Senior Projects Spring 2017   Bard Undergraduate Senior Projects

Spring 2017

The Effects of Autobiographical Growth Narratives on Math Performance in Women

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Senior Project Submitted to

The Division of Science, Mathematics, and Computing

of

Bard College

By

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Annandale-on-Hudson, New York

May, 2017

Acknowledgements

I would like to first thank my advisor, Professor Thomas Hutcheon, for being such a great, encouraging, and intellectually stimulating advisor and for tirelessly, consistently helping me design, execute, and enjoy this entire process as much as I have. I would not have been able to do this without you.

Without the Posse Foundation, I do not know that I would have ever gotten a chance to attend a great school like Bard, so I would like to thank Posse for supporting me, carrying me, giving me lifelong friends, and showing me how to make a difference in myself and my community. New Orleans Posse 1 forever!

Thank you to the Bard Psychology faculty, specifically Kristin, Justin, and Tom Cain for being a sounding board for my ideas all semester and for helping me prepare for the real world. I was helped so much by your guidance and wisdom.

I would not have been able to accomplish this work, or probably my senior year, without the moral and emotional support of my wonderful best friend, roommate, and bandmate Gemma- thanks for putting up with me and being my best companion throughout my time at Bard. Also, Ben Malinski- you really are one of a kind. Additional thanks to my network of very important people: Evan, Natalya, my dad, Colin, and especially my Aunt Dina, who continues to teach me how to "adult".

A huge shout out to the psychology women who came before me who led me through the initially intimidating process of choosing a topic and pursuing science, Helena, Marna, and Maayan. And of course, thanks to Matt, Josh, and Leah- my psychology crew that kept me sane the last three years. Commiserating with you three has been a highlight of my Psychology career.

Last but not least, I would like to thank the amazing Bard community that made these four years the most intense, wonderful, exciting, comforting, challenging, and memorable of my life so far. I have learned so much from every interaction in this special bubble and I feel so lucky to have been a part of it.

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Abstract

Women suffer from the negative stereotype that they are innately worse at math compared to men, which contributes to a gender gap in math fields (Spencer, Steele, & Quinn, 1999). However, this stereotype has a greater negative impact on women with fixed mindsets, who believe that intelligence is inflexible and innate (Aronson, Fried, & Good, 2002). Mindset interventions thus far have sought to shift fixed mindset to growth mindset, characterized by the belief that effort can increase intelligence, through in-class workshops or lectures about the plasticity of the brain and the malleability of intelligence (Dweck & Leggett, 1988; Dweck, 2000; Dweck, 2008). The current study improves upon existing mindset interventions through the inclusion of a writing task that asks participants to generate autobiographical narratives about growth experiences. This intervention should create an internalization of growth mindset that is longer lasting, less susceptible to counter-information, and more directive for behavior than existing interventions (Reich & Arkin, 2006; Wilson, 2011; Aronson, 1999). Participants' theories of math intelligence were measured, and then participants were placed into a growth narrative condition, a growth article condition, or a high-point narrative condition, which served as a control. Participants then took a math assessment followed by measures of task involvement, enjoyment, and effort. Analyses showed no main effect of condition; there was no difference on math performance or task measures between participants who wrote about growth, read about growth, or wrote about a positive experience. However, there was a significant main effect of initial mindset on math performance, task involvement, enjoyment, and effort, such that initial growth mindset correlated with better performance and higher scores on all the task measures. Limitations and implications for the results are discussed.

Stereotype Threat

Individuals define themselves in terms of what traits, abilities, and values they have, which make up their self-concept. Self-concept can be defined as one's perception and evaluation of the self, which develops over time through interactions and interpretations of one's environment (Cohen, 1998). Maintaining a stable sense of self while navigating situations that challenge one's self-concept can be difficult and emotionally taxing (Bargh, Chen, & Burrows, 1996). For example, taking a difficult math test can be even harder if there are distracting contradictory messages about one's competence or ability to perform well on the test. Some groups have aspects of their self-concepts targeted consistently. Women suffer from the stereotype that innate math intelligence is not a female characteristic, or part of the female self-concept (Spencer et al., 2016). The commonly accepted societal message that women are not genetically gifted at math influences women's self-concept, resulting in the assumption that being bad at math is an inherent trait (Ceci & Williams, 2011). This societal message affects women's math experiences before they even have the chance to determine its truth. It is damaging for women in math domains, who presumably want to perform well, to be faced with a message that being bad at math is an innate part of their self-concept (Shapiro & Williams, 2012).

This stereotype, faced in both academia and the workforce, perpetuates the belief that women are innately inferior in math compared to their male counterparts. Beyond just mathematics, the fields of science, technology, and engineering have been classified as male domains, with women being considered less adept in these fields (Ceci & Williams, 2011; Hyde, Fennema, & Lamon, 1990). Gender gaps in these fields have led women to be less likely to receive jobs and major in these areas, despite being qualified and capable. Under-representation

and gender bias have also led to discrimination against women in math and science domains (Williams & Ceci, 2015). Notably, women do not even have to explicitly express an awareness of the stereotype that they are "worse" at math in order for it to affect their behavior. An international study by Nosek and colleagues (2009) found that over 70% of people implicitly associate science, technology, engineering, and math fields (S.T.E.M.) with males instead of females. For women, a reminder of gender before engaging in math tasks, or even the presence of a difficult math assessment, is enough to prime the "male=math stereotype" (Shapiro & Williams, 2012). When women are primed with a reminder of their gender prior to engaging in a math task, they are reminded of the fact that they are being assessed in a male-stereotyped domain, in which they are expected to perform worse. This causes women to redirect cognitive resources away from the challenging task toward attempting to disprove the stereotype, overly analyzing their competence, or generally being anxious about their performance. This distraction can lead to underperformance, perpetuating the cycle of women being worse at math than men, who do not face the same threat during testing (Spencer et al., 2016).

Despite a lack of significant differences in early, inherent math readiness between boys and girls (Lee, Autry, Fox, & Williams, 2008), there remains a negative stereotype that women are less adept at math. This stereotype partially explains the low percentage of women in math related fields (Hill, Corbett, & St. Rose, 2010). It could be argued that women are just less interested in math, which is why they choose not to pursue it at higher levels. However, early stereotyping messages and classroom discrimination could play a role in women's choices. Even without actively admitting to classifying math as a male domain or to being affected by societal messages, stereotypes have the capability to influence beliefs and attitudes, even unconsciously (Greenwald & Banaji, 1995). If women are consistently given less support in math and science,

are repeatedly told that they do not possess the same innate skills that men do in these fields, and have difficulty on tasks because of fear of failure, they would understandably avoid higher level math courses. This avoidance might occur despite women's interest in the subject. It is difficult to determine if lack of interest is responsible for the gender gap in math fields, when women are influenced by stereotypes as early as six years old. Research has indicated that implicit associations between male and math, despite equal interest in math for both girls and boys, were present in elementary school students (Cvencek, Meltzoff, & Greenwald, 2011). Therefore, lack of interest and perceived incompetence in math are probably not the only causes of the gender gap in math fields. Internalized messages from society and early classroom experiences that suggest a lack of competence and belonging play a large part in deterring women from math domains.

Narratives

Individuals often use narratives of autobiographical memories, or memories about themselves and their experiences, to maintain a stable sense of self, especially in circumstances where self-concept is threatened (Bluck, Alea, Haberman, & Rubin., 2005). For example, when criticized for being lazy, an individual might cite times they have been very productive in order to contradict that criticism. Thus, experiences filed away for use later make up narratives that individuals can call to mind in times when they need to respond to a question of their character (McAdams, 2001). Autobiographical memories, or memories dealing with personal experiences, and how individuals reconstruct and recall those memories, help maintain a stable identity through the reparation of threatened traits with autobiographical evidence.

Recalling episodes that exemplify a certain trait make salient that aspect of the self-concept (Jennings & McLean, 2013). Recalling a memory that gives evidence of a trait insulates

against a threat suggesting the trait is lacking, which brings self-concept back to equilibrium.

When threats to the self-concept arise, either internally or from external sources, narratives can

serve as useful tools to counter those threats and repair a threatened self-image. In one study,

college students were given false feedback indicating that they were intolerant and

discriminatory toward other races. They were then given a chance to recount, in writing,

instances where they showed tolerance. The only instruction given was to write about a time that

the individual believed he or she demonstrated tolerant behavior (Jennings & McLean, 2013).

This trait-specific narrative technique showed the greatest repair of self-concept against this

threat toward their character, in comparison to students who used other methods of repair, like

distraction or positive narratives. In other words, participants who were asked to recall episodes

that displayed the trait of tolerance were more confident in their assertions of being tolerant and

felt most secure about that trait of their self-concept. This research suggests that recalling

specific instances of a characteristic can repair a threatened self-concept and allow individuals to

repair or modify an aspect of their identity that is being challenged.

Narratives to Counter Stereotype Threat

If women experience stereotype threat from the stereotype that they cannot succeed in

math, an autobiographical memory of effortful success would challenge the threat that suggests

that women are unable to succeed with effort. This stereotype targets particular aspects of

women's self-concept, namely their perseverance, grit, and ability to improve with hard work.

The specific content of the narrative would have to address the root of the stereotype that affects

women's performance for it to be most effective. The stereotype, which states that men are

innately better at math compared to women, suggests some genetic difference in the skills that

men and women are born with (Dweck, 2007). This assumption also posits that the differences

between men and women are inflexible. Even if men were born with more math ability than women, women could counter that imbalance through increasing their own ability. However, the stereotype suggests that women are incapable of getting to a point that they can understand math at a high level, simply because they do not possess the "gift" that men do (Dweck, 2007). A narrative that supports improvement with effort undermines and challenges the assumption that, even in math fields, women cannot improve. The idea that improvement is possible for anyone through effort is helpful for any domain, but especially in one where success is thought to be out of reach for a stereotyped group.

Beliefs about Intelligence

This particular stereotype, that women are innately bad at math, is indicative of a fixed mindset. As mentioned previously, fixed mindset is characterized by a belief that intelligence is genetic and cannot really improve over time (Hong, Chiu, Dweck, Lin, & Wan, 1999; Dweck, 2007). Individuals can hold different "theories" of intelligence that dictate how they respond to obstacles, unfamiliar material, and feedback. Importantly, even individuals with equal intellectual abilities and grades respond very differently to academic challenges if they hold different theories of intelligence (Dweck, 2000; De Castella & Bryne, 2015). The belief in fixed, inflexible intelligence causes individuals to focus in on measurement of personal ability and withdraw effort if they feel that their perceived ability does not match the ability needed to complete a task. Conversely, growth mindset motivates individuals to expend more effort on difficult tasks, because they believe effort to be the only necessity for achievement. Individuals with fixed mindset tend to focus on performance goals, which are meant to display ability instead of effort. Those who have more growth mindset value learning goals more, or goals that increase ability and skill, regardless of initial ability (Dweck & Leggett, 1988).

Holding a fixed mindset about intelligence is associated with many detrimental behaviors and cognitions. Namely, fixed mindset is strongly correlated with lower performance on tasks, less persistence on tasks, unwillingness to engage in challenging work, and giving up when a task seems impossible (Dweck, 1986; Dweck, 2008). Research by Blackwell and colleagues studied how implicit, or less conscious, theories of intelligence affected mathematical achievement in adolescents. They found that adolescents who held the belief that intelligence is malleable experienced an upward trajectory in academic performance over the course of the next two years of schooling (2007). Further, an experimental intervention that taught students about incremental theories of intelligence lead to positive changes in students' motivation and performance. This finding was in stark contrast to that of students who were given no incremental teaching, who displayed a downward trajectory in academic performance (2007).

