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Implicit Theories of Intelligence Predict Achievement Across an Adolescent Transition: A Longitudinal Study and an Intervention

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Two studies explored the role of implicit theories of intelligence in adolescents' mathematics achievement. In Study 1 with 373 7th graders, the belief that intelligence is malleable (incremental theory) predicted an upward trajectory in grades over the two years of junior high school, while a belief that intelligence is fixed (entity theory) predicted a flat trajectory. A mediational model including learning goals, positive beliefs about effort, and causal attributions and strategies was tested. In Study 2, an intervention teaching an incremental theory to 7th graders ($N = 48$) promoted positive change in classroom motivation, compared with a control group ($N = 43$). Simultaneously, students in the control group displayed a continuing downward trajectory in grades, while this decline was reversed for students in the experimental group.

The adolescent years are filled with many changes, making it a psychologically intriguing stage of development. The adolescent experiences rapid maturational changes, shifting societal demands, conflicting role demands, increasingly complex social relations, and new educational expectations (e.g., Montemayor, Adams, & Gullotta, 1990, Wigfield, Byrnes, & Eccles, 2006). These intense changes have led many researchers to view adolescence as a time of challenge with the potential for both positive and negative outcomes. While most individuals pass through this developmental period without excessively high levels of "storm and stress," many individuals do experience difficulty. For example, in their study of the *Four stages of life*, Lowenthal, Thurnher, and Chiriboga (1975) found that 40% of respondents rated adolescence as the worst time of life—much higher than any other stage of the life course.

Recent research has specifically targeted the early adolescent years as a critical point in development. That is, relatively few problems are found during late childhood; in general, these younger children are well behaved, feel good about themselves, and do well in school during those years. In contrast, the early adolescent years are marked by normative increases in antisocial behavior and normative declines in self-esteem, school engagement, and grades (e.g., Eccles, 2004; Harter, 1998; Simmons & Blyth, 1987; Watt, 2004; Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991; Wigfield, Eccles, & Pintrich, 1996). Elder (1968) noted that the entry into junior high school (normally occurring at age 12 or 13) may be the closest American society comes to a formal rite of passage. As such, the junior high transition has been thought of as a catalyst for future problems (Eccles, 2004; Montemayor et al., 1990; Wigfield et al., 2006).

Eccles, Midgley et al. (1993) found several differences between the elementary school and junior high school contexts that could account for this effect. The junior high school environment emphasizes competition, social comparison, and ability self-assessment at a time of heightened self-focus; it is associated with a decrease in decision making and choice at a time when the desire for control is growing; and it disrupts social networks and support when they are most needed. Together, these changes point to a mismatch between the adolescent's needs and the environment they are thrown into—one common result of which is disengagement from school (Eccles, Wigfield, Midgley, & Reuman, 1993; Eccles, 2004; Entwisle, 1990).

How students negotiate these changes has major implications for their academic futures. Sadly, in the face of these challenges, many students (including

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many able students) suffer declining grades, and some never recover from such setbacks (Eccles, Lord, & Midgley, 1991; Gutman & Midgley, 2000; Midgley, Feldlaufer, & Eccles, 1989; Wigfield et al., 1996). However, clearly not all students succumb. Therefore, in recent years, researchers and practitioners have been especially interested in exploring what makes some students resilient and able to meet these challenges or even to flourish during this time (Dweck & Sorich, 1999; Eccles et al., 1991; Gutman & Midgley, 2000; Henderson & Dweck, 1990; Pintrich & de Groot, 1990; Wigfield & Eccles, 2002). At the same time, the urgent press to find remedies for these problems has led to a call for theory-based intervention strategies to address the motivational problems so prevalent in adolescence (Maehr & Midgley, 1996; Maehr & Meyer, 1997; Midgley & Edelin, 1998; Stipek et al., 1998).

A Motivational Model of Achievement

What are the psychological mechanisms that enable some students to thrive under challenge, while others of equal ability do not? Over the past years, one motivational model that has been developed to address this question suggests that core beliefs can set up different patterns of response to challenge and setbacks (Dweck, 1999; Dweck & Leggett, 1988; Dweck & Sorich, 1999; Henderson & Dweck, 1990). In the present research, we apply this model to understand what helps or hinders students' motivation and achievement as they negotiate the transition to junior high school.

Implicit Theories of Intelligence: Two Frameworks

In this model (see Dweck & Leggett, 1988; Dweck, 1999), students may hold different "theories" about the nature of intelligence. Some believe that intelligence is more of an unchangeable, fixed "entity" (an *entity* theory). Others think of intelligence as a malleable quality that can be developed (an *incremental* theory). Research has shown that, even when students on both ends of the continuum show equal intellectual ability, their theories of intelligence shape their responses to academic challenge. For those endorsing more of an entity theory, the belief in a fixed, uncontrollable intelligence—a "thing" they have a lot or a little of—orients them toward measuring that ability and giving up or withdrawing effort if the verdict seems negative. In contrast, the belief that ability can be developed through their effort orients those endorsing a more incremental theory toward challenging tasks that promote skill acquisition and toward using effort to overcome difficulty (Dweck & Leggett, 1988).

Relative to entity theorists, incremental theorists have been found (a) to focus more on *learning goals* (goals aimed at increasing their ability) versus *performance goals* (goals aimed at documenting their ability; see e.g., Dweck & Leggett, 1988); (b) to believe in the utility of effort versus the futility of effort given difficulty or low ability (e.g., Hong, Chiu, Dweck, Lin, & Wan, 1999); (c) to make low-effort, mastery-oriented versus low-ability, helpless attributions for failure (e.g., Henderson & Dweck, 1990); and (d) to display mastery-oriented strategies (effort escalation or strategy change) versus helpless strategies (effort withdrawal or strategy perseveration) in the face of setbacks (e.g., Robins & Pals, 2002). Thus, these two ways of thinking about intelligence are associated with two distinct frameworks, or "meaning systems" (Hong et al., 1999), that can have important consequences for students who are facing a sustained challenge at a critical point in their lives. It is important to recognize that believing intelligence to be malleable does not imply that everyone has exactly the same potential in every domain, or will learn everything with equal ease. Rather, it means that for any given individual, intellectual ability can always be further developed. (See, e.g., the description of academic ability as developing expertise in Sternberg & Horvath, 1998.)

Impact of Theories of Intelligence on Real-World Academic Achievement

Researchers have begun to assess the consequences of these two different frameworks for student outcomes (see, e.g., Hong et al., 1999; Robins & Pals, 2002; Stipek & Gralinski, 1996). In a study of students undergoing a junior high school transition, Henderson and Dweck (1990) found that students who endorsed more of an incremental view had a distinct advantage over those who endorsed more of an entity view, earning significantly higher grades in the first year of junior high school, controlling for prior achievement.

The relation between theory of intelligence and achievement is further supported by experimental research. For example, Aronson, Fried, and Good (2002) taught an incremental theory to college students, and compared them with two control groups: one a no-treatment group; and one taught a version of the "multiple intelligences" model of ability (Gardner, 1983). Students in the incremental theory training group subsequently earned higher grades, controlling for SAT scores, than did their counterparts in either the multiple intelligence or the no-treatment control groups. In a recent study, Good, Aronson, and Inzlicht (2003) also found that an incremental theory intervention led to significant improvement in adolescents' achievement test scores compared with a control group.

These studies show that theories of intelligence can be manipulated in real-world contexts and have a positive impact on achievement outcomes. However, these studies had several limitations. First, they did not examine the role of theories of intelligence in long-term achievement trajectories. Second, they did not examine mediators of the impact of theories of intelligence on change in grades. Third, they did not probe for motivational changes in the classroom. Fourth, in the Good, Aronson, and Inzlicht study with adolescents, the control group received an antidrug message, not an academic intervention. Thus, several important questions remain unanswered. First, are students' theories related to their achievement *trajectory*? Previous research has shown that theory of intelligence is related to one-time assessments of grades and standardized tests, but it is not clear whether students' theories of intelligence can have lasting effects across junior high school or whether changing implicit theories can reverse a downward achievement trajectory.

