98.1.198>
- Duckworth, A. L., & Yeager, D. S. (2015). Measurement matters: Assessing personal qualities other than cognitive ability for educational pur-

- poses. *Educational Researcher*, 44, 237–251. <http://dx.doi.org/10.3102/0013189X15584327>
- Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques: Promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest*, 14, 4–58. <http://dx.doi.org/10.1177/1529100612453266>
- Durik, A. M., & Harackiewicz, J. M. (2007). Different strokes for different folks: How individual interest moderates the effects of situational factors on task interest. *Journal of Educational Psychology*, 99, 597–610. <http://dx.doi.org/10.1037/0022-0663.99.3.597>
- Durik, A. M., Hulleman, C. S., & Harackiewicz, J. M. (2015). One size fits some: Instructional enhancements to promote interest don't work the same for everyone. In K. A. Renninger, M. Nieswandt, & S. Hidi (Eds.), *Interest in mathematics and science learning* (pp. 49–62). Washington, DC: American Educational Research Association.
- Durik, A. M., Vida, M., & Eccles, J. S. (2006). Task values and ability beliefs as predictors of high school literacy choices: A developmental analysis. *Journal of Educational Psychology*, 98, 382–393. <http://dx.doi.org/10.1037/0022-0663.98.2.382>
- Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 74–146). San Francisco, CA: Freeman.
- Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin*, 21, 215–225.
- Flake, J., Barron, K. E., Hulleman, C. S., McCoach, D. B., & Welsh, M. E. (2015). Understanding cost: The forgotten component of expectancy-value theory. *Contemporary Educational Psychology*, 41, 232–244.
- Garcia, J., & Cohen, G. L. (2011). A social psychological approach to educational intervention. In E. Shafir (Ed.), *Behavioral foundations of policy*. Princeton, NJ: Princeton University Press.
- Gentner, D., Loewenstein, J., & Thompson, L. (2003). Learning and transfer: A general role for analogical encoding. *Journal of Educational Psychology*, 95, 393–405.
- Gick, M. L., & Holyoak, K. J. (1980). Analogical problem solving. *Cognitive Psychology*, 12, 306–355. [http://dx.doi.org/10.1016/0010-0285\(80\)90013-4](http://dx.doi.org/10.1016/0010-0285(80)90013-4)
- Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist*, 54, 493–503. <http://dx.doi.org/10.1037/0003-066X.54.7.493>
- Gollwitzer, P. M., & Brandstätter, V. (1997). Implementation intentions and effective goal pursuit. *Journal of Personality and Social Psychology*, 73, 186–199. <http://dx.doi.org/10.1037/0022-3514.73.1.186>
- Grays, M. P. (2013). *Measuring motivation for coursework across the academic career: A Longitudinal invariance study*. [Unpublished doctoral dissertation.] James Madison University, Harrisonburg, VA.
- Harackiewicz, J. M., Barron, K. E., Tauer, J. M., & Elliot, A. J. (2002). Predicting success in college: A longitudinal study of achievement goals and ability measures as predictors of interest and performance from freshman year through graduation. *Journal of Educational Psychology*, 94, 562–575. <http://dx.doi.org/10.1037/0022-0663.94.3.562>
- Harackiewicz, J. M., & Borman, G. (2014, April). Scaling up social psychological interventions to address achievement gaps in education. Symposium at the annual conference of the American Educational Research Association. San Francisco, CA.
- Harackiewicz, J. M., Canning, E. A., Tibbetts, Y., Giffen, C. J., Blair, S. S., Rouse, D. I., & Hyde, J. S. (2014). Closing the social class achievement gap for first-generation students in undergraduate biology. *Journal of Educational Psychology*, 106, 375–389. <http://dx.doi.org/10.1037/a0034679>
- Harackiewicz, J. M., Canning, E. A., Tibbetts, Y., Priniski, S. J., & Hyde, J. S. (2015). Closing achievement gaps with a utility-value intervention: Disentangling race and social class. *Journal of Personality and Social Psychology*. Advance online publication. <http://dx.doi.org/10.1037/pspp0000075>
- Harackiewicz, J. M., Durik, A. M., Barron, K. E., Linnenbrink-Garcia, L., & Tauer, J. M. (2008). The role of achievement goals in the development of interest: Reciprocal relations between achievement goals, interest, and performance. *Journal of Educational Psychology*, 100, 105–122. <http://dx.doi.org/10.1037/0022-0663.100.1.105>
- Harackiewicz, J. M., Rozek, C. R., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. *Psychological Science*, 23, 899–906. <http://dx.doi.org/10.1177/0956797611435530>
- Harackiewicz, J. M., Tibbetts, Y., Canning, E., & Hyde, J. S. (2014). Harnessing values to promote motivation in education. In S. A. Karabenick & T. C. Urdan (Eds.), *Advances in motivation and achievement* (Vol. 18, pp. 71–105). Bingley, UK: Emerald Publishing. <http://dx.doi.org/10.1108/S0749-742320140000018002>
- Hidi, S., & Harackiewicz, J. M. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research*, 70, 151–179. <http://dx.doi.org/10.3102/00346543070002151>
- Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, 41, 111–127. http://dx.doi.org/10.1207/s15326985ep4102_4
- Hulleman, C. S., An, B., Hendricks, B., & Harackiewicz, J. M. (2007, June). *Interest development, achievement, and continuing motivation: The pivotal role of utility value*. Poster presented at the Institute of Education Sciences Research Conference, Washington, DC.