Understandably, fixed mindset is much more detrimental to groups that are perceived to be low in actual ability in certain domains (Zhao & Wichmann, 2015). Not having good grades in math and then believing that improvement is impossible, characterizing fixed mindset, would be disheartening to anyone who values improvement or success. Thus, stereotypes about math ability should not be as discouraging to women who believe ability can improve over time. Women with growth mindset in math domains do not view the stereotype that they are born inferior at math as discouragement from getting better. However, even smart girls suffer from fixed mindset on math material, due to a greater susceptibility to stereotype threat. Dweck and Licht discovered the extent to which bright young women cope very differently to confusion compared to their male counterparts in math domains (1984). The study compared boys and girls with identical IQs on a packet of math questions that included a portion of very confusing material. Half of the students were given the packet with confusing material at the beginning of

the assessment and half of the students were given the same assessment, but with the confusing material at the end. Results indicated that bright girls did not perform as well when the confusing material was at the beginning of the task than when it was at the end, despite equal ability. Notably, this study shows that women are capable of performing well on difficult material, but are more susceptible to discouragement and self-doubt when they initially face challenge, as compared to men. These results indicate that even with similar ability, girls with fixed mindset in math do not cope well with experiences that call their ability into question.

While both men and women face the same increased difficulty in higher-level mathematics, those who hold a fixed mindset in math domains see this increased difficulty as a confirmation that they do not have what it takes to succeed. Supporting that claim, it appears that the gender gap in math performance between men and women begins to appear at the end of eighth grade, but only for students with fixed mindset (Dweck, 1988). That being said, men with fixed mindset still perform lower than both men and women with growth mindset but not as low as women with fixed mindset, who are most susceptible to stereotype threat in math fields. These patterns are also present in higher education. A study followed a Columbia pre-med chemistry course and found the typical gender divide of males performing better than women, but only for students who thought that intellectual skills were a gift, indicating fixed mindset. Notably, gender differences were reversed for those who held incremental beliefs; women performed better than men, controlling for actual ability (Grant & Dweck, 2003). These results suggest that ability is not the variable holding women back from high-level performance in academia, but rather a greater susceptibility to being negatively affected by stereotype threat when holding a fixed mindset.

Similar results were found in a study by Good and colleagues (2005), which tracked Columbia University students through a calculus course. Initial mindset was measured and the researchers checked in over the course of the semester to see if women experienced stereotyping and discrimination in the classroom. Results indicated that all of the women felt that discrimination was present in the classroom and many women struggled with feeling welcome in the class environment. However, women with growth mindset, even those who admitted that stereotyping was present, did not report feeling as out of place in the class. In fact, they reported working harder, having higher performance, enjoying the class more, and were more likely to go on to pursue future math courses. In contrast, women who had fixed mindset reported that they were discouraged, defeated by the stereotyping, performed lower, and were less likely to continue pursuing math as a major (Good, Dweck, & Rattan, 2005).

As mentioned previously, the stereotype that women are inherently inferior at math compared to men suggests that women who are negatively affected by this stereotype hold the belief that men have innate talent in mathematics that women do not. This explains why women may not pursue higher levels of mathematics, due to a lack of confidence in increasing their skills as academic demands rise. If the stereotype was solely characterized by men being born better, but allowed for women to improve with effort, it would not have such detrimental effects. Importantly, however, the stereotype suggests that women are born with lower abilities and can never improve to the same ability that men have. The fixed beliefs of intelligence around math ability explain the stereotype threat that negatively affects women's performance on math tasks that are difficult, or those that serve as assessments of their ability, or in which gender is primed. However, some interventions that seek to shift mindsets about intelligence have been successful in lessening the detriments of fixed beliefs on women's math performance.

Mindset Interventions

Mindset interventions that encourage growth mindsets have been effective in challenging notions of inflexible abilities and the behavioral issues that accompany them (Dweck, 2000). Most interventions introduce students to the theory that intelligence is malleable and grows over time, with effort. For example, Dweck and Blackwell designed an eight-session growth mindset intervention for junior high school students that included information about the plasticity of the brain, how it forms connections when learning new material, and how intellectual skills can increase with cognitive training over time (2007). Tips on how to apply this information to schoolwork was also included. The control group was given high-quality instruction about useful study skills, but no information about the expandable nature of intelligence. Results indicated that prior to the interventions, both groups were showing a sharp decline in their academic performance and grades. After the growth mindset intervention, however, students showed a rapid recovery from their declining performance and earned significantly higher math grades than the group that was shown no information on expandable intelligence. Further, interviews from teachers indicated that the students who were given the growth intervention were significantly more engaged, more motivated to learn and ask questions, and participated more than their counterparts in the control group (Blackwell et al., 2007).

However, most interventions used to shift mindsets about intelligence or ability are not personal to the individual- they involve providing information about how the brain can grow or anecdotes about how other individuals experienced growth over time (Dweck, 2000; Blackwell et al., 2007; Zhao & Wichman, 2015). Interventions can vary from lectures about brain plasticity to anecdotes about individuals who increased their intelligence over time. In her research, Dweck often divides groups into "growth" or "normal" classes with one group of students being exposed

to growth workshops over a period of classes that include information about how the brain is plastic and can always expand with new information (Dweck, 2007). Students are given a series of assessments during and after the workshop to determine whether the groups differ in academic performance.

Another mindset shifting strategy that has been used is emphasizing the effort and hard work of accomplished mathematicians and scientists instead of emphasizing their genetic, innate brilliance during class lectures. Good, Dweck, and Rattan (2005) used this method in a study, which organized a geometry math class in two different ways. Both included historical information about the mathematicians who originated the concepts being taught. However, in one group, innate talent and natural skill of the mathematicians were highlighted, reflecting fixed mindset, and in the other group, sustained interest and persistent effort, reflecting growth mindset, were emphasized. The researchers sought to determine if even these subtle differences compromised task performance. Results indicated that the women who were shown information emphasizing innate skill did worse than both their male and female counterparts who were shown historical information emphasizing growth tenants. Men also did worse in the fixed condition, but not as poorly as women. Conversely, women in the growth condition who learned about the effort and dedication of accomplished scholars did just as well as their male counterpart. Still, it is unclear how long these mindset shifts last, or if they extend into specific domains, or just to general intelligence beliefs.

Narrative Mindset Interventions

These sorts of interventions may be effective in the laboratory, or for the duration of a classroom intervention with repeated exposure. However, students may be missing out on the benefits of these interventions when there is no prompt provided for them to engage in mindset

shifts. Additionally, students may not seek out the advantageous effects of these interventions independently, or know how to implement them without direct, specific instruction. A self-generated and personally relevant strategy may be more effective, longer lasting, and easier to implement in shifting mindsets about math intelligence for women, who are particularly susceptible to fixed mindset.

Narratives can be used to edit or change existing aspects of the self-concept that are not useful or are even harmful to an individual. Indeed, research performed by social psychologist Timothy Wilson (2011) has indicated that editing personal narratives can change behavior, performance, and self-perception for the better. Wilson utilizes what he calls a "story-editing approach" to change the stories individuals live by and unconsciously fulfill, which they may not even be aware are negatively affecting them. For example, one study following freshman performance over the first year in college showed a sharp contrast in academic performance between those who edited their personal narratives about ability, from viewing it as a fixed to a flexible trait, and those who did not.

College can be a very sudden transition academically for students who have never had to work very hard to get good grades in high school (Terenzini et al., 1994). Most students have a period where they struggle early in their college careers as they adjust to the workload and time management demands. Recovering and persisting through this initial difficulty is dependent on internalized narratives about one's capability, which explains why performance drops unexpectedly for even very bright students. Wilson posits that some students see initial struggle as a sign that they will need to work harder to get the same grades they received in high school, while others see it as a confirmation that their admission to college was a mistake and they do not have what it takes to succeed in higher education. The former narrative, characterized by

growth theory of intelligence, usually motivates students to work harder, which results in better grades. The latter, characterized by fixed theory of intelligence, decreases motivation and increases self-doubt, leading to self-sabotage and uninvolvement (Wilson, 2011; Reich & Arkin, 2006). Wilson wanted to determine whether or not changing the underlying theory of intelligence of the narrative could help students act in line with the belief that they could succeed with increased effort.

The intervention showed half of a group of freshman thirty minutes' worth of videos of upper college students recounting their experience of initially doing poorly academically and then eventually doing better, improving their G.P.A.s, and feeling more comfortable as they learned to adjust the amount of effort and time needed for classwork. The other half of the freshman sample, the control group, were not shown anything. Compared to the control group, participants who were shown these video narratives got better grades and were less likely to drop out of college over the following two years. These results indicate that a one-time narrative shift, in the form of personal anecdotes, completely changed the course of academic careers for the students. Wilson argues that the mechanism behind this shift is that students are given evidence of a different narrative from peers who had relatable difficulty in adjustment. Then, the freshmen internalized that narrative and subsequently expended more effort due to the belief that success is achievable with more effort. Those students saw results for their improved effort and then began to shift their own narrative to one that is characterized by the belief that harder work is needed in order to meet higher academic expectations. Similar patterns can be found in many fields besides academia, like exercise, weight loss, parenting, behavior problems, and reducing racial prejudice (Wilson, 2011). In order to rise to a challenging task, it is necessary to repair and modify aspects of our self-concept that are being threatened through the use of narratives.

One advantage of narrative interventions that make use of Tim Wilson's "story editing approach" is that they are longer lasting in changing behavior than temporary interventions (Wilson, 2011; Aronson et al., 2002). Mindset interventions that seek to shift fixed mindset to growth mindset have historically been instructive in nature, characterized by articles, classroom workshops, or lectures about brain plasticity. However, these tactics may not be as effective if participants do not stay committed to the intervention or internalize the new narrative to the point of applying it outside of a classroom or laboratory setting (Dweck, 2000). There have not been many studies exploring the long-term effects of one-time mindset shifts.

What the story-editing approach provides is a self-sustaining intervention that allows participants to shift an existing notion and repair a threatened self-concept through the adoption of a new narrative. For example, students shifted from the belief they were not smart enough to be at a certain university to the belief that they just need to work harder. This repaired the intelligence and perseverance traits through the adoption of a narrative that they could succeed with hard work. This shift, in turn, leads to more effort, which would presumably lead to higher performance, proving the narrative to be valid. This outcome causes students to continue to act in line with the effortful behavior, with the new realization that they are capable (Wilson, 2011). These small edits to self-defeating narratives trigger a positive cycle of self-reinforcing thinking that sustains itself, with only minimal instruction at the beginning of the intervention. Instead of using interventions that seek to convince people to adopt externally provided theories, the narrative intervention allows individuals to feel personally connected to the beliefs they are producing and adopting.

Research suggests that attitude change is most effective and lasting when individuals advocate for a particular belief in their own words, a phenomenon sometimes referred to as the

"saying-is-believing" effect (Higgins & Rholes, 1978). Publically committing to a stance, and describing details of that belief in your own words has been shown to increase support and acceptance of the advocated belief (Pallak, Cook, & Sullivan, 1980). Further, citing past experiences that are consistent with and support an expressed belief strengthens that belief and makes it more resistant to counter-information (Fite, Lindeman, Rogers, Voyles, & Durik, 2017). It also makes beliefs more resistant to change, more accessible, more easily activated, and more persistent over time (Fazio, 1995; Lord, Ross, & Lepper, 1979). One mindset intervention asked African American college students, who suffer from stereotype threat and get lower grades than White students despite similar intelligence scores, to provide and describe research supporting the expandable nature of intelligence in their own words. This tactic was more effective at internalizing growth mindset in these individuals, as measured by psychological engagement with tasks and task performance, compared to just being given information supporting growth mindset (Aronson, Fried & Good, 2001). Further, these beliefs proved to persist over time and were less susceptible to counter-evidence or salient contradictory information.