Second, *why* is theory of intelligence related to grades? No previous research has examined the process or mechanisms through which theory of intelligence is related to grades or through which changing theory of intelligence results in improved grades.

Third, does teaching an incremental theory provide an added benefit over a similar academic intervention? And finally, might change in theory have an impact on classroom behavior? The current research addressed these questions.

The Present Research

The present research uses data from a longitudinal field study of students in their junior high school years and a classroom intervention study to examine the relation between theory of intelligence and achievement, and to test mediators of this relation. We report results that extend previous research in several ways. First, the present research followed students through junior high school to examine the relation of theory of intelligence to longer term achievement trajectories. Previous research has relied on one-time assessments of achievement outcomes when examining the link between theory of intelligence and real-world achievement. Second, the present research tests a mediational model of the relation between theory of intelligence and achievement outcomes. Previous research has suggested several individual motivational variables that may play a role in this relation, but the full mediational model has never been tested in a single study. Third, the present research uses an intervention to test whether teaching an incremental theory of intelligence can reverse a declining achievement trajectory. Finally, the present research moves beyond self-reports and assesses whether students' *behavior* changed in response to the incremental intervention by examining teachers' spontaneous reports of students' behavior.

Study 1

In Study 1, we followed four waves of entering junior high school students, measuring their implicit theories and other achievement-related beliefs at the outset of junior high and then assessing their achievement outcomes as they progressed through the seventh and eighth grades. We then tested an integrated causal model, based on prior experimental research, of the processes linking achievement-related beliefs measured at the onset of junior high to achievement strategies and actual achievement outcomes over the junior high transition.

Method

Participants and Procedures

Participants were 373 students (198 females and 175 males) in four successive entering seventh-grade classes of 67–114 students each, at a public secondary school in New York City (due to the small sample sizes of the individual cohorts, we present findings collapsed across the four cohorts). The cohorts did differ significantly on their grades (e.g., the mean grades at the beginning of junior high school were 70.79, 68.49, 74.95, and 81.68 for Cohorts 1–4, respectively) and theory of intelligence (e.g., the mean theory scores at the beginning of junior high school were 4.51, 4.20, 4.40, 4.64 for Cohorts 1–4, respectively); however, they did not differ systematically (i.e., linearly across the cohorts). Importantly, the effect of theory on grades was not dependent on cohort.

The sample was varied in ethnicity, achievement, and socioeconomic status (SES). The participants were 55% African American, 27% South Asian, 15% Hispanic, and 3% East Asian and European American. They were moderately high-achieving, with average sixth-grade math test scores at the 75th percentile nationally; 53% of the participants were eligible for free lunch. Each of the four waves of students was followed through the full 2 years of junior high school. Informed consent was obtained each year from parents and students. We emphasized the voluntary nature of participation and the fact that students could withdraw at any time without penalty.

The 5-year study followed four waves of students as they progressed through the seventh and eighth grades. At the beginning of the fall term, participants in the entering seventh grade class filled out the motivational questionnaire assessing theory of intelligence, goals, beliefs about effort, and helpless versus mastery-oriented responses to failure. Two or more trained research assistants administered the questionnaire during a regular class period with the permission of the teacher. We obtained prior mathematics achievement test scores (spring of sixth grade) for the students entering seventh-grade class from school records. Each year, at the end of both the fall and spring terms, we obtained mathematics grades for all seventh- and eighth-grade students participating in the study.

There was one math teacher teaching each grade —thus, only one teacher per cohort per year. Classes were heterogenous with respect to achievement (i.e., there was no mathematics tracking in the school). There was nothing unusual about the mathematics instruction in the school (i.e., it was not particularly progressive or innovative). The students were relatively high-performing on average compared with the mean for public school students in New York City, but not extraordinarily so, and there was a substantial number of students who were not high-performing. (In Study 2 we will test that the relation between theory, other beliefs, and math achievement can be replicated in a different school with a lower-achieving student population.)

Measures

Achievement (baseline and outcome). National percentile scores on the Citywide Achievement Test (CAT), a standardized mathematics achievement test given in the spring term of sixth grade ($M = 38.31$, standard deviation [SD] $= 6.86$, range $= 19-50$), served as the measure of prior mathematics achievement. Seventh-grade fall ($M = 74.04$, $SD = 13.16$, range $= 50-98$) and spring ($M = 75.37$, $SD = 13.10$, range $= 50-99$) and eighth-grade fall ($M = 73.42$, $SD = 15.02$, range $= 50-100$) and spring ($M = 75.20$, $SD = 15.04$, range $= 49-99$) term grades in math were used to assess academic outcomes. (All students within each grade took the same mathematics curriculum with the same teacher.) Students' mathematics grades were based on a combination of tests, homework, a project, and class participation. Mathematics is a subject that many students find difficult; thus, it meets the requirement of being a sufficiently challenging subject to trigger the distinctive motivational patterns related to theory of intelligence, which may not manifest themselves in situations of low challenge (Grant & Dweck, 2003). Mathematics is also a subject in which progress requires building upon previously learned material; thus, deficits in math skills may tend to accumulate over time, producing longer term differences in achievement trajectories. In addition, because assessment of progress in mathematics is relatively objective (with evidence of mastery of specific concepts and operations in the form of verifiable answers) outcomes should accurately reflect real and sustained achievement over time.

Motivational Variables

A set of scales designed to measure key motivational variables, including implicit theories of intelligence, goal orientation, beliefs about effort, and attributions and strategies in response to failure, was used to assess participants' motivational profiles at the outset of junior high school. This questionnaire consists of the following subscales, containing items rated on a 6-point Likert-type scale from 1 (*Agree Strongly*) to 6 (*Disagree Strongly*).

Theory of intelligence. The scale consists of six items: three entity theory statements (e.g., ''You have a certain amount of intelligence, and you really can't do much to change it''); and three incremental theory statements (e.g., ''You can always greatly change how intelligent you are''; Dweck, 1999). The incremental theory items were reverse scored and a mean theory of intelligence score was calculated for the six items, with the low end (1) *representing a pure entity theory*, and the high end (6) *agreement with an incremental theory*. The internal reliability of the theory measure was .78 in Study 1 ($N = 373$), with a mean of 4.45 and a SD of .97 (range 1–6). The test–retest reliability for this measure over a 2-week period was .77 ($N = 52$).

Learning goals. (From the Patterns of Adaptive Learning Survey [PALS], Task Goal Orientation subscale, Midgley et al., 1998). The three items of the learning goal subscale ($\alpha = .73$, $M = 4.41$, $SD = 1.09$, $N = 373$) were selected from the PALS and measure the value of learning as a motivation (''An important reason why I do my school work is because I like to learn new things'') even when it is not easy (''I like school work best when it makes me think hard'') or conflicts with short-term performance (''I like school work that I'll learn from even if I make a lot of mistakes''). The test–retest reliability for this measure over a 2-week period was .63 ($N = 52$).

Effort beliefs. The nine-item effort beliefs subscale contained four positive and five negative items (Blackwell, 2002). Positive items measured students' belief that effort leads to positive outcomes (e.g., ''The harder you work at something, the better you will be at it''). Negative items assessed students' belief that effort has an inverse, negative relation to ability (''To tell the truth, when I work hard at my schoolwork, it makes me feel like I'm not very smart''), and is ineffective in achieving positive outcomes (''If you're not good at a subject, working hard won't make you good at it''). Items were merged to create a measure of Positive Effort Beliefs ($\alpha = .79$, $M = 4.66$, $SD = .89$). The test–retest reliability for this measure over a 2-week period was .82 ($N = 52$).