- Hulleman, C. S., & Cordray, D. S. (2009). Moving from the lab to the field: The Role of fidelity and achieved relative intervention strength. *Journal of Research on Educational Effectiveness*, 2, 88–110. <http://dx.doi.org/10.1080/19345740802539325>
- Hulleman, C. S., Durik, A. M., Schweigert, S., & Harackiewicz, J. M. (2008). Task values, achievement goals, and interest: An integrative analysis. *Journal of Educational Psychology*, 100, 398–416. <http://dx.doi.org/10.1037/0022-0663.100.2.398>
- Hulleman, C. S., Godes, O., Hendricks, B. L., & Harackiewicz, J. M. (2010). Enhancing interest and performance with a utility value intervention. *Journal of Educational Psychology*, 102, 880–895. <http://dx.doi.org/10.1037/a0019506>
- Hulleman, C. S., & Harackiewicz, J. M. (2009). Promoting interest and performance in high school science classes. *Science*, 326, 1410–1412. <http://dx.doi.org/10.1126/science.1177067>
- Jacobs, P. (2013, October 1). America's hottest professor is more than just a pretty face—Here's why students are crazy about his class. *Business Insider*. Retrieved from <http://www.businessinsider.com/interview-with-americas-hottest-professor-david-daniel-2013-9>
- Johnson, M. L., & Sinatra, G. M. (2013). Use of task-value instructional inductions for facilitating engagement and conceptual change. *Contemporary Educational Psychology*, 38, 51–63. <http://dx.doi.org/10.1016/j.cedpsych.2012.09.003>
- Kohn, A. (1999). *Punished by rewards*. Boston, Massachusetts: Houghton Mifflin.
- Kosovich, J. J., & Hulleman, C. S. (2016). A utility value framework: Task-goal relevance in achievement motivation. Manuscript under review.
- Kosovich, J. J., Hulleman, C. S., Barron, K. E., & Getty, S. (2015). A practical measure of student motivation: Establishing validity evidence for the expectancy-value-cost scale in middle school. *The Journal of Early Adolescence*, 35, 790–816.
- Lazowski, R. A., & Hulleman, C. S. (2015). Motivation interventions in education: A meta-analytic review. *Review of Educational Research*, 86, 602–640.
- McGaugh, J. L. (2000). Memory—A century of consolidation. *Science*, 287, 248–251. <http://dx.doi.org/10.1126/science.287.5451.248>

- Mueller, P. A., & Oppenheimer, D. M. (2014). The pen is mightier than the keyboard: Advantages of longhand over laptop note taking. *Psychological Science*, *25*, 1159–1168. <http://dx.doi.org/10.1177/0956797614524581>
- Nelson, M. C., Cordray, D. S., Hulleman, C. S., Darrow, C. L., & Sommer, E. C. (2012). A procedure for assessing intervention fidelity in experiments testing educational and behavioral interventions. *The Journal of Behavioral Health Services & Research*, *39*, 374–396. <http://dx.doi.org/10.1007/s11414-012-9295-x>
- Newby, T. J. (1991). Classroom motivation: Strategies of first-year teachers. *Journal of Educational Psychology*, *83*, 195–200. <http://dx.doi.org/10.1037/0022-0663.83.2.195>
- O'Donnell, C. L. (2008). Defining, conceptualizing, and measuring fidelity of implementation and its relationship to outcomes in K–12 curriculum intervention research. *Review of Educational Research*, *78*, 33–84.
- Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., & Dweck, C. S. (2015). Mind-set interventions are a scalable treatment for academic underachievement. *Psychological Science*, *26*, 784–793. <http://dx.doi.org/10.1177/0956797615571017>
- Peters, D. L., & Daly, S. R. (2013). Returning to graduate school: Expectations of success, values of the degree, and managing the costs. *The Journal of Engineering Education*, *102*, 244–268. <http://dx.doi.org/10.1002/jee.20012>
- Pike, A. G., & Dunne, M. (2011). Student reflections on choosing to study science post-16. *Cultural Studies of Science Education*, *6*, 485–500. <http://dx.doi.org/10.1007/s11422-010-9273-7>
- Purves, D., Augustine, G. J., Fitzpatrick, D., Katz, L. C., LaMantia, A. S., McNamara, J. O., . . . Williams, S. M. (2001). Plasticity of mature synapses and circuits. In D. Purves, G. J. Augustine, D. Fitzpatrick (Eds.), *Neuroscience* (2nd ed.). Sunderland, MA: Sinauer Associates. Retrieved from <http://www.ncbi.nlm.nih.gov/books/NBK10878/>
- Renninger, K. A., & Hidi, S. (2011). Revisiting the conceptualization, measurement, and generation of interest. *Educational Psychologist*, *46*, 168–184.