Another mindset intervention asked participants to connect evidence about the malleability of intelligence to personal experiences that evidenced growth as a result of effort (Miele & Molden, 2010). Results showed enhanced internalization of growth mindset, in terms of engagement with and performance on the task, in comparison to participants who were not asked to include their personal experience. This research suggests that personal experience, self-generated evidence, and describing a phenomenon in one's own words can have effective and lasting changes on individual beliefs and attitudes. Personal narratives involve generating and describing personal experiences in one's own words, which makes them highly effective in self-

persuasion. Personal narratives that specifically recall episodes of growth can be utilized as an intervention strategy to increase internalization of growth mindsets.

Self-Persuasion

The benefit of using a personal narrative detailing growth in some area, as opposed to simply reading an article that evidences growth, is that individuals are more effectively persuaded when they believe an idea is coming from the self (Aronson, 1999). Self-persuasion is defined as placing people in situations where they are motivated to persuade themselves to change their own attitudes or behaviors. Self-persuasion is proven to be more effective and longer lasting in behavioral and attitudinal shifts than persuasion that comes in the form of traditional, direct techniques, like advertising or teacher instruction. It is more effective in shifting mindset than simply presenting evidence supporting the malleability of intelligence (Aronson et al., 2002). Its effectiveness stems from the fact that people who are exposed to direct persuasion are aware that some external force is attempting to influence them. In self-persuasion, individuals believe the motivation for change comes from within (Aronson, 1999). When an individuals ask themselves why they are doing something, they can point to an external source in direct persuasion, like a commercial, pamphlet, article, authority figure, or a teacher's directions. Self-persuasion, on the other hand, leads individuals to believe that they are the ones who actually want to change, adopt some new belief, or behave in a certain way.

Research has indicated that attempts to change students' attitudes toward school through the use of lectures are often unfruitful and rejected (Kirschner, Sweller, & Clark, 2006). In contrast, interventions that seek to arouse motivation in students through self-generating reasons are more effective at increasing performance and persistence in academia. Research by Canning and Harackiewicz (2015) found that students who were instructed to write about the utility value

of a novel mental math technique, as opposed to being told directly what the utility value was, performed the technique better and had more confidence in using the technique. In contrast, direct messages provided by the researcher about the utility value of the technique undermined performance and lessened student interest. However, those negative effects were reversed when these participants were given the chance to generate personal examples of the utility value after the initial researcher lecture. This study emphasizes the effectiveness of self-generated information in shifting attitudes and behaviors.

Self-persuasion differs from the "saying-is-believing" technique only slightly, in that it is more focused on the message and not the delivery. Putting a presented idea into one's own words, as in the "saying-is-believing" technique, is more effective than regurgitating exact information or simply reading content (Higgins & Rholes, 1978). But coming up with a personal, unique example evidencing a belief characterizes self-persuasion (Aronson, 1999). For instance, reading a pamphlet about the hazards of smoking would be an example of direct persuasion. Simply summarizing the pamphlet about the hazards of smoking would be more characteristic of "saying-is-believing". Telling a story about a loved one who had health issues as a result of smoking, and using that as justification for not smoking would be an example of self-persuasion. The most effective method of persuading someone not to smoke is self-persuasion, because it combines factual evidence, anecdotal experience, and self-generated dialect.

The long-lasting effect of self-persuasion is particularly relevant for this research, as this intervention will hopefully result in mindset shifts that last beyond the task that participants engage in. Moreover, individuals should be more open to using this intervention if it comes from themselves. Most direct persuasion techniques that are aimed at public health or attitude shifts, like persuading smokers to quit smoking, encouraging people to use condoms, or convincing

discriminators to reduce prejudiced attitudes, have been minimal and short-lived. This is particularly the case when the message is very different from the individual's existing lifestyle or attitude (Hyman & Sheatsley, 1947; Pratkanis & Aronson, 1992). Therefore, a mindset intervention that leads to changes in academic performance and engagement should be presented in a self-persuasive manner, in order to make it not only more effective, but also more accessible and longer lasting. Additionally, the self-generated nature of this exercise makes it possible to implement at any time. Individuals can choose to spend a few minutes writing about growth before a challenging task and see a change in their involvement, effort, and performance on the task without depending on external resources.

The Current Study

Past mindset interventions have provided evidence for the malleability of intelligence through lectures, articles, and classroom interventions (Dweck, 2000; Miele & Molden, 2010; Blackwell et al., 2007). The rationale behind using personal, autobiographical narratives to shift mindset is two-fold. The first is that personal experience is more relevant and significant to individuals than descriptions of others, or the presentation of evidence. As research has shown, individuals are more attentive and responsive to information that is related to the self and to individual characteristics (Bargh, 1982). The second is that recalling and describing episodes detailing growth as evidence of growth mindset is more convincing and directive for behavior than consuming external evidence describing someone else's ability or information supporting the ability to improve over time with effort (Aronson et al., 2002).

The hypothesis is that participants who are asked to recount a personal experience of growth will score the highest on a math task, be most involved in the task, have the highest task enjoyment, and expend the most effort on the task compared to participants who are just shown

evidence of the malleability of intelligence or asked to write a positive narrative. Further, individuals who initially report having a fixed mindset about intelligence should benefit the most from the growth narrative exercise. An interaction between initial mindset and condition is expected, such that those with low-growth mindset will have more improvement on math performance than those with high-growth mindset in the growth narrative condition. In other words, individuals who hold a fixed mindset, but who then describe an episode of growth in the narrative condition will perform similarly on the math task to individuals who hold a growth mindset over all conditions. I predict that the difference in scores between the growth and fixed mindset individuals in the growth narrative condition will be the smallest compared to the other conditions.

The current study will involve participants reporting their personalized theories of math intelligence. The personalized measure of math intelligence measures individual theories about their own math abilities, and is thought to be a better predictor of performance and motivation as compared to opinions about lay theories in general (Bandura, 1997). Only math theories of intelligence will be measured, due to math being a stereotyped domain for women. This domain specific questionnaire also determines whether or not the narrative manipulation will extend growth mindset to math domains regardless of the content of the growth narrative that the participant engages in. Then, participants will be placed into one of three conditions: the growth narrative condition, the growth article condition, or the high-point narrative condition, before taking a math assessment.

The act of storying past experiences has been shown to have self-regulatory effects unrelated to the content of the narrative, due to the enhancement and stabilization of self-concept (Jennings & McClean, 2013). Therefore, a high-point narrative will be included that asks

participants to write about a positive experience. If growth narratives are most effective in internalizing growth mindset, then a comparison high-point narrative condition rules out the possibility that the effectiveness of narratives stems from simply recounting any experience, unrelated to the threat at hand.

Method

Participants

Participants were 164 female Amazon Mechanical Turk workers between the ages of 18 and 30 (*M*=25.38, *SD*=3.12). A total of 180 participants were initially recruited and 16 participants were disqualified for not providing a completion code, either because they did not fit the demographic criteria pre-screening questions or because they decided not to continue with the survey. Thus 164 participants successfully completed the study, answering each question fully and providing a completion code. Due to the nature of an Internet sample, age and gender were self-reported. This information is considered reliable, as research has indicated that most Mturk users report demographic information truthfully (Buhrmester, Kwang, & Gosling, 2011).

Procedure

All participants completed this survey online through Amazon Mechanical Turk (MTurk), from a list of Human Intelligence Tasks (HIT) that are available for the online Mturk worker community to choose from. The task was available for participants to take for two weeks, but most of the data came in within a few hours of publishing the task. The survey was built using the online tool SurveyGizmo, and a survey link was provided on MTurk. The survey link provided on MTurk included a short synopsis of the survey and a link that brought participants directly to the survey. The information on the short synopsis that MTurk workers could see as they browse HITS indicated that only female participants, between the ages of 18 and 30, were

needed at this stage in the data collection process. Participants were prescreened in SurveyGizmo with two initial demographic questions asking for gender and age, so that the only individuals who were able to continue to the survey were women between the ages of 18 and 30. Participants were disqualified if they did not fit the criteria, shown a message informing them of their ineligibility, and sent to the final page of the survey without a confirmation code. The short synopsis that was presented is shown below:

"I am conducting a survey about how reading and writing affects math performance. In this survey, you will be asked to engage in either writing or reading comprehension exercise, and then asked to perform a short math reasoning assessment. At this point in the data collection, we are only looking for female participants between the ages of 18 and 30. This survey should only take about 35 to 40 minutes- you will be paid 2 dollars for completing this survey. Please do not begin this task if you do not fit those criteria. At the end of the survey, you will receive a code to paste into the box below to receive compensation for taking this survey."

Word minimum requirements were programmed into the survey, as well as answer validation, so that participants could not move forward to another question until they had completed the question they were on. This ensured that all participants whose data was analyzed answered every question completely. Participants were approved and compensated after a review of responses and after confirmation codes were matched between SurveyGizmo and Mturk. The hypothesis was tested using data from the 164 participants, with fifty-five participants in the growth narrative condition, fifty-six participants in the growth article condition, and fifty-two participants in the high-point narrative condition.

At the beginning of the survey, participants were asked to read a consent form, which informed them that if they clicked 'Continue' on SurveyGizmo, it would serve as a confirmation of their consent to participate. This was used in lieu of a signature. See **Appendix B** for the Informed Consent Agreement. Then, participants completed a modified version of the

Personalized Theories of Intelligence Survey created by De Castella & Bryne (2015) (See **Appendix C)**. Next, participants were randomly assigned into one of the three conditions. In the growth narrative condition, the participants were given a writing prompt asking them to recall and describe an experience where they showed growth in some area of their life over time. In the growth article condition participants were shown an article, previously used by Miele & Molden (2010), about the malleability of intelligence and ability. Participants were instructed to read the growth article under the guise of being told that they were participating in a reading comprehension tasks. In the control condition, the high-point narrative condition, participants were given a writing prompt asking them to recall a positive experience. See **Appendix D** for the three conditions and their prompts. Participants then engaged in the mathematical reasoning task. See **Appendix E** for the full math reasoning assessment.

Finally, participants completed measures of Task Involvement, Effort, and Enjoyment (Elliot & Harackiewicz, 1996). See **Appendix F** for these measures. Upon completion of this task, participants were shown a debriefing form giving them information about the nature of the study, contact information for any questions or concerns, and a brief synopsis of predicted results. See **Appendix G** for the debriefing form.

Once participants completed the survey, they were shown a completion code that they were instructed to paste into a box on the MTurk website to await payment approval. Once the participant submitted their completion code and SurveyGizmo participant ID number on MTurk, their responses were reviewed, confirmation codes were matched, and their surveys were approved. Incomplete surveys, indicated by a lack of confirmation code, were rejected. Once the submissions were approved, the participant was compensated through MTurk. Participants were

given the option in the debriefing form to email the researcher for the math answer key or with any questions or concerns.