Helpless responses to failure. To assess students' characteristic response patterns to academic difficulty, students were presented with a hypothetical failure scenario, and asked to report what they would think and what they would do as a result (Blackwell, 2002):

> You start a new class at the beginning of the year and you really like the subject and the teacher. You think you know the subject pretty well, so you study a medium amount for the first quiz. Afterward, you think you did okay, even though there were some questions you didn't know the answer for. Then the class gets their quizzes back and you find out your score: you only got a 54, and that's an F.

Participants were asked to rate their likely response on the following two subscales:

(a) Helpless attributions ($\alpha = .76$, $M = 4.82$, $SD = 1.18$): Students rated how much they would think their ability or other factors caused the failure. Two high mastery (effort-based) attributions were initially included (''I didn't study hard enough,'' ''I didn't go about studying in the right way'') but were endorsed by most students and were dropped to increase reliability. The remaining four helpless attributions were retained, and a scale reflecting fewer ability-based, ''helpless'' attributions was indexed by disagreement with these items. (''I wasn't smart enough,'' ''I'm just not good at this subject,'' ''The test was unfair,'' ''I didn't really like the subject''). The test–retest reliability for this measure over a 2-week period was .85 ($N = 52$).

(b) Positive strategies ($\alpha = .84$, $M = 5.19$, $SD = 1.15$): Students rated how likely they would be to engage in positive, effort-based strategies (e.g., ''I would work harder in this class from now on'' ''I would spend more time studying for tests'') or negative, effort-avoidant strategies (e.g., ''I would try not to take this subject ever again'' ''I would spend less time on this subject from now on'' ''I would try to cheat on the next test''). Positive and negative items were combined to form a mean Positive Strategies score. The test–retest reliability for this measure over a 2-week period was .71 ($N = 52$).

Results and Discussion

Relations Among Theory of Intelligence and Other Motivational Variables

As shown in Table 1, an incremental theory of intelligence was positively associated with positive effort beliefs ($r = .54$, $p < .01$), learning goals ($r = .34$, $p < .01$), low helpless attributions ($r = .44$, $p < .01$), and positive strategies ($r = .45$, $p < .01$). In addition, these variables were all significantly positively correlated with one another (rs ranged from .34 to .72, $p < .01$). Thus, an incremental theory of intelligence, learning goals, positive beliefs about effort, non helpless attributions, and strategies in response to failure formed a network of interrelated variables.

Relation Between Theory of Intelligence and Academic Achievement

Theory of intelligence and other motivational variables measured at the beginning of seventh grade were not significantly correlated with prior (sixth-grade spring) math test scores (rs ranged from $-.09$ to .09, *ns*). Thus, these variables cannot be

Table 1
Relations Among Theory of Intelligence and Motivational Variables Measured at Beginning of Seventh Grade

	1.	2.	3.	4.	5.	6.
1. Incremental theory						
2. Learning goals	.34**					
3. Positive effort beliefs	.54**	.58**				
4. Low helpless attributions	.44**	.41**	.64**			
5. Positive strategies	.45**	.54**	.72**	.62**		
6. Sixth-grade math achievement	.09	−.06	−.02	.02	−.03	

Note. ** $p < .01$.

considered artifacts of high prior ability or achievement (cf. Pomerantz & Saxon, 2001). However, as students made the transition to junior high school, their theory of intelligence became a significant predictor of their mathematics achievement (*r*s ranged from .12 in the fall term of seventh grade, $p<.05$, to .20 in the spring term of eighth grade, $p<.05$). Moreover, an incremental theory of intelligence at the beginning of junior high school predicted higher mathematics grades earned at the end of the second year of junior high school ($\beta = .17$, $t = 3.40$, $p<.05$), controlling for the effect of math achievement test scores before entering junior high school ($\beta = .43$, $t = 8.48$, $p<.05$). This result held ($\beta = .10$, $t = 2.50$, $p<.05$) using math grades earned in the first term of junior high school ($\beta = .70$, $t = 17.50$, $p<.05$) instead of end of sixth-grade test scores.

Relation of Theory of Intelligence to Mathematics Grade Growth Trajectories

To assess the contribution of theory of intelligence to the *trajectory* of achievement over the junior high school transition, we looked at the growth curves in mathematics grades for students with different implicit theories. Growth curves were computed using Bryk and Raudenbush's (1987, 1992) Hierarchical Linear Modeling (HLM) program. The Level 1 equation was

$$Y_{it} = \beta_{0i} + \beta_{1i}(\text{time}) + e_{it},$$

where β_0 represents the intercept, or the average math grades at Time 1 (i.e., time was coded as 0, 1, 2, 3), and β_1 is the slope, or average change per unit of time. The trajectory of math grades was computed across the four assessments (fall seventh grade, spring seventh grade, fall eighth grade, and spring eighth grade).

Implicit theory of intelligence was entered at Level 2. Before computing the growth curves, we wanted to control for potential differences between the four cohorts. Although all students within each cohort had the same teacher and curriculum, not all cohorts had the same teacher; thus, there could be differences in the grading practices or efficacy of teachers between cohorts. Therefore, dummy variables were created for each cohort and entered into the equation at Level 2. The Level 2 equation for the growth curves was

$$\begin{aligned}\beta_{0i} &= \gamma_{00} + \beta_{01}(\text{theory}) + \gamma_{02}(\text{Cohort 1}) \\ &\quad + \gamma_{03}(\text{Cohort 2}) + \gamma_{04}(\text{Cohort 3}) \\ \beta_{1i} &= \gamma_{10} + \gamma_{11}(\text{theory}) + \gamma_{12}(\text{Cohort 1}) \\ &\quad + \gamma_{13}(\text{Cohort 2}) + \gamma_{14}(\text{Cohort 3}).\end{aligned}$$

By entering the cohort dummies into the Level 2 equations, we are estimating the mean-level growth adjusted for possible cohort differences. The average grade at Time 1 for the sample was 72.05, about a C –. There was no main effect of theory of intelligence on Time 1 grades ($\beta = .98$, $t = 1.47$, *ns*) and no change in average grade across the 2 years ($\beta = .39$, $t = .90$, *ns*). However, there was a significant effect of theory of intelligence on change in grades ($\beta = .53$, $t = 2.93$, $p<.05$). The significant effect of theory of intelligence at Level 2 represents an interaction between theory of intelligence and time. This interaction suggests that the math achievement growth patterns differ based on one's theory of intelligence. To understand this interaction, we followed the guidelines suggested by Aiken and West (1991) and graphed the interaction using scores of 1 *SD* above and below the theory of intelligence mean (see Figure 1).

Although students with the entity and incremental theories did not differ significantly in their math achievement test scores as they entered junior high school, as these results show, they began to pull apart over the 2 years of junior high school. We found that theory of intelligence is related to a set of motivational constructs; thus, we need to take the motivational constructs into account when discussing the effect of theory of intelligence. In the next section, we address the role of these motivational constructs.