- Renninger, K., & Wozniak, R. H. (1985). Effect of interest on attentional shift, recognition, and recall in young children. *Developmental Psychology*, *21*, 624–632. <http://dx.doi.org/10.1037/0012-1649.21.4.624>
- Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. *Psychological Bulletin*, *138*, 353–387. <http://dx.doi.org/10.1037/a0026838>
- Robbins, S. B., Lauver, K., Le, H., Davis, D., Langley, R., & Carlstrom, A. (2004). Do psychosocial and study skill factors predict college outcomes? A meta-analysis. *Psychological Bulletin*, *130*, 261–288. <http://dx.doi.org/10.1037/0033-2909.130.2.261>
- Rosenbaum, P. R., Angrist, J., Imbens, G., Hill, J., Robins, J. M., & Rosenbaum, P. R. (2002). Covariance adjustment in randomized experiments and observational studies. *Statistical Science*, *17*, 286–327. <http://dx.doi.org/10.1214/ss/1042727942>
- Rozek, C. S., Hyde, J. S., Svoboda, R. C., Hulleman, C. S., & Harackiewicz, J. M. (2015). Gender differences in the effects of a utility-value intervention to help parents motivate adolescents in mathematics and science. *Journal of Educational Psychology*, *107*, 195–206. <http://dx.doi.org/10.1037/a0036981>
- Schraw, G., & Lehman, S. (2001). Situational interest: A review of the literature and directions for future research. *Educational Psychology Review*, *13*, 23–52. <http://dx.doi.org/10.1023/A:1009004801455>
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston, MA: Houghton Mifflin Company.
- Shavelson, R. J., Phillips, D. C., Towne, L., & Feuer, M. J. (2003). On the science of education design studies. *Educational Researcher*, *32*, 25–28. <http://dx.doi.org/10.3102/0013189X032001025>
- Sigall, H., & Mills, J. (1998). Measures of independent variables and mediators are useful in social psychology experiments: But are they necessary? *Personality and Social Psychology Review*, *2*, 218–226. http://dx.doi.org/10.1207/s15327957pspr0203_5
- Simons, J., Vansteenkiste, M., Lens, W., & Lacante, M. (2004). Placing motivation and future time perspective theory in a temporal perspective. *Educational Psychology Review*, *16*, 121–139. <http://dx.doi.org/10.1023/B:EDPR.0000026609.94841.2f>
- Spinath, B., Eckert, C., & Steinmayr, R. (2014). Gender differences in school success: What are the roles of students' intelligence, personality, and motivation? *Educational Research*, *56*, 230–243. <http://dx.doi.org/10.1080/00131881.2014.898917>
- Symons, C. S., & Johnson, B. T. (1997). The self-reference effect in memory: A meta-analysis. *Psychological Bulletin*, *121*, 371–394. <http://dx.doi.org/10.1037/0033-2909.121.3.371>
- The Princeton Review. (2012). *The best 300 professors*. Farmingham, MA: Author.
- Thorndike, E. L., & Woodworth, R. S. (1901). The influence of improvement in one mental function upon the efficiency of other functions. *Psychological Review*, *8*, 247–261. <http://dx.doi.org/10.1037/h0074898>
- Tofighi, D., & MacKinnon, D. P. (2011). RMediation: An R package for mediation analysis confidence intervals. *Behavior Research Methods*, *43*, 692–700. <http://dx.doi.org/10.3758/s13428-011-0076-x>
- Voyer, D., & Voyer, S. D. (2014). Gender differences in scholastic achievement: A meta-analysis. *Psychological Bulletin*, *140*, 1174–1204. <http://dx.doi.org/10.1037/a0036620>
- Vroom, V. H. (1964). *Work and motivation*. New York, NY: Wiley.
- Walton, G. M., & Cohen, G. L. (2011). A brief social-belonging intervention improves academic and health outcomes of minority students. *Science*, *331*, 1447–1451. <http://dx.doi.org/10.1126/science.1198364>
- Wigfield, A., & Cambria, J. (2010). Expectancy-value theory: Retrospective and prospective. In T. C. Urdan & S. A. Karabenick (Eds.), *The decade ahead: Theoretical perspectives on motivation and achievement* (*Advances in motivation and achievement*; Vol. 16, pp. 74–146). Bingley, UK: Emerald Group Publishing Limited.
- Wilson, T. D. (2006). Behavior: The power of social psychological interventions. *Science*, *313*, 1251–1252. <http://dx.doi.org/10.1126/science.1133017>
- Yeager, D. S., & Walton, G. M. (2011). Social-psychological interventions in education: They're not magic. *Review of Educational Research*, *81*, 267–301. <http://dx.doi.org/10.3102/0034654311405999>

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