Materials

Personalized Theories of Intelligence. Participants first completed an eight-item Personalized Measure of Theories of Intelligence (De Castella & Bryne, 2015), modified to refer specifically to math intelligence, instead of general intelligence. This measure is based on Dweck's (1999) Ideas about Intelligence Questionnaire, which assesses people's theories about their intelligence and ability. People's beliefs about intelligence fall on a spectrum between fixed and growth. Fixed, or innate, mindset is characterized by the belief that you are born with a certain amount of intelligence that cannot really increase over time. Conversely, growth mindset is characterized by the belief that intelligence is malleable and can be increased through effort, persistence, and learning. For this study, participants' pre-existing beliefs about their math abilities were measured, in order to get an assessment of whether or not they had a more fixed or a growth mindset in math domains.

The measure included items such as "I don't think I personally can do much to increase my math abilities," capturing entity, or fixed, beliefs about math by reverse scoring and items like "With enough time and effort, I think I could significantly improve my math intelligence level," capturing growth beliefs about math intelligence. Participants reported their level of agreement with each statement on a 1 (*disagree very much)* to 6 (*agree very much)* scale. See the exact measure with a full list of statements in **Appendix C.**

Narratives. Participants were randomly assigned to one of three conditions: a growth narrative condition, a growth article condition, or a high-point narrative condition. The narrative conditions consisted of short prompts asking participants to think and write about specific

experiences in their lives. These narrative writing prompts were modified from the Life Story

Interview by Dan McAdams (2001). The life story model of adult identity is a psychological

instrument used in the social sciences that explores and analyzes the storied nature of human

conduct and behavior through the examination of narrations about life experiences. It requires

individuals to conceptualize their lives as a novel with different chapters and a plot outline, with

specific key scenes that stand out as especially important. In this study, specific incidents of a

"high point" and a "growth point" in the participants' life are utilized.

Growth Narrative: Participants were asked to write, for about five minutes, about a time

in their life where they showed growth in some area over time. The area of growth could be in

any domain, from academia to athleticism. Participants were asked to provide as much detail as

possible, and encouraged to give information about what skill was involved, what they think the

growth says about them as an individual, and the impact of the process (See **Appendix D).**

Growth Article: Participants were presented with a reading comprehension task, where

they were shown a scientific article and told to answer several open- ended questions about the

article's content after they finished reading it. The passage was actually a manipulation of

growth beliefs about ability, as used by Miele and Molden (2010). The fictitious article is named

"The Origins of Intelligence: Is the Nature-Nurture Controversy Resolved" and was stated to

have appeared as a publication in the November 2007 issue of *Psychology Today.* This article

includes false scientific evidence that supports the idea that intelligence and ability are

determined by one's environment and can improve over time, reflecting growth theory of

intelligence. The article cites several false studies about individuals who have shown tremendous

development in skills or intelligence as a result of their environments. Participants were

instructed to pay careful attention to the details of the passage and were told that they would be

asked several open-ended questions about the passage's content and meaning at the end. These instructions were included prior to the presentation of the article to increase impact and attention (See **Appendix D**).

High-point Narrative: Participants were asked to write, for about five minutes, about a time in their life that stands out as an especially positive experience. They were asked to provide as much detail as possible, give information about why the experience stood out as positive, and explain what they think the experience says about them as an individual (See **Appendix D).**

Mathematical Reasoning Assessment. Participants then completed a Mathematical Reasoning Assessment which included eight math questions that participants were led to believe assessed their math abilities, in comparison to the average population. See **Appendix E** for a copy of the questions and instructions that were used, in addition to the answer key. These questions were taken from standardized test websites, and are similar in nature to items one might see on SAT or GRE exams. These questions are designed to be challenging and ambiguous in their answers, but not extremely difficult for the average high school educated individual. The eight questions include a variety of math topics, but none require any college-level math knowledge. The questions vary in both format and content. Five of them are multiple choice, one has a visual component, and the others vary in types of math. Some required algebraic calculations; others involved arithmetic, probability, or visual logic. Some questions were taken from a previous senior project by Siira Rieschl (2015), and are marked as such in the **Appendix E**. Participants were instructed that they could use a calculator and scratch paper for the task, but could only input one final answer for each question. Participants were given as much time as they needed to answer these questions. Participants were not given their final score at the end of the assessment, but if they wanted to know their score, they were told to email the

researcher for a list of answers and explanations. Participants' performance was scored by how many questions they answered correctly out of eight. No partial credit was granted and each correct response counted for one point. Therefore, the highest score possible was an 8 and the lowest score possible score was a 0.

Task Involvement, Effort, and Enjoyment. After completing the mathematical assessment, participants completed measures of Task Involvement, Effort, and Enjoyment (Harackiewicz & Elliot, 1993), modified to refer to the specific task in this study. The six-item Task Involvement scale ($\alpha =. 74$) measured how focused the participants were on the tasks, with items like "While solving the reasoning problems, I was totally absorbed in the problems." The two-item Task Effort index ($\alpha =. 95$) included statements like, "I put a lot of effort into solving the reasoning problems." The final three-item Task Enjoyment index ($\alpha =. 80$) included measures like "I enjoyed solving the reasoning problems." Participants rated how much they identified with these statements on a 7- point scale from 1 (*strongly disagree)* to 7 (*strongly agree)*. For the exact measure, see **Appendix F.**

Results

The data that were collected from the internet sample on SurveyGizmo included the participants' scores on the math assessment, as measured by the number of math questions answered correctly out of 8, demographic information, math intelligence beliefs as measured by the modified Personalized Theories of Intelligence Questionnaire (DeCastella & Bryne, 2015), written narratives or short answer questions that were presented after the growth article, and task involvement, effort, and enjoyment, as measured by the Task Involvement, Effort, and Enjoyment Questionnaire (Elliot & Harackiewicz, 1996).

Data Preparation

After excluding participants who did not provide confirmation codes or were disqualified based on failure to meet demographic criteria ($n=16$), data from 164 participants were analyzed. Participants were randomly assigned into the growth narrative condition ($n=55$), growth article condition ($n=56$), or the high point narrative condition ($n=53$). Participants' math assessments were graded by the experimenter in Excel through the process of counting the correct number of answers from 0 to 8. Correct answers yielded one point. No partial credit credit was awarded. Wrong answers did not negatively affect the score. There were no blank answers due to the forced response option in SurveyGizmo. Participants were given a final "math performance score" based on the algorithm above.

Participants' responses on the Task Involvement, Task Effort, and Task Enjoyment Questionnaire were coded by the experimenter in Excel, and a score for each of the three measures was recorded. Participants responded using a 6-point Likert scale, between 1 (*disagree very much*) and 6 (*agree very much*). For the six Task Involvement items, three of the items were reverse coded and then the six items were added together to yield a final score between 6 and 36, with higher scores indicating higher involvement. For task effort, the two items were added together to yield a final score between 2 and 12, with higher scores indicating higher effort levels. The Task Enjoyment measure consisted of three items, one of which was reverse coded. The three items were added together to yield a final score between 3 and 18, with higher scores indicating more enjoyment on the task.

Math Performance

The average score on the math reasoning assessment across all conditions was 3.27 out of 8 ($SD=3.12$). The distribution of scores can be seen in *Figure 1*.

Initial Correlations

Preliminary analyses of the data indicated a positive correlation between mindset and math performance, such that higher growth mindset was positively associated with higher scores on the math assessment $r=.22, p=.01$. Mindset was also significantly correlated with higher task involvement, $r=.36, p<.001$, higher task enjoyment, $r=.32, p<.001$, and higher task effort, $r=.16, p=.04$. These results suggest that having higher growth mindset, as opposed to a fixed mindset, may confer a tendency to perform better on math tasks and to a higher index of self-assessed involvement with and enjoyment of the task. These results are consistent with previous mindset literature showing higher performance, task involvement, persistence, and motivation in academic settings for individuals with higher growth mindset (Dweck, 2008).

Condition on Math Performance

The effect of condition on math performance was analyzed using a one-way (Condition: growth narrative, growth article, high-point narrative) analysis of variance (ANOVA) (*Figure 2*). There was a marginal main effect of condition on math performance $F(2,158)=2.35 \ p=.09$. However, post-hoc analyses showed that participants in the growth narrative (*M*=3.49, *SD*=2.03) and growth article (*M*=3.52, *SD*=2.09) conditions scored significantly, $p<.05$, higher on the math assessment than participants assigned to the high-point narrative condition (*M*=2.77, *SD*=1.91), as shown in *Figure 2*.

Mindset on Math Performance

The average score for participants' mindset as measured by the Personalized Theories of Intelligence, on a scale between 8 to 48, with higher numbers indicating more growth mindset, was 35.02 (*SD*=9.80). In order to determine whether there was an interaction between participants' initial mindset and the condition they were placed in, participants were separated

into "high" and "low" growth mindsets using a median split, with a median of 37. If participants

scored 37 or above on the intelligence questionnaire, they were placed in the "high growth

mindset" group. If they scored below a 37, they were placed in the "low-growth mindset" group.

Among the 164 participants, 83 participants were classified as being in the "high-growth

mindset" group and 81 participants were classified as being in the "low-growth mindset" group.

This resulted in the following distribution: Among the low growth mindset group, 28 were in the

growth narrative condition, 28 were in the growth article condition, and 29 were in the high-

point narrative condition. Among the high-growth mindset group, 27 were in the growth

narrative condition, 32 were in the growth article condition, and 24 were in the high-point

narrative condition. Therefore, we see an even distribution of participants between mindset

groups and conditions.

The effects of mindset and condition on math performance and the interaction between

mindset and condition were analyzed using a 3 (Condition: growth narrative, growth article,

high-point narrative) by 2 (Mindset: low-growth, high-growth) analysis of variance (ANOVA)

There was a significant main effect of mindset on math performance, $F(1,158)= 4.28$, $p=. 04$,

such that high-growth mindset participants (M=3.61, SD=2.12) scored significantly higher than

low-growth mindset participants (M=2.91, SD=1.89) on the math assessment. Therefore, there

appears to be a significant association between initial mindset and performance on the math task.

Having a higher initial growth mindset correlated with better performance on the math task,

regardless of the condition to which the participants were assigned. This finding is consistent

with previous literature showing higher math task performance in individuals with growth

mindset compared to fixed mindset (Dweck, 2007).

However, there was no significant interaction between mindset and condition, *F* (2, 158)=2.11, *p*=. 12. Therefore, the hypothesis that there would be an interaction between initial mindset and condition was not supported. In fact, looking at the trend in means, low-growth mindset participants performed about the same in the growth narrative (*M*=2.82, *SD*=1.87) and the high-point narrative (*M*=2.86, *SD*=1.79) conditions, as compared to the growth article condition (*M*=3.08, *SD*=2.08). In the high-growth mindset group, participants assigned to the growth narrative condition performed the highest on the math assessment (*M*=4.19, *SD*=1.98), followed by those in the growth article group (*M*=3.84, *SD*=2.08), and those in the high-point narrative group performed the worst among the three conditions (*M*=2.67, *SD*=2.08). These patterns would suggest some benefit of the narrative intervention for people who have an initial growth mindset about math intelligence, but little benefit for those who hold a fixed, or low growth mindset about math intelligence.

Task Involvement, Enjoyment, and Effort

It was hypothesized that there would be a main effect of condition on Task Involvement, Enjoyment, and Effort, such that participants in the growth narrative condition would be more involved, effortful, and have more enjoyment during the task than participants in the high-point narrative and growth article conditions. An interaction between condition and mindset was also expected, such that participants with an initial low growth mindset who were placed in the growth narrative condition would scores higher on measures of task involvement, enjoyment, and effort compared to the low growth mindset participants in the other two conditions. In other words, the differences between the low-growth and high-growth mindset participants would be the smallest in the growth narrative condition, compared to the growth article and high-point conditions.