Mediational Pathways

One goal of the present study was to go beyond documenting the relation between theory of intelligence and academic achievement to explain why this relation exists. However, we had four mediators that might, individually or in combination, explain this

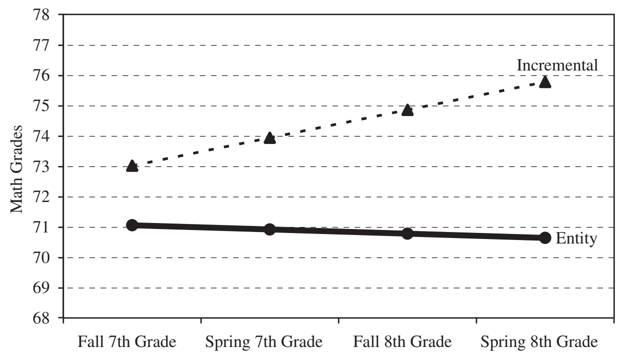

Figure 1. Graph of interaction effect of theory of intelligence and time on math achievement: Growth curves of predicted mathematics grades over 2 years of junior high school for students with incremental (+1 *SD* above the mean) and entity (– 1 *SD* below the mean) theories of intelligence.

relation, and classic tests of mediation (e.g., Baron & Kenny, 1986) are designed for one mediator. Therefore, we used three complementary approaches to address the question of why an incremental theory is related to increasing math grades. First, we created a single factor of the four hypothesized motivational constructs (learning goals, positive effort beliefs, low helpless attributions, and positive strategies) and followed Baron and Kenny's (1986) guidelines for testing mediation to determine whether this motivational factor mediates the relation between theory of intelligence and school performance. Second, we treated the motivational constructs independently and used structural equation modeling (SEM) to test a model that explains the process of why theory of intelligence is associated with school performance. Third, we combined these two methods and tested whether each trivariate relation in the process model (created in the second method) passes the test of mediation. Below we present the results for each method.

Single factor. We entered all the items for the motivational constructs into an exploratory factor analysis and saved the first unrotated factor score. All items had loadings on this first factor above .30, except 3 of the 12 effort beliefs and 1 of the 4 learning goal items. This factor accounted for 31.79% of the variance, and represents the shared variance between the four motivational constructs. We next tested whether this global motivational factor mediated the relation between incremental theory and change in grades (i.e., the difference between math grades from the beginning to the end of junior high school). We found that it was a significant mediator of this relation ($z = 2.04$, $p < .05$). The incremental theory effect on change in math grades was reduced from .20 ($p < .05$) to .11 (*ns*; the effect of the factor on grades was .19, $p < .05$). Thus, an incremental theory predicted more positive motivational patterns, which in turn led to increasing math grades.

Process model. We used SEM with latent variables and began by examining the measurement model in which all latent variables were allowed to covary freely. Implicit theory was indexed by the three entity items and the three incremental items (reverse scored); learning goals were indexed by the three learning goal items. Positive effort beliefs were indexed by four parcels; three of these included one positive (reverse scored) and one negative item paired at random, while the fourth contained one positive (reverse scored) and two negative items (see Kishton & Widaman, 1994, for a discussion of parceling of questionnaire items). Low helpless attributions were indexed by four items, and positive strategies by five items. Growth curves of math grades over the 2 years of junior high school (four assessments) were used as the outcome variable (''increasing math grades''). The measurement model had adequate fit to the data ($\chi^2 = 517.47$, $p < .05$, $df = 253$, CFI = .94, RMSEA = .05, $p = .22$). The modification indices suggested that the ''spend more time'' item from the strategies factor and the ''you can learn new things, but can't really change your basic intelligence'' and ''no matter how much intelligence you have, you can always change it'' items from the theory of intelligence scale could load onto the learning goals factor. However, the magnitude of these loadings was much lower than the other learning goals items (all $< .17$); therefore we chose not to model these cross-loadings.

We next sought to test the fit of our process model. Our model specified that an incremental theory of intelligence leads to positive effort beliefs and learning goals, which in turn lead to fewer ability-based, helpless attributions and more positive strategies, which in turn lead to improved grades. This full model has never been tested simultaneously; however, several of the proposed paths have been tested individually in the laboratory to establish the causal links or in real-world settings with longitudinal data. Previous research has shown (a) an incremental versus entity theory of intelligence leads to pursuing learning versus performance goals (e.g., Dweck, Tenney, & Dinces, 1982); (b) an incremental versus entity theory of intelligence leads to having positive versus negative beliefs about effort (e.g., Hong et al., 1999); (c) pursuing learning versus performance goals leads to a mastery versus helpless response pattern (e.g., Elliott & Dweck, 1988; Robins & Pals, 2002); and (d) pursuing learning versus performance goals leads to improving grades (Grant & Dweck, 2003).

Figure 2 shows the full model with standardized path coefficients. The model had adequate fit to the data ($\chi^2 = 6{,}044.23$; $df = 291$; $p < .05$; CFI = .92; RMSEA = .06; p close fit = .03). All proposed paths were significant at the .05 level or better, except that from learning goals directly to attributions. This nonsignificant path was not included in the final model. In addition, the covariance between the intercept and slope was nonsignificant; thus, it was students' motivational framework, rather than their initial achievement, that determined whether their math grades would climb or not as they made their way through junior high school.

Process model and mediation tests. The process model suggests multiple mediational pathways. That is, it suggests that (a) learning goals mediate the relation between incremental theory and positive

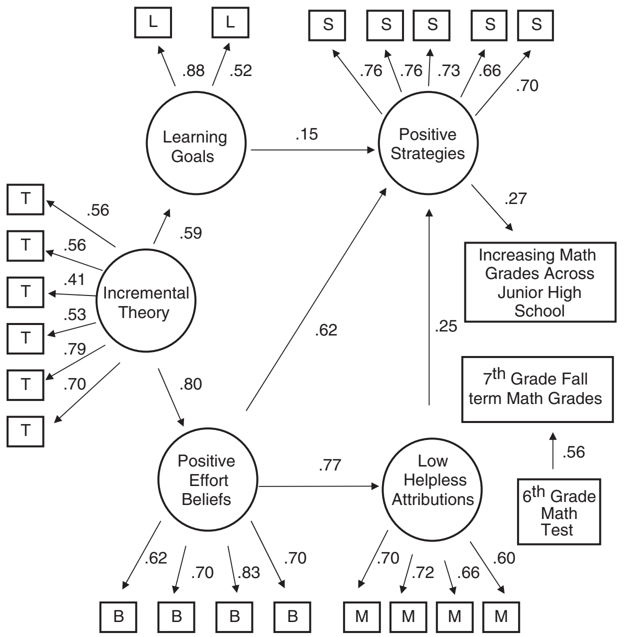

Figure 2. Path model of processes linking fall seventh-grade theory of intelligence and other motivational variables to growth curves of mathematics grades over 2 years of junior high school (Study 1). $N = 373$. Standardized coefficients presented. $\chi^2 = 606.22$; $df = 290$; $p < .05$; CFI = .990; RMSEA = .068; p close fit = *ns*. The covariance between learning goals and positive effort beliefs was modeled ($r = .49$), but is not depicted for ease of presentation. All paths $p < .05$.

strategies, (b) positive strategies mediate the relation between learning goals and increasing grades, (c) effort beliefs mediate the relation between incremental theory and helpless attributions, (d) effort beliefs mediate the relation between incremental theory and positive strategies, (e) helpless attributions mediate the relation between effort beliefs and positive strategies, (f) positive strategies mediate the relation between effort beliefs and increasing grades, and (g) positive strategies mediate the relation between helpless attributions and increasing grades. The overall fit of the model suggests that the model reproduces the interrelations among the variables well; however, it cannot tell us whether the individual paths represent significant mediation. Therefore, we used OLS regression and the Sobel (1982) test to test the significance of each mediational pathway in the model. We conducted seven tests of mediation using learning goals, effort beliefs (twice), helpless attributions, and positive strategies (three times) as the mediators. All seven tests showed that the mediation was significant (*z*s ranged from 2.14 to 8.56, *p*s < .05).

Thus, although we found that the shared variance among the four mediators explains the relation between theory of intelligence and grades, our process model suggests that there might be unique interrelations among the motivation constructs that explain *why* theory of intelligence is related to grades. Further research is needed to determine whether it is the unique variance and interrelations that are important or whether the relation between theory of intelligence and grades is better explained by a global motivational construct.