Task Involvement

The average score for the Task Involvement measure among all 164 participants was 27.08 (*SD*=5.14). The main effects and the interaction of condition and mindset on task involvement were analyzed using a 3 (Condition: growth narrative, growth article, high-point narrative) by 2 (Mindset: low-growth, high-growth) ANOVA. Results indicated that there was no significant main effect of condition on task involvement, F (2,158) =2.55, *p*=. 08, but post-hoc analyses showed that participants in the growth narrative condition were more involved in the task than participants in the high-point narrative condition, significant at *p*<. 05. This finding is consistent with previous mindset literature showing higher task involvement in growth mindset conditions (Blackwell et al., 2007). There was a main effect of mindset on task involvement F (1,158)=26.84, $p < .001$, such that participants in the high-growth mindset group (*M*=28.99, *SD*=4.48) were more involved in the task than participants in the low-growth mindset group (*M*=25.12, *SD*=5.06). This finding is consistent with prior mindset literature. There was no interaction between mindset and condition, F (2,158) =. 45, *p*=. 64, however.

Task Effort

The average Task Effort score for all participants was 10.48 (*SD*=1.74). Task effort among conditions and mindset was analyzed using a 3 (Condition: growth narrative, growth article, high-point narrative) by 2 (Mindset: low-growth, high-growth) ANOVA. There was no main effect of condition on task effort, F (1,158) =1.80, *p*=. 17, and no interaction between mindset and condition, F (2,158) =. 34, *p*=. 72. However, there was a significant main effect of mindset F (1,158) =9.38, *p*< .001, such that participants in the high-growth mindset group (*M*=10.88, *SD*=1.44) reported expending more effort on the task than participants in the low-growth mindset group (*M*=10.07, *SD*=1.92). This finding is in line with previous research

showing more persistence and effort on difficult tasks for individuals with growth mindset (Dweck, 1991; Dweck, 2007; Dweck, 2008).

Task Enjoyment

The average Task Enjoyment score for all participants was 12.93 (SD=3.89). The main effects and interactions between condition and mindset on task enjoyment were analyzed using a 3 (Condition: growth narrative, growth article, high-point narrative) by 2 (Mindset: low-growth, high-growth) ANOVA. There was no main effect of condition on task enjoyment, $F_{(2,158)}$ =1.91, p=. 15. There was, however, an interaction between mindset and condition on task enjoyment $F_{(2,158)}$ =2.72, p=. 07 that approached statistical significance. Post-hoc analyses showed that participants in the growth narrative condition enjoyed the task more than those in the high-point narrative condition (significant at p=. 05). There was a main effect of mindset on task enjoyment, $F_{(1,158)}$=6.70, p=. 01, such that participants with high-growth mindset (M=13.72, SD=3.89) enjoyed the task significantly more than participants in the low-growth mindset condition (M=12.12, SD=3.76), p <. 05. This finding is in line with previous research showing more satisfaction and enjoyment on difficult tasks for individuals with growth mindset (Dweck, 2008).

Discussion

The current study examined the impact of autobiographical growth narratives on performance, involvement, effort, and enjoyment on a math task in women, a demographic that is presently underrepresented in math fields (Hill, Corbett, & St. Rose, 2010). Two hypotheses were tested. The first hypothesis was that women who were asked to write a narrative about a personal growth experience would score the highest on math performance, task involvement, task effort, and task enjoyment, compared to participants who were asked to read an article about

growth and to participants who wrote a narrative about a positive, "high point" experience. It was expected that describing a personal growth experience would most effectively internalize growth mindset in women, and subsequently direct behavior and combat stereotype threat for women in math domains more than traditional types of mindset interventions.

The second hypothesis was that there would be an interaction between initial mindset and condition. It was predicted that the growth narrative manipulation would be most effective at shifting mindset for participants who came in with initial fixed mindset, such that their scores on the math assessment and the task measures would be the most significantly, positively affected. Thus the scores of participants with initial fixed mindset were expected to be similar to those of participants who came in with growth mindset after both had received the growth narrative manipulation. The difference between high-growth and low-growth mindset participants in the growth narrative condition was predicted to be the smallest, compared to the other two conditions.

In general, the *a priori* hypotheses were not supported. There was no significant main effect of condition observed on the measures. Scores on the math assessment, task involvement, effort, and enjoyment were not significantly different among participants assigned to the growth narrative, growth article, and high-point narrative conditions. This was true for all participants and when the results were examined by initial mindset. No significant interaction between condition and initial mindset was observed; all conditions yielded similar differences on the dependent measures between the fixed and growth mindset participants. There was, as expected, a significant effect of the initial mindset on math performance and task involvement, effort, and enjoyment. Higher initial growth mindset correlated with better performance on the math task,

higher task involvement, more task effort, and more task enjoyment, regardless of the condition to which the participants were assigned.

Participants in the growth narrative condition and the growth article condition performed similarly on all task measures, which is important because it suggests that mindset interventions can be implemented successfully in online populations. These manipulations were effective at significantly increasing women's involvement, effort, enjoyment, and performance on a math task through a short online intervention. Further, a five-minute directed writing exercise about growth was as sufficient in shifting mindset and reducing the negative effects of fixed mindset on math performance as existing interventions that require externally provided information. Considering how detrimental fixed theories of intelligence around math can be for women (Dweck, 2007; Good et al., 2008), a self-generated task necessitating no external resources that increases performance and involvement with a math task could be highly useful. The accessibility and convenience of this intervention makes it appealing and more likely to be utilized in academic and professional fields. Widespread use of a insulating growth narrative intervention that increases enjoyment and performance could help slow the damaging cycle of stereotype threat and the resulting lower performance that deters women from math fields.

This study's premise rested on the already established phenomenon that growth theories of intelligence help individuals who are stereotyped to do poorly in a specific field (Dweck, 2007). This study focused specifically on women's performance in math, which is a field that favors male performance and stereotypically views men as having some innate superiority in math, that women lack (Spencer et al., 1999; Hyde et al., 1990). It was predicted, and supported, that women who held higher growth mindsets about math intelligence would perform better on the tasks compared to women with fixed theories of intelligence. Research has shown that

women with growth theories of intelligence around math are not negatively impacted by the negative stereotype that women are inferior to men in math domains, suggesting an insulating effect of growth mindset against stereotype threat. Conversely, women who hold fixed theories of intelligence around math show decreased performance, less task engagement, and negative affect induced by stereotype threat, when participating in a stereotyped domain (Dweck, 2007). The current study's results are consistent with previous mindset literature showing higher performance, task involvement, effort, and enjoyment for individuals with higher reported growth mindset (Dweck, 2000; Blackwell et al., 2006; Zhao & Wichman, 2015).

Limitations and Implications for Future Studies

Notably, this intervention was most helpful for women who already had higher growth mindset. It may be the case that the intervention was not as effective for the fixed mindset participants because women in this age group (18-30) have already suffered from the negative effects of fixed mindset in previous math experiences. Women who have already graduated high school, gone to college, or moved on to the professional world may not have had growth mindset tenants implemented early enough to allow for a positive development in the math field, which explains why the low-growth mindset women have much lower scores on all of the task measures. The negative association with math that comes from years of stereotyping in educational settings and society could have prevented our participants from acquiring the basic math skills needed to perform well on the math assessment.

This intervention may be better suited for young children entering math education for the first time. A effective growth narrative exercise could create positive associations with math, provide motivation for math tasks, and insulate young girls before, or in the first few circumstances, where they would face stereotype threat. Indeed, many of Dweck's studies

implement mindset interventions in elementary and middle school classes (Elliott & Dweck, 1988; Dweck, 2000). Pairing early exposure to math education with growth narratives that enhance messages of competence, confidence, and effortful success could create an initially positive association with math domains that could snowball into continued interest and enjoyment. At the very least, it could lead to stronger, internalized insulation when stereotype threat arises deterring women from math challenges. Although it may be the case, due to long-standing internalized fixed mindset in some women, that this intervention will only be effective in an adult population with repeated implementation of the narrative manipulation. Future research should run a longitudinal study comparing the growth narrative and growth article conditions specifically in a repeated study, to see if recurring implementation of the narrative technique has a stronger effect long-term. For women who have already developed a fixed mindset, future studies should examine how to implement the positive influence of the growth narrative intervention, perhaps through repeated exposure or more detailed, involved narratives.

Additionally, future research should include a measure of persistence on a task. The goal of the intervention was to decrease the stereotype that negatively impacts women with fixed mindsets in math intelligence. Performance was measured because research has shown that mindset shifts can cause significant differences in performance among population with the same academic history and general ability (Blackwell et al., 2007), but it may be the case that this sample has already been negatively impacted by stereotype threat in math and has consequently not pursued it further, leading to low actual ability. Persistence, effort, and responses to failure can serve as more useful indicators of future success as opposed to performance, especially in difficult subjects or when a test score is viewed in isolation, as is the case in this study. Difficult tasks that require persistent, focused effort may be more analogous to experiences that women in

math classes face often, in comparison to assessments. Including measures of persistence and responses to initial failure on a task over time provides a more comprehensive understanding of how this manipulation could benefit women in math domains, where initial failure to grasp complex problems and difficulty on certain topics is commonplace, across gender and actual ability.

Because the participants were only tested once, it is difficult to get a full scope of how the intervention affected performance and persistence going forward. Mindset research has indicated that initial low performance is not a predictor of continued failure. Instead, increased effort as a response to failure is more indicative of later performance and continued interest in a subject (Wilson, 2011; Dweck, 2008; Blackwell et al., 2007). In difficult transitions to higher-level material, many students actually do worse initially. However, holding growth mindset theories of intelligence causes them to expend additional effort, due to the belief that they can rise to meet the higher demands with higher expended effort. In contrast, individuals who face obstacles with more fixed ideals see initial difficulty or failure as a sign that they do not have the ability to meet the current expectations, so they withdraw effort and lose interest (Rattan et al., 2011). Future studies should include repeated testing of the dependent variables after the initial manipulation.

Though the math assessment did not require knowledge of advanced mathematics, it was still designed to be difficult and required some previous experience with, and practice with, algebra. People not currently in academia or not in math fields may not encounter these topics on a regular basis. Future studies should collect information about the participant's major or field of study, how long it has been since they were enrolled in school, their highest-level math course, and standardized test scores in mathematics, to control for actual math ability. An unequal distribution of math majors versus individuals who have never taken a math course being

assigned to different conditions could have affected performance and skewed the results. Future studies will control for these variables. However, random assignment of the participants should have controlled for individual differences in academic ability to a degree.

Because of the nature of an online sample, there was no regulation or control for whether or not the participants had calculators or used them. Each of the problems could have presumably been solved by hand, but may have caused frustrations or more human error if the participant was not using a calculator. If more participants used calculators in one condition and not in the other, the results could have been skewed. Due to the factors mentioned above, the math scores may not have been adequate indicators of how this narrative technique might work in real-world application.