In summary, Study 1 provided support for the validity of the proposed model of achievement motivation and did so in a real-world setting. Junior high school students who thought that their intelligence was a malleable quality that could be developed affirmed learning goals more strongly, and were more likely to believe that working hard was necessary and effective in achievement, than were students who thought that their intelligence was fixed. In turn, those students with learning goals and positive effort beliefs were more likely to make fewer ability-based, helpless attributions when faced with the prospect of setbacks: Students with these beliefs were less likely to attribute a potential failure to lack of ability, and more likely to say they would invest more effort or change strategy in response than were students who held an entity theory.

These different patterns of responses to challenge and difficulty were reflected in significant discrepancies in the actual performance of the students. Nearly 2 years later, students who endorsed a strong incremental theory of intelligence at the beginning of junior high school were outperforming those who held more of an entity theory in the key subject of mathematics, controlling for prior achievement. Moreover, their motivational patterns mediated this relation such that students with an incremental orientation had more positive motivational beliefs, which in turn were related to increasing grades.

Study 2

If the different theories of intelligence are indeed associated with contrasting motivational patterns, then teaching students to think of their intelligence as malleable should cause them to display more positive motivation in the classroom, and in turn to achieve more highly. In Study 2, we first replicated the test of our mediational model on a new, lower-achieving sample of students over a shorter time course. Next, in the spring term, we performed an intervention to teach an incremental theory to half of the students, and then assessed the effects on classroom motivation and achievement, in comparison with students in a control group. Do students, having been taught to think of intelligence as malleable, show more positive motivation and greater effort in the classroom? Do they achieve more highly than their peers who were taught useful skills but were not taught the incremental theory?

Method

Participants

Participants were 99 students (49 females and 50 males) in the seventh-grade class at a public secondary school located in New York City (this sample was drawn from a different school than Study 1). The participants were 52% African American, 45% Latino, and 3% White and Asian. The students were relatively low-achieving, with sixth-grade math test scores at the 35th percentile nationally. Seventy-nine percent of the students were eligible for free lunch. Participation in the study was entirely voluntary, and the consent of both parents and students was obtained in advance. Of the 99 seventh-grade students who took part in the questionnaire study, a total of 95 students subsequently elected to participate in the intervention study. Of these 95, 5 students (3 from the experimental and 2 from the control group) were unable to attend sessions regularly, and were therefore eliminated from the analysis. Thus, a total of 91 students participated in the incremental theory intervention: 48 in the experimental group and 43 in the control group. Students in the two groups did not differ significantly in their academic achievement (fall term math grades were 2.38 for the experimental group, vs. 2.41 for the control group, on a 4.0 scale) or on any of the baseline motivational constructs.

Materials and Procedure

Measures: Achievement (baseline and outcome). Sixth-grade mathematics grades served as measures of prior student achievement. Seventh-grade fall and spring term final grades in mathematics were used to assess outcomes in the form of growth curves.

Motivational variables. The same questionnaire administered in Study 1 was used to assess students' initial motivational profiles, including theories of intelligence, learning and performance goals, beliefs about effort, and attributions and strategies in response to failure at the beginning of the fall seventh-grade term.

Intervention protocol. The intervention was conducted during eight 25-min periods, one per week, beginning in the spring term of seventh grade. Students were seen in their existing advisory classes, to which they had been assigned by the school at random in groups of 12–14 students. These periods had initially been designated as periods during which students were to receive more individual attention from a teacher. Each existing advisory group was randomly assigned to either the experimental (incremental theory training) condition or to the control condition. Students were told that they had the opportunity to participate in an 8-week workshop in which they would learn about the brain and be given instruction that could help them with their study skills after which they would receive a certificate of completion, and that their participation was voluntary.

Table 2 provides an overview of the eight-session intervention protocol. Students in both the experimental and control groups participated in similarly structured workshops, both of which included instruction in the physiology of the brain, study skills, and antistereotypic thinking. In addition, through science-based readings, activities, and discussions, students in the experimental group were taught that intelligence is malleable and can be developed; students in the control group had a lesson on memory and engaged in discussions of academic issues of personal interest to them.

The intervention was modeled on and expanded from theory-altering experimental materials previously developed in lab studies (e.g., Chiu, Hong, & Dweck, 1997) and in the Aronson et al. (2002) theory-changing intervention (e.g., the depiction of growing neural pathways). The key message was that learning changes the brain by forming new connections, and that students are in charge of this process. This message of malleable intelligence was presented in the context of an interesting reading, which contained vivid analogies (e.g., to muscles becoming stronger) and examples (e.g., of relatively ignorant babies becoming smarter as they learned), supported by activities and discussions. (See Appendix A for detailed descriptions of the eight sessions.)

Research team. Sixteen undergraduate assistants were recruited to serve as mentors for the students, and were trained to teach one of the motivational intervention workshops. A team of two mentors served as workshop leaders for each of the groups. (To minimize differences between groups, each team consisted of one male and one female, and included one African American or Hispanic leader.) For each session, mentors were given readings to complete in advance, and then met in weekly training meetings to review the material and prepare to present it to students. Experimental and control group leaders met separately for those meetings in which training for the incremental theory lesson (Sessions 3 and 4)

Table 2
Summary Chart: Intervention Protocol

Sessions	Experimental group	Control group
1 and 2	*The Brain—Structure & Function*: Brain Anatomy, Localization of Function, Neuronal Structure, Neurotransmission	*Same as experimental group*
3 and 4	*Incremental Theory Intervention Reading* (aloud in class): "You Can Grow Your Intelligence" *Activity*: "Neural Network Maze," showing how learning makes your brain smarter	*Alternative Lesson: Memory Reading* (aloud in class): "Memory" *Activity*: "Grocery Store Tricks," teaching mnemonic strategies
5 and 6	*Anti-Stereotyping Lesson*: Slides, activity, discussion to illustrate the pitfalls of stereotyping. *Study Skills Lesson*: Slides, lecture, discussion, handouts teach time management and study skills.	*Same as experimental group*
7 and 8	*Discussions*: Learning makes you smarter; Labels (e.g., stupid, dumb) should be avoided	*Discussions*: Academic difficulties and successes, preferences; Memory and the brain

or for discussions based on that material (Sessions 7 and 8) was given. In place of training in the incremental theory intervention, control group mentors were trained in an alternative unit on the structure of memory. Otherwise, their intervention workshops contained the same content. After each classroom session, workshop leaders in each condition wrote summaries of the session and met separately for a debriefing.

Measures: Postintervention Assessment

Recall and comprehension of the workshop content. At the end of the intervention, students in both groups were given a multiple-choice quiz on the content of the workshops. Some of the questions tested information taught to both groups (e.g., "When you judge someone by how they look, you are probably using a memory/experiment/stereotype/plan"). Other items tested material taught in the experimental incremental theory group, but with plausible answers for students in the other group (e.g., "What happens in your brain when you learn something new? You run out of neurons/You grow strong new connections between nerve cells/Your brain chemicals get worn out."). We assured students that the purpose of the quiz was to find out how well we taught the workshop, and that they were not being graded and would receive their certificates regardless of the accuracy of their answers on the quiz.

Changes in theory of intelligence. To assess whether students' theory of intelligence changed over the course of the workshop, the Theory of Intelligence questionnaire was readministered to participants 3 weeks following the last session of the intervention.

Teacher assessments of students' classroom motivation and behavior. The math teacher was asked to cite in writing individual students who had shown changes in their motivational behavior in the spring term (after the workshop), and to describe these changes. These written comments were coded for whether a comment was made for each student and whether the comment referred to a positive change in motivational behavior. (The teacher did not know which experimental condition each student had been placed in, or indeed that there were two distinct groups.)