Another change that could have led to increased performance in the growth narrative condition could have been the inclusion of a domain specific narrative about math improvement over time instead of allowing the participants to write about any sort of growth in any subject. Stereotype threat negatively affects women because of fixed mindsets in math domains specifically; the stereotype suggests that women are innately bad at math and fixed mindset suggests that they cannot improve (Shapiro & Williams, 2012; Dweck, 2007). So, it is possible that to combat the negative effects of stereotype threat for women in math domains, it is necessary to specifically target math theories of intelligence, instead of generally priming growth mindset for any domain. Studies have shown that even mindset interventions that generally inform on the malleability of intelligence and plasticity of the brain can improve performance on overall academic performance, including math, science, and literature (Dweck, 2000; Dweck, 2008; Blackwell et al., 2007; Miele & Molden, 2010). It may be the case that because women in particular are more susceptible to negative expectations in this domain due to the existing

stereotype that a more targeted narrative combating the suggestion of inflexible math ability is needed. Many women may not have a triumphant experience with math effort and consequential success. The fact that math-gender stereotypes are present so early in classroom settings (Steele, 2003) could mean that many women have already faced many negative experiences with math failure and the vicious cycle of expected failure and consequential withdrawal of effort. The negative effects of stereotyped interactions could have already thwarted the fundamental development in early math class settings these prior experiences could have contributed to their fixed mindsets, so that the brief interventions performed in this study were not able to be effective. Another possibility is that by asking women for growth experiences in math and bringing to mind episodes of failure would instead call to mind only negative experiences, in the event that a growth example was not present for the participant.

One interesting finding, which was not significant but was a consistent pattern among all dependent measures, that warrants further exploration was that in the growth narrative group, participants who initially reported having a growth theory of intelligence in math actually performed better, engaged with the task more, enjoyed the task more, and expended more effort than participants who came into the study with fixed mindsets about math. The focus of the study was to shift performance in those with initial fixed math mindsets, while individuals with growth mindsets were viewed as not having the same vulnerability to stereotype threat or detrimental responses to difficult tasks. The fact that the narrative manipulation was most beneficial for participants with growth mindset about math suggests that this intervention is most useful for individuals who already have the belief that they are capable of growth.

Several theories can explain this finding. For growth theorists, having confirmation, in the form of growth tenants, that their abilities are malleable, likely enhances the strength of the

growth mindset for their performance and behavior. In contrast, individuals with fixed mindset get discrepant information, they are asked to narrate how skills and intelligence are malleable when they previously reported believing them to be fixed. Research has shown that it is more difficult to change opinions, thoughts, beliefs, than to confirm them (Sherman & Cohen, 2006; Steele, 1988). Therefore, the initial fixed mindset individuals may have more difficulty shifting to a higher growth mindset than those who already hold a growth mindset in the math domain. Discrepant information, like growth ideas while holding a fixed mindset, could causes cognitive dissonance in fixed mindset individuals and distract them from fully focusing on the task (Rothbart & Park, 1986). We know that mindset shifts can be effective for those with fixed mindset (Dweck, 1988; Dweck, 2000), but they seem to be even more effective for those who already possess growth mindset. Further exploration is needed to confirm whether or not this is the case, and why exactly this is.

Conclusion

In line with previous research, this study showed higher math performance, task involvement, effort, and enjoyment in women who had higher growth mindset regarding math intelligence coming into the study. However, the growth narrative and growth article interventions did increase performance on the dependent measures more than the high-point control, suggesting some positive effect of growth mindset internalization. Overall, it is notable that participants in the growth narrative condition performed similarly to those in the growth article condition, which has been shown to shift mindset in previous studies (Miele & Molden, 2010; Zhao & Wichman, 2015). This suggests that individuals can actually increase growth mindset to the point of improving task performance, even in an unrelated domain, like math, just by recounting one personal experience of growth. These findings are particularly important,

because they suggest that mindset interventions can be self-generated and self-sustaining, functioning to improve performance without the instruction of a teacher or the necessity to read any prepared, distributed information. The intervention was successful in an online population, which is promising for the large-scale application of mindset shifts in education and professional fields. No prior study, to my knowledge, has successfully improved performance through a mindset intervention in an online sample with only a brief writing exercise consisting of an autobiographical anecdote. Future studies should look at the impact of repeated, sustained interventions measuring persistence and also controlling for individual differences in math ability. Additionally, future research should use stratified samples to compare the effects of growth narrative and growth article interventions specifically on task persistence, performance, and involvement with, effort toward, and enjoyment of, the task.

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Table 1

Correlations Between Mindset, Math Performance, Task Involvement, Effort, and Enjoyment

Variables	1	2	3	4
1. Mindset	----			
2. Math Performance	.215**	----		
3. Task Involvement	.357**	.178*	-----	
4. Task Effort	.156*	.055	.502*	----
5. Task Enjoyment	.316**	.170*	.497**	.267**

**. Pearson correlation is significant at the .01 level (2-tailed).

*. Pearson correlation is significant at the .05 level (2-tailed).
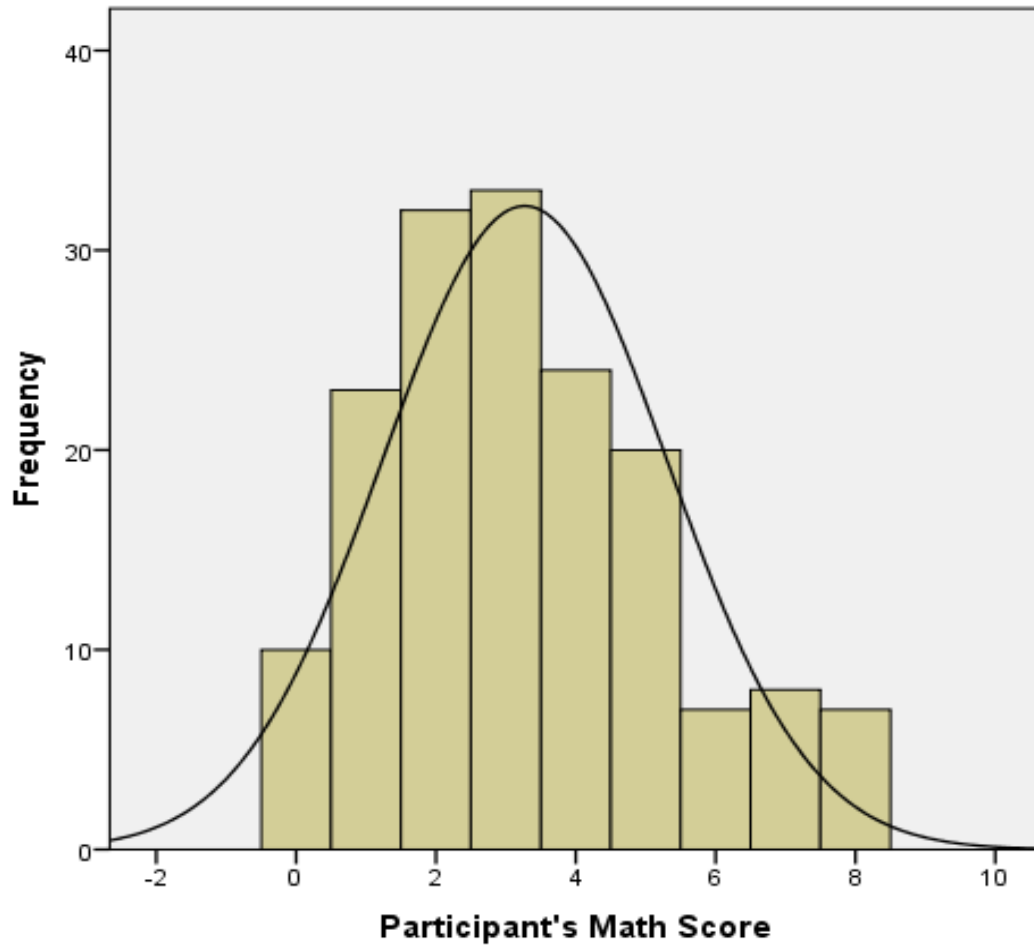
Figure 1. Math Scores: All Participants. The score represents the number of items answered correctly out of the eight assessment questions. The frequency is the number of participants who received that score. N= 164, M= 3.27, SD=2.03.
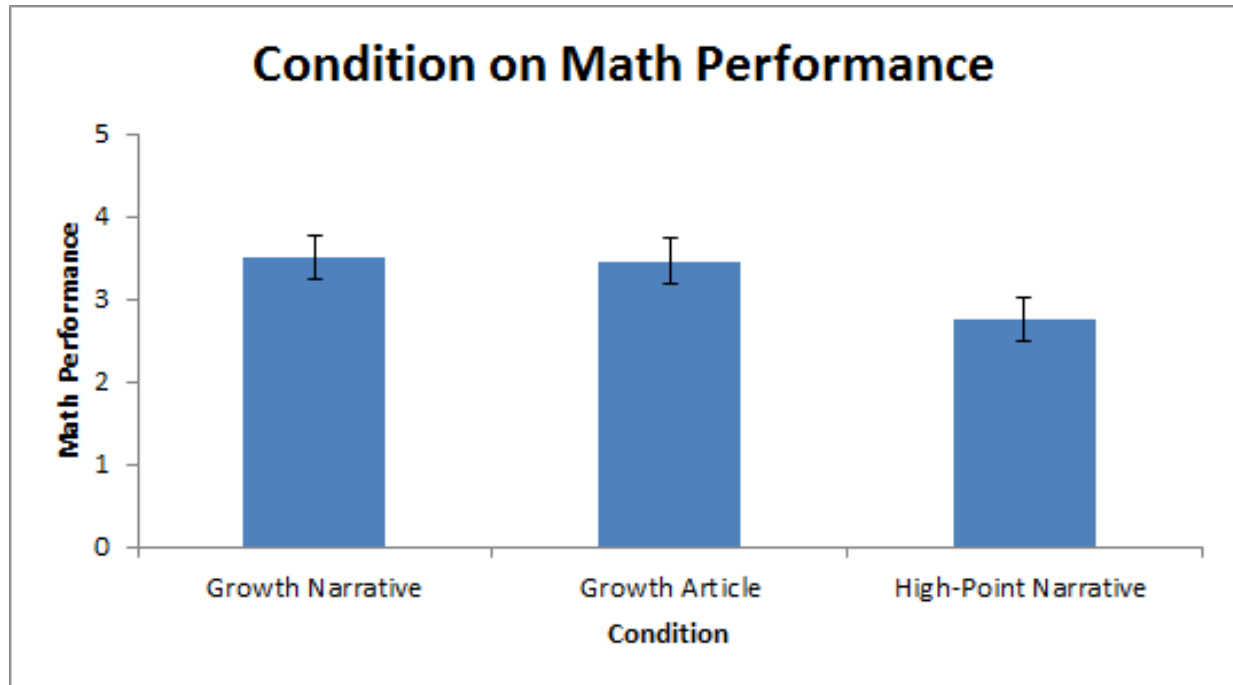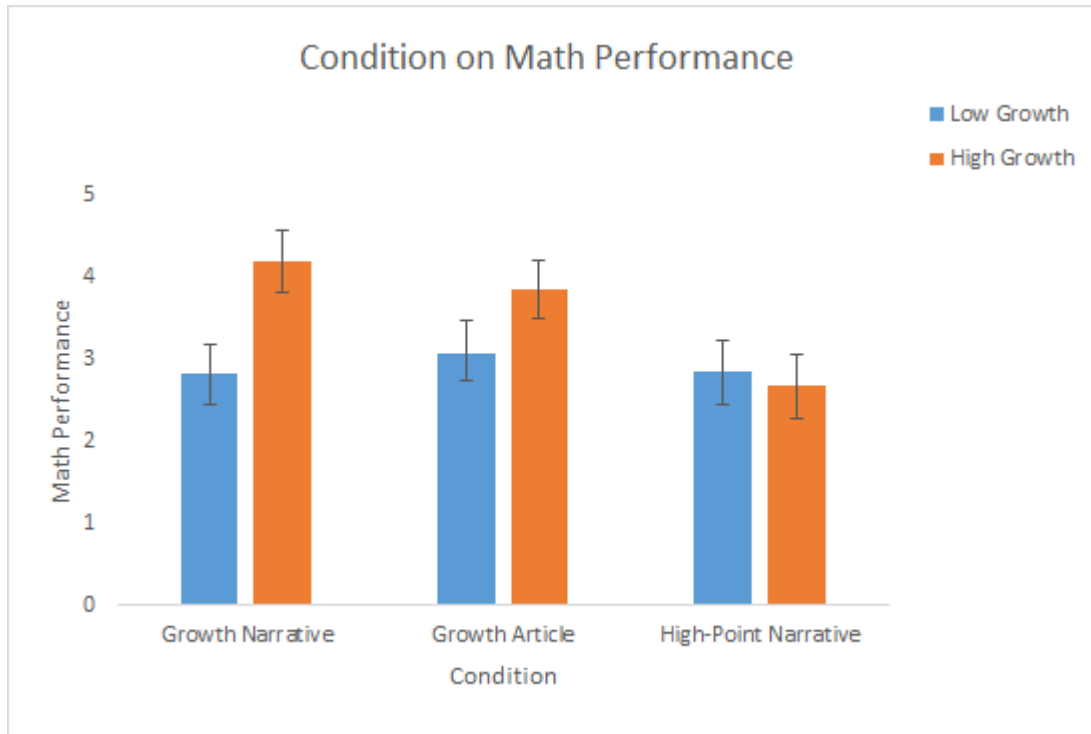
Figure 2. Effect of Condition on Math Performance for all participants, as measured by correct