Achievement outcomes. Growth curves using assessments at three time points (spring sixth grade, fall seventh grade, and spring seventh grade) were used to examine differences between the experimental and control groups' achievement trajectories following the intervention. For the overall sample, the means were as follows: spring sixth grade ($M = 2.86$, $SD = 0.97$, range = 0–4.33), fall seventh grade ($M = 2.33$, $SD = 1.19$, range = 0–4), and spring seventh grade ($M = 2.11$, $SD = 1.30$, range = 0–4).

Results and Discussion

Replication of Mediational Analysis

We replicated the mediational analysis of the relation between initial theory of intelligence, other motivational variables, and mathematics grades at the end of the fall term of seventh grade. That is, the unrotated first factor (i.e., general motivational beliefs) mediated the relation between theory of intelligence and math grades, controlling for prior math achievement ($z = 1.83$, $p = .07$) and the process model fit the data well ($\chi^2 = 6.30$; $df = 7$; *ns*; CFI = 1.00; RMSEA = .00; *p* close fit = .66).

Impact of the Incremental Theory Intervention

Learning of material. We conducted a manipulation check by examining differences between the experimental and control groups on their learning of the intervention material. If the intervention was successfully communicated, then we would expect the experimental group to perform better on the items that tested their incremental theory knowledge, but the two groups should perform equally well on the items that tested their knowledge of brain structure and study skills. We used a one-way analysis of variance (ANOVA) to test whether the experimental and control groups differed in how well they learned the material. The groups did not differ on their scores for general workshop content, with the experimental group getting 73.0% correct versus 70.5% correct for the control group ($F = .18$, $d = .10$, *ns*). The experimental group, however, scored significantly higher on the items that tested the incremental theory intervention content than did the control group (84.5% vs. 53.9%, $F = 23.36$, $d = .95$, $p < .05$). In addition, we tested the learning of the incremental material across the experimental subgroups using ANOVA and found no differences ($F = 2.28$, *ns*). Thus, the theory of intelligence message was successfully communicated to the experimental groups, and learning of general content was equivalent across groups and across conditions.

Change in theory of intelligence. We also tested the efficacy of the intervention by examining change in experimental participants' theory of intelligence. As expected, a paired sample *t* test showed that participants in the experimental group changed in theory of intelligence such that they endorsed an incremental theory more strongly after participating in the intervention (4.36 preintervention vs. 4.95 postintervention, Cohen's $d = .66$, $t = 3.57$, $p < .05$), but participants in the control group did not change (4.62 preintervention vs. 4.68 postintervention, Cohen's $d = .07$, $t = .32$, *ns*). We tested whether the two groups differed significantly in the extent to which they changed using a 2 (experimental vs. control) by 2 (pretest, posttest) ANOVA with the pre–post scores as a repeated measures variable. We found that the experimental group did show a significantly greater change in theory of intelligence than the control group ($F = 3.98$, $p < .05$), and were significantly higher in incremental theory than the control group after the intervention ($d = .47$; $F = 4.50$, $p < .05$).

Change in classroom motivation. Teacher reports of students showing change in motivation in their math class were coded for positive or negative change by coders blind to the condition of the student referenced in the comment. Intercoder agreement was 100% for the categories of positive and negative change. Only two students were cited for negative change, and thus differences between the experimental and control groups could not be assessed. Seventeen students were cited by their teacher as showing improvement in motivation and/or performance. Of these, over three fourths (13 students) were in the experimental, incremental theory-training group. Thus, 27% of students in the experimental group were spontaneously cited by their teacher as showing positive change, compared with only 9% of those in the control group. This was a significant difference ($\chi^2 = 4.72$, odds ratio $= 3.26$, $p < .05$).

Following are the typical comments by the math teacher about students in the experimental group:

> "L., who never puts in any extra effort and doesn't turn in homework on time, actually stayed up late working for hours to finish an assignment early so I could review it and give him a chance to revise it. He earned a B+ on the assignment (he had been getting C's and lower)."
>
> "M. was [performing] far below grade level. During the past several weeks, she has voluntarily asked for extra help from me during her lunch period in order to improve her test-taking performance. Her grades drastically improved from failing to an 84 her recent exam."

Incremental Theory Intervention and Academic Achievement

Effect of intervention condition on mathematics grade trajectories. To assess the effect of the intervention on academic achievement, we examined the growth curves of students' math grades over the course of the study. We first examined how math achievement changed across the junior high school transition, using Bryk and Raudenbush's (1987, 1992) HLM program.

The intervention was conducted between the second and third time points. Our goal was to determine whether the intervention created a turning point in the math trajectories for the students in the experimental condition. For this purpose, we created a knot (also referred to as a change point) to determine whether there was an abrupt change in the math trajectory after the intervention (e.g., Biesanz, West, & Kwok, 2003). Creating a knot point provided several advantages over ANOVA or curvilinear growth curves. The knot point allowed us to (a) model the type of abrupt change that is not easily modeled with curvilinear trajectories, (b) use all the math achievement data that we have for each individual, and (c) test the hypothesis that the intervention serves as a turning point in the math trajectory for the students involved. We created dummy codes for the time segment before and after the knot point. That is, the Level 1 equation was

$$Y_{it} = b_{0i} + b_{1i}(X1) + b_{2i}(X2) + e_{it},$$

where b_0 represents the intercept or the average math grades at Time 1. $X1$ is a dummy variable representing change from Time 1 to Time 2 math grades; $X2$ is a dummy variable representing change from Time 2 to Time 3. The full equation represents a starting level of math grades (b_0) plus the change in math grades from Time 1 to Time 2 (b_1), plus the change in math grades from Time 2 to Time 3 (b_2). Thus, the full equation allows prediction of the growth terms separately for the two time intervals (before the intervention and after the intervention).

Students were randomly assigned to their math classes in both years, and all students had the same teacher and followed a common curriculum. However, in order to control for potential differences between the classrooms due to the classroom environment, or the teacher–classroom interactions, dummy variables were created for each class and entered into the equation at Level 2. The Level 2 equation for the growth curves was

$$\begin{aligned} b_{0i} =& g_{00} + g_{01}(\text{Class 1}) + g_{02}(\text{Class 2}) \\ &+ g_{03}(\text{Class 3}) \\ b_{1i} =& g_{10} + g_{11}(\text{Class 1}) + g_{12}(\text{Class 2}) \\ &+ g_{13}(\text{Class 3}) \\ b_{2i} =& g_{20} + g_{21}(\text{Class 1}) + g_{22}(\text{Class 2}) \\ &+ g_{23}(\text{Class 3}). \end{aligned}$$

By entering the classroom dummies into the Level 2 equations, we estimated the mean level growth between each time interval, adjusted for possible classroom effects.

To examine the effect of the intervention condition on the mathematics grades growth trajectory, we entered a dummy variable for experimental condition (0 = *control* and 1 = *experimental*) into all the Level 2 equations. The average grade for the sample at Time 1 (spring of sixth grade) was 2.72, about a C+. There was a significant decline in grades between Time 1 and Time 2 (fall of seventh grade; $b = -.34$, $t = -4.29$, $p < .05$) and between Time 2 and Time 3 (spring of seventh grade; $b = -.20$, $t = -2.61$, $p < .05$). There was no main effect of experimental condition on Time 1 grades ($b = .18$, $t = .83$, *ns*) or on change in grades between Time 1 and Time 2 ($b = -.12$, $t = -.60$, *ns*). However, there was a significant effect of experimental condition on change in grades across the intervention (Time 2 to Time 3; $b = .53$, $t = 2.93$, $p < .05$). Thus, the sample as a whole was decreasing in grades, but this decline was eliminated for those in the experimental condition (see Figure 3). The decline in grades suffered by the control group students mirrors that commonly observed over the junior high school transition (see, e.g., Gutman & Midgley, 2000). However, this downward trajectory was halted for the experimental group within a few months of the intervention teaching a malleable intelligence theory.