scores out of eight, by condition (*M*= 3.27, *SD*=2.03). There was no significant main effect of

condition, *p* > .05, but participants in the growth narrative (*M*=3.49, *SD*=2.03) and growth article

(*M*=3.52, *SD*=2.09) conditions did score significantly higher on the math assessment than

participants high-point narrative condition (*M*=2.77, *SD*=1.91), *p* <.05, in post-hoc analyses.

Figure 3. Condition on math performance for all participants, as measured by correct scores out of eight, by condition and mindset (*M*= 3.27, *SD*=3.12). The only significant main effect present was of mindset, *p*=.04, such that high-growth mindset participants scored higher on the math assessment compared to low-growth mindset.
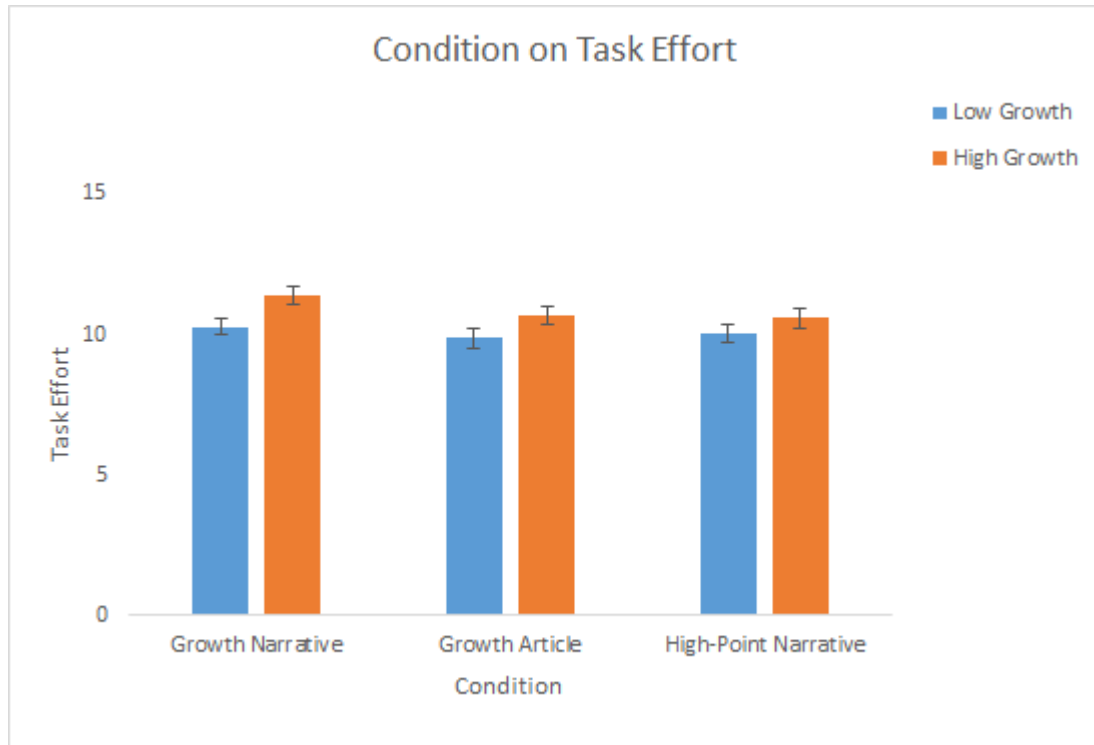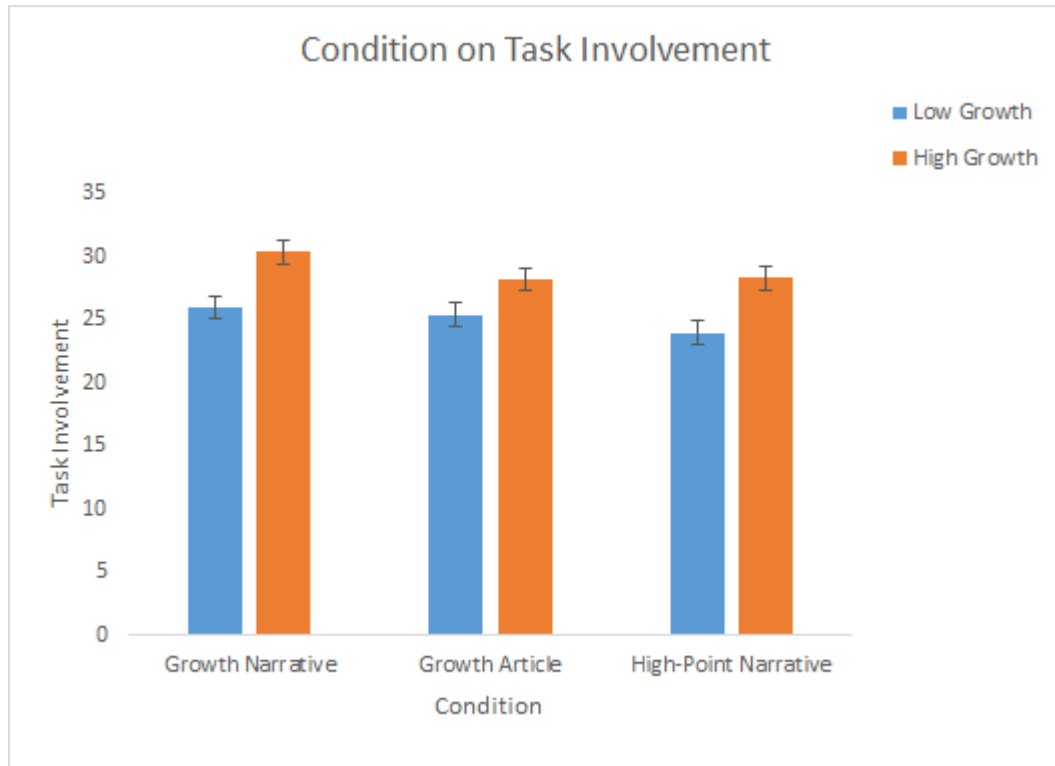
Figure 4. Condition on Task Effort for all participants, as measured by participant's score on two Likert items (*M*= 10.48, *SD*=1.74). There was a main effect of mindset, *p*=.003, such that participants with high growth mindset reported expending more effort on the task compared to participants with low growth mindset.

Figure 5. Condition on Task Involvement for all participants, as measured by participant's score on six Likert items (*M*=7.08, *SD*=5.14). There was a main effect on mindset, *p*<.001, such that participants with high growth mindset reported being more involved in the task than participants with low growth mindset.
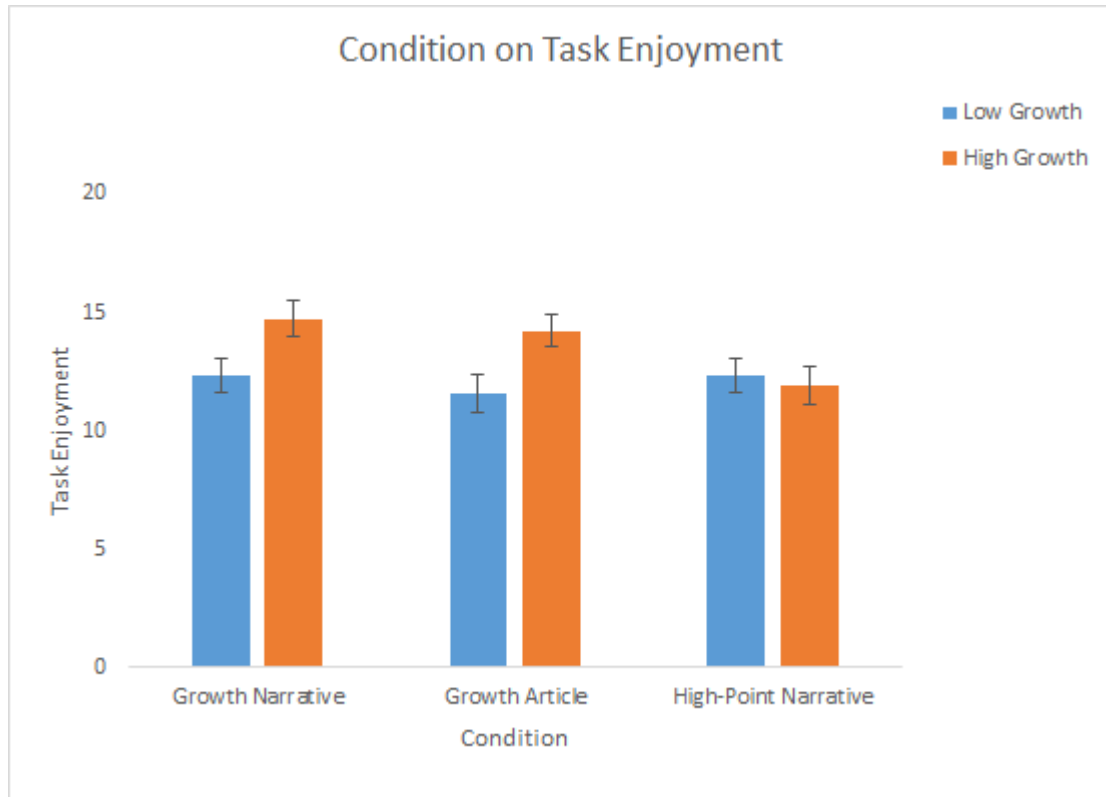
Figure 6. Condition on Task Enjoyment for all participants, as measured by the participant's added score on the three Likert scale items, by condition and mindset (*M*=12.93, *SD*=3.89). There was a main effect of mindset, *p*=.01, such that participants with high growth mindset enjoyed the task more than participants with low growth mindset.