Mathematics achievement trajectories: Experimental condition and initial theory of intelligence. We anticipated that the impact of this targeted intervention would be the greatest for those students who initially endorsed an entity theory more strongly (and thus had more room for change in their theory and the most to gain in terms of positive motivation from the training). Therefore, we examined the effect of the interaction of experimental condition and students' initial theory of intelligence (measured at the beginning of seventh grade) on change in math grades from Time 2 (preintervention) to Time 3 (postintervention); we found that the interaction effect was marginally significant ($b = -.28$, $t = -1.71$, $p < .10$). This effect is likely only marginally significant because of our small sample size and should be replicated with a larger sample with more power to detect the interaction.

To understand this interaction, we again followed the guidelines suggested by Aiken and West (1991) and graphed the interaction using scores of 1 *SD* above and below the theory of intelligence mean and

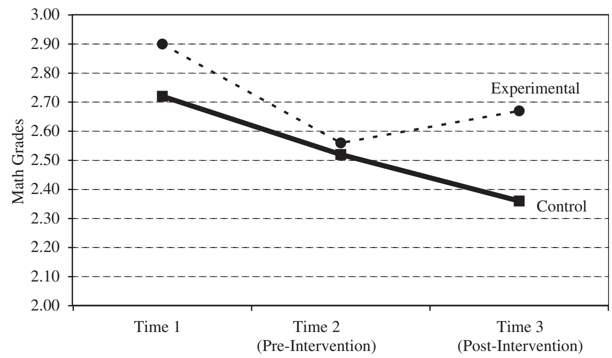

Figure 3. Predicted math grades by experimental condition.

found that students who endorsed more of an entity theory at the beginning of seventh grade reaped the most benefit from the incremental theory intervention. Their declining grade trajectory was reversed following the intervention, while the grades of students in the control group who endorsed more of an entity theory continued to decline. This finding supports the contention that it was the incremental theory message in particular that was responsible for the achievement benefit, rather than some other positive motivational factor in the experimental condition, which should have affected students with both theories of intelligence equally, and confirms that even a brief targeted intervention, focusing on a key belief, can have a significant effect on motivation and achievement.

General Discussion

Past research suggested that a student's theory of intelligence is a key belief, one that sets up contrasting patterns of achievement motivation. The present research demonstrates these relations in a real-world achievement setting, and begins to show just how these variables may influence academic outcomes over a challenging transition. This research confirms that adolescents who endorse more of an incremental theory of malleable intelligence also endorse stronger learning goals, hold more positive beliefs about effort, and make fewer ability-based, "helpless" attributions, with the result that they choose more positive, effort-based strategies in response to failure, boosting mathematics achievement over the junior high school transition. Furthermore, this motivational framework at the beginning of junior high school was related to the trajectories of students' math achievement over the 2 years of junior high school: Students who endorsed a more incremental theory framework increased in math grades relative to those who endorsed a more entity theory framework, showing that the impact of this initial framework remained predictive over time.

In an experimental study, teaching a malleable theory of intelligence was successful in enhancing students' motivation in their mathematics class, according to teacher reports. The experimental group, in addition, showed no decline in math performance after the intervention (as opposed to the decline found for them before the intervention and the continued declining grades found for the control group). The fact that promoting an incremental theory seemed to have the effect of generating increased motivation in the classroom again supports the idea that students' theory of intelligence is a key factor in their achievement motivation. Within a single semester, the incremental theory intervention appears to have succeeded in halting the decline in mathematics achievement.

The present research addresses a central question about the longevity of the achievement differences associated with implicit theories of intelligence (Henderson & Dweck, 1990), showing that students' theories when they made the transition to junior high school were related to their grades during the next 2 years of their junior high school experience. Furthermore, these findings support the idea that the diverging achievement patterns emerge only during a challenging transition. Before junior high school, students who endorsed more of an entity theory seemed to be doing fine. As noted in previous research, motivational beliefs may not have an effect until challenge is present and success is difficult (Dweck, 2002; Grant & Dweck, 2003). Thus, in a supportive, less failure-prone environment such as elementary school, vulnerable students may be buffered against the consequences of a belief in fixed intelligence. However, when they encounter the challenges of middle school, these students are less equipped to surmount them.

These different patterns also emerged during adolescence, when beliefs about intelligence appear to crystallize and become more coherent (see, e.g., Dweck, 2002; Nicholls & Miller, 1983; Nicholls, Patashnick, & Mettetal, 1986; Pomerantz & Ruble, 1997). As these conceptions of intelligence develop, they may begin to form a constellation with students' goals, beliefs about effort, attributions, and responses to challenge. Thus, they become linked in a framework of beliefs and goals that have real consequences for achievement. However, as our research has shown, the content of these meaning systems can differ substantially between individuals within the same developmental period, and thus can have very different impacts on their adaptation to the same environment. Prior research in developmental psychology has often paid insufficient attention to how individuals psychologically construct their worlds, and to the effect these meaning systems have on actual behavior and achievement (see Dweck & London, 2004; Levitt, Selman, & Richmond, 1991; Thompson, 2000). This line of inquiry is especially important because past and present research suggests that these meaning systems can be changed. More constructive mental models can be taught, with beneficial consequences for students' achievement.

There were many factors working against finding effects of the incremental theory intervention. First, the incremental theory portion of the intervention was performed when students were already more than a third of the way into the spring term. Thus, by the time of the intervention they had already earned some of the marks that would determine their final grade for the term. Second, math skills are cumulative and, even with strong motivation, it may be difficult for students to catch up on what they missed in so short a time. Third, the teacher already knew these students and may have had set impressions of them and their capabilities. Moreover, even if the teachers had expectations that participating in the workshop would help the students, they were blind to the students' experimental condition. Fourth, the control intervention was in many ways highly similar to the incremental intervention (except for the malleable intelligence message), and was in itself a seemingly substantial intervention, replete with positive messages and useful skills.

Limitations and Future Directions

The present study has several limitations. First, Study 1 and Study 2 were each conducted in a single school. Although our findings were consistent across the two schools, there may be factors specific to a school that aid or hinder the effect of the incremental theory training. Future studies should be conducted across schools to assess whether school effects are important. Second, in Study 2, although both groups received a session of antistereotype training, the students in the experimental group had an additional brief discussion about how terms such as stupid and dumb are a form of stereotyping. As a result, the experimental group received slightly more antistereotyping training than the control group. This extra antistereotyping training may have contributed to our findings. Third, in Study 2, the students were only followed for a short time. Further research is needed to assess the long-term effects of implicit theory interventions (e.g., is the change in students' theories permanent or do they regress to their initial theory levels?).

Fourth, our findings only begin to answer the question of why endorsing an incremental theory is related to better grades. Study 1 suggested several mediators, but more research is needed to test whether teaching an incremental theory leads to a change in those motivational variables. We have some very preliminary data to suggest that the incremental training did result in change in the motivational factors identified in Study 1. When the teachers' comments from Study 2 were coded for these factors, we found that teachers cited positive change in the very factors found to mediate the effects of incremental theory on grades. Specifically, the positive-change teachers' comments were further coded for two types of change: increased emphasis on effort (e.g., ''begun to work hard on a consistent basis'') and increased interest in learning (e.g., ''valued his growth in learning''). (Again, coders were blind to the targets' condition.) A comment could be coded as falling into more than one category if the teacher mentioned both of these factors. Intercoder agreement was 100% for the categories of increased effort and 86% for increase in learning goals. Differences in categorization were resolved through discussion. We found that more of the students in the incremental-theory training condition were cited by teachers as showing increased interest in learning (15% of incremental group vs. 2% of control group, $\chi^2 = 4.25$, odds ratio $= 7.17$, $p < .05$) and increased effort (23% of incremental group vs. 7% of control group, $\chi^2 = 4.43$, odds ratio $= 3.62$ $p < .05$) than were students in the control group. This is a very preliminary result and future research should include more detailed assessment of the mediators and their role in changing grades. Fifth, Study 2 only involved students. It is possible that our results would have been stronger if we had also included teachers and parents in the intervention. Finally, our findings are based on small effect sizes, so it is important to neither overestimate nor underestimate the practical significance of these findings. However, small effects are to be expected because academic achievement is a quintessential example of a multiply determined outcome (Ahadi & Diener, 1989). Moreover, it is often overlooked that small effect sizes can have a major impact on outcomes over time (Abelson, 1985; Rosenthal & Rubin, 1982).

Conclusion

Why should changing beliefs about the nature of intelligence make such a difference in students' attitudes and performance? How can one hope to influence student achievement without addressing the many overwhelming factors, such as home environments and school conditions, that have an impact on how students perform? Adopting this psychological approach, we do not deny the importance of these other influences. Rather, we suggest that ultimately, many of the important social environmental conditions have an influence through the psychology of the child (see RosenthalDweck & London, 2004). Children's beliefs become the mental ''baggage'' that they bring to the achievement situation. Indeed, research suggests that negative experiences have lasting negative effects *primarily* when they affect an individual's beliefs (see Dodge, Pettit, Bates, & Valente, 1995; Dweck & London, 2004; Gibb et al., 2001; Thompson, 2000).

While recognizing that there can be real differences between individuals in the speed of their intellectual growth, and without denying that there may be differences in capacity, we suggest that a child's focus on assessing these differences can have unfortunate consequences for motivation. In contrast, a focus on the potential of students to develop their intellectual capacity provides a host of motivational benefits.

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Appendix A: Intervention Protocol

Sessions 1 and 2: The Brain: Structure and Function.

Both motivation and control group: Using illustrative slides, ''Brain Fact'' cards, and activities, we taught all students in both conditions some of the basic facts about the anatomy and function of the brain. These included the fact that the brain consists of several regions that have different functions, such as sensory and motor, higher cognition, and memory; that it is divided into two hemispheres, connected by a bundle of nerve fibers; that it is connected to and transmits information to and from the body through the spinal cord; and that it is composed of billions of nerve cells, which are connected in a complicated network. We explained how information passes from nerve cell to nerve cell through a series of electrical and chemical signals, and illustrated this principle by having the students act as neurons and form an information chain along which an impulse, or message, was passed. Students also engaged in an ''experiment'' in which they mapped the touch sensitivity at various places (arm, hand, neck), and viewed a slide showing a ''homonculus,'' representing the differing amounts of brain area devoted to each part of the body.

Sessions 3 and 4: Theory Intervention/Memory Unit

Motivational intervention group: The students in this group took turns reading aloud an age-appropriate article written by the first author, ''You Can Grow Your Intelligence.'' The article described the changes that occur in the brain as a result of learning, including formation of new and stronger connections between nerve cells, and discussed scientific research findings that show how mental activity results in measurable physical changes in the brain. The article compared the brain with a muscle that can be developed with exercise, and concluded that learning makes you smarter. After the reading, the mentors led students in a discussion in which they were asked to think of things they had learned to do well, and to recall how practice had been the key to attaining mastery. They also discussed how their brains had changed as a result of this learning, and how they had actually become smarter. Finally, to reinforce the message, the students completed an activity page in which they traced a ''Neural Network Maze'' spelling out the word ''SMARTER'' to illustrate what happens when one learns something new.

Control group: To provide an academically similar but theoretically neutral activity, students in the control group read an article describing how memory is thought to work, including the distinction between short- and long-term memory, and how memory strategies such as ''chunking'' information into fewer units and using repetition to transfer information from short- to long-term memory can aid in recall. They then discussed their own preferred ways to remember things and what they had difficulty remembering, and engaged in an activity, ''Grocery List Tricks,'' in which they practice mnemonic strategies, such as making visual associations for items to be remembered.

Sessions 5 and 6: Stereotypes; Study Skills

Both motivation and control group: To counteract negative stereotypes regarding gender and race prevalent among some students, we included a lesson on the pitfalls of stereotyping the self and others. In addition, we reasoned that without knowledge of techniques for putting enhanced motivation to use, students might become stalled at the outset, while skills in the absence of motivation should not produce as much benefit. Thus, we incorporated a study skills lesson for all students, to provide the rudimentary tools needed to put motivation to work, as well as to offer a rationale for and benefit of the workshop for all students.

In a double session during the students' regular science class time, all students participated first in the unit on stereotyping, in which they viewed slides of diverse people and guessed their occupations, and then did an exercise in which they wrote occupations that they believed themselves capable or incapable of attaining in or outside a box figure. Workshop leaders then revealed the true occupations of the people pictured in the slides, and led a discussion of the nature of stereotyping and the pitfalls of limiting oneself or others' ambitions according to preconceived ideas. They explained that our need to categorize objects in our environment and to make quick evaluations of them, while natural and adaptive in some situations, could lead to prejudice and mistaken assumptions about people and situations—that is, stereotypes. Such stereotypes, they explained, might even work against a student's own potential, if negative perceptions of his or her group were common.

In the second half of the class, mentors gave a presentation on study skills. Topics included goal setting, time management tips, and strategies for studying, remembering, understanding, and organizing material. For example, we discussed time management techniques such as breaking up longer term projects into several parts with shorter term finish-by dates; study strategies such as outlining chapters, making index cards with important terms and definitions, and working with a partner to quiz themselves on these; memory tips such as writing summaries of what they read, visualizing what they read or heard, and reading out loud; and comprehension strategies such as reading assigned questions before reading material, and reading over notes from class at the end of the day. At the end of the presentation, we handed out folders containing summary presentation notes and planner pages, along with a set of basic tools (highlighter, index cards, etc.).

Sessions 7 and 8: Discussions

Motivational intervention group: The students engaged in two discussions, led by their workshop leaders, exploring the significance of the fact that the brain could grow and get stronger through practice. In the first session, the mentors asked the students to think of those things they had learned to do well, and to recall how they had been inept at the beginning but had learned, through error and practice, to excel. Discussion stressed that the mistakes they made in the course of learning had been necessary and even helped them learn, and that they had actually grown smarter in the course of learning: Their brains had changed, developed new connections, and strengthened existing ones. The discussion concluded with the message that everything you learn makes you smarter, and that being smart is a choice you make.

In the second discussion, workshop leaders discussed labels people give one another, such as ''stupid'' or ''brainiac,'' based on how well they perform at certain tasks. They then discussed how these labels, which are really a form of stereotyping, can make people afraid to try or work hard in school for fear of looking stupid or appearing to be a ''nerd,'' and that this amounts to self-handicapping: holding oneself back from actually learning and becoming smarter and better at things. We concluded with the message that ''Everything is hard before it is easy.''

Control Group: In the first of these two sessions, workshop leaders led a discussion in which students discussed their current academic situations, including which subjects were the easiest and which were the most difficult, which classes and subjects they enjoyed the most and least, and why. Workshop leaders asked students to share some of their favorite study strategies.

In the second discussion, workshop leaders reminded students of the lesson on memory strategies, and posed the question of where in the brain memory might occur, and how memory might work differently in humans compared with other animals. The students completed an activity page, ''Whose Brain is It?'' in which they matched pictures of animals to an illustration of their brains and a description of their special skills, and discussed the differences among the animals' in brain structure, memory, and mental capabilities.