Appendix A
IRB Application

Section 1: Contact Information
Eva Frishberg (337) 654-1845, evafrishberg@gmail.com , Psychology, Undergrad
Thomas Hutcheon, thutcheon@bard.edu

Section 2: External Funding
No. Only requesting from the Bard Psychology Department. [Office1] Qualifies for Expedited
Review

Section 4: Dates of Project
Start Date: September, 2016
End Date: May 2017

Section 5: Description of Project
Can Autobiographical Narratives about Growth Combat Stereotype Threat in Women and
Increase Performance on Math Tasks?

Research Question
        We often use narratives of autobiographical memories to maintain a stable sense of self in
circumstances where our self-concept is threatened. For example, when someone is told they are
intolerant, they will bring to mind examples and specific incidents that counter that claim, or
times that they exemplified tolerance (Jennings & McLean, 2013).
        Stereotype threat occurs when an individual's fear of confirming a stereotype associated
with their group interferes with their performance, thus confirming the negative stereotype
(Spencer, Steele, & Quinn, 1999). For example, there is a prevalent stereotype that women are
innately bad at math, which causes women to underperform on math tasks, due to the distraction
of trying to avoid fulfilling the stereotype. The stereotype that women are innately bad at math
reflects a fixed mindset theory of intelligence, which is characterized by the belief that
intelligence and ability are genetic and cannot really improve over time (Hong et al., 1999).
        Manipulations of mindset thus far have attempted to shift ideas about intelligence by
providing information that evidences growth over time, thus causing individuals to adopt growth
mindsets and motivating them to apply effort (Dweck, 1986). This study seeks to combine the
positive influence of growth mindset concepts with personal autobiographical narrative, by
asking participants to recount an example of personal growth in some area.
We predict that recalling and describing an example of some skill acquisition over time will
cause an internalization of growth mindset, combating the negative effects of stereotype threat
that women experience when faced with math assessments (Smith & White, 2002).

Section 5:Specific Populations:
Amazon Mechanical Turk Users between the ages of 18 and 30

Section 6: Estimated Number of participants
160

Section 7: Risks and Benefits
There will be challenging questions on the math assessment, but they will be no more difficult than course work and high level math that individuals who have taken standardized tests before have been exposed to.

Section 8: Consent Form
Written consent, 18 years, understand risks and benefits, agreement. **See Appendix B.**

Section 9:Confidentiality Procedure:
The researcher will be able to access the participant's Amazon Mechanical Turk ID number and the participant's location, as made available through Amazon Mechanical Turk. If the participant has inquiries about payment rejections or the study and they choose to email myself or my advisor, Thomas Hutcheon, I will then have access to their email address and name, if they choose to provide it. All MTurkID numbers will be kept securely on a password protected laptop. In SurveyGizmo, I will set up the survey to be anonymous, which will hide the IP addresses, geo-location, and email invite data, so that the only information made available to me, the researcher, will be the survey responses and the unique, randomized, completion code provided by SurveyGizmo at the end of the survey. All of that information will be kept securely on a password protected laptop.

Section 10: Deception
No deception will be used in this study. I will be telling participants that they are going to engage in either a writing or reading comprehension exercise followed by a math task, which is true.

Section 11: Debriefing Statement
 Please see the attached debriefing statement, **Appendix**

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Eva Frishberg** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 06/02/2015

Certification Number: 1774920

Section 12: Certification of Completion in the Ethical Treatment of Human Research Participants

Section 13: Recruitment Procedure

I plan on recruiting participants online from Amazon Mechanical Turk. To use Amazon Mechanical Turk, I will need to create a Human Intelligence Test (HIT) from my Amazon Mechanical Turk account. First, I must build a survey, which I will do in SurveyGizmo, and then provide a survey link on MTurk. The survey link you provide for MTurk includes a short synopsis of the survey you will asking workers to engage in and then provide a link that will bring them to the SurveyGizmo survey. I will be given the option to only show this survey to female MTurk Workers, between the ages that I indicated (18 to 30). The information on the short synopsis that MTurk workers can see as they brows HITS will also say that we only need women participants, between the ages of 18 and 30, at this stage in the data collection process. My short synopsis will look like this:

" I am conducting a survey about how reading and writing affect math performance. In this survey, you will be asked to engage in either a writing or reading comprehension exercise, and then asked to perform a short math reasoning assessment. At this point in the data collection, we are only looking for female participants between the ages of 18 and 30. This survey should only take about 35 to 40 minutes- you will be paid 2 dollars for completing this survey. Please do not

begin this task if you do not fit those criteria. At the end of the survey, you will receive a code to paste into the box below to receive compensation for taking this survey."

To ensure that I am only getting female participants, I will have a demographic page at the beginning of the SurveyGizmo survey, and if the Mturk worker fills in that they are not a woman, the survey will end with a message that says :

"We're sorry, but you do not meet the requirements for this study. Thank you for your participation."

Once participants complete the SurveyGizmo survey, workers will be shown a completion code that they then will paste into a box on the MTurk website. On the SurveyGizmo site, I will be given the option to show each participant a randomized survey code at the end of the survey. The method involves entering a piped text in an end of survey message, then making that survey message appear upon completion.
Once the participant submits their completion code and SurveyGizmo participation ID number on Amazon Mechanical Turk, I will be able to log into my MTurk account and approve their survey completion, if they did indeed fill everything out. I can reject surveys that are incomplete or if an individual was rejected by the survey for indicating that they were not female between the ages of 18 and 30. Once I approve the survey completion, the participant will be compensated through MTurk and either given money on an Amazon gift card or transferred funds directly to their bank account, based on personal preference.

Section 14: Procedure
Before the survey begins, participants will be asked to fill in some demographic information, namely their age and gender. I will program SurveyGizmo to end the survey without a completion code if the participant indicates that they are not female or between the ages of 18 and 30. If they submit "female" as their gender, or an age under 18 or over 30, the next screen to pop up will be "We're sorry, but you do not fit the requirements for this survey. Thank you for your participation." If they do indicate that they are female, and between the ages 18 and 30, the survey will begin.
First, participants will be asked to read a consent form and then informed that if they click 'Continue' on SurveyGizmo, that they consent to participate. This will be used in lieu of a signature. See **Appendix B f**or the informed Consent Agreement.
Then, participants will complete the Personalized Theories of Intelligence Survey created by De Castella & Bryne (2015) , in which they will answer eight items assessing theories of personal intelligence and ability. Participants will report their level of agreement with each statement on a 1 (*disagree very much)* to 6 (*agree very much*) scale. This personalized measure specifically measures individual theories about one's own abilities, which are thought to be better predictors

of performance and motivation, as compared to opinions about lay theories in general (Bandura, 1997). See **Appendix C** for this measure.

Next, participants will be randomly assigned into one of three conditions. In the first condition, participants will be given a writing prompt asking them to recall and describe an experience where they showed growth in some area of their life over time. In another condition, participants will be given a writing prompt asking them to recall a positive experience. These narrative writing conditions are based on off prompts from the Life Story Interview by Dan McAdams (2008). the In the last condition, participants will be shown an article, previously used by Miele and Molden (2010), about the malleability of intelligence and ability. They will be instructed to read this article under the guise of being told that they are participating in a reading comprehension tasks. They will be asked to pay special attention to the details, being told that they will have to answer questions on the passage later. After reading, several short answer questions will be asked to increase the impact of the article. See **Appendix D** for the prompts. Participants will then engage in the mathematical reasoning task where they will be asked to answer eight questions taken from standardized test websites, similar to questions you would find on the SAT or GRE. These questions are designed to be difficult with ambiguous answers, some are taken from a previous senior project by Siira Rieschl, and will be marked as such. Participants will be instructed that they can use a calculator and scratch paper to while working, but can only choose or input one final answer on the survey. See **Appendix E for** the full math reasoning assessment. Participants' performance will be scored by how many questions they get correctly. I will also be collecting time data on SurveyGizmo by seeing how long participants spent on each math question. Participants will not be given their final score, but if they want to know how they did, they can email the researcher for list of answers and explanations.

Finally, participants will complete measures of Task Involvement, Effort, and Enjoyment (Elliot & Harackiewicz, 1996) that will be modified to refer to the specific mathematical reasoning assessment in this study. The six-item Task Involvement scale measures how focused participants were on the task, the two-item task effort index measures how much effort participants expended for the task, and the three-item Task Enjoyment scale measures how much participants liked solving the problems. Participants will rate how much they identity with each statement on a 7 point scale from 1 (*strongly disagree*) to 7 (*strongly agree*). See **Appendix F f**or this measure.

Section 15 Recruiting Script:
This script will be shown at the beginning of the SurveyGizmo survey, which Mturk workers will get to once they click the link on MTurk. This blurb will also be on the MTurk website in the HITs section so browsing workers can determine what is involved in this survey.

"I am conducting a survey about how reading and writing affect math performance. In this survey, you will be asked to engage in either a writing or reading comprehension exercise, and then asked to perform a short math reasoning assessment. At this point in the data collection, we

are only looking for female participants between the ages of 18 and 30. Please do not begin this task if you do not fit those criteria. This survey should only take about 35 to 40 minutes- you will be paid 2 dollars for completing this survey. At the end of the survey, you will receive a code to paste into the box below to receive compensation for taking this survey."

Section 16: Testing Script

Each page on SurveyGizmo will have instructions which are shown below in each of the Appendices. The first page will say something like this:

Pre-Screening Demographic Questionnaire:
Hello! Before we begin, please answer some demographic information. Indicate your age and gender below:

Age: ____
Gender: ( ) male ( ) female

(If age is between 18 and 30 and gender is female, the survey will continue as shown below. If age or gender do not fit the requirements, the survey will close with "We're sorry, but you do not fit the requirements for this survey. Thank you for your participation.")

Page One:
Welcome! Thank you for showing interest in the study. This study should take you about 35 to 40 minutes to complete. Please read the following Informed Consent Agreement thoroughly before beginning. By clicking continue, you indicate that you agree to participate, though you may stop your participation at any time by simply closing out the browser. However, please note that to be compensated for participation, you must complete the survey and submit the code at the end of the survey to Amazon Mechanical Turk.

Page Two:
Informed Consent Document, see **Appendix B**

Page Three:
Before you start, please:
-      Maximize your browser window; Close any other browsers and programs that are not relevant to this study.
-      Switch off any distracting objects, such as phone/email/music.
-      Complete the study in one sitting.
-      Do not use a small device, such as a smart phone, to complete this study.

The next page presented will be dependent on the condition that the participant is placed in.

Page 4:

Reading comprehension Condition:

You will now be presented with a research article. Please read the article at your own pace for comprehension. Once you finish reading, you will be asked a few   questions about the concepts presented in the article. Please scroll down to read the entire page. See article and questions in **Appendix D.**

Growth Narrative Condition:

See prompts in **Appendix D.**

High Point Condition:

See prompt in **Appendix D.**

Page 5:

Next, you will take a short math assessment, made up of eight questions, designed to get a general idea of your math abilities, compared to the average population. These questions will assume that you have basic knowledge of algebra, arithmetic, geometry, and data analysis. If you cannot answer a question, simply guess. Your score will not be affected by answering a question incorrectly.

Page 6: Math Assessment, See **Appendix E.** Participants will finish each question and then click submit, bringing them to the next page.

Page 7: Task Involvement, Enjoyment, and Effort Questionnaire.

Instructions: Read each of the following statements carefully and indicate your agreement with it using the scale below. There are no "right" or "wrong" answers. Answer in the way that is right for you, being as truthful as possible.

(each item will be presented on a likert scale from 1 (disagree very much) to 6 (agree very much) and the participant will choose the number they most identify with).

See **Appendix F** for the task

Page 8: Thanks and Debriefing

Thank you for your participation in this study! Below, please find more information about the study and ways you can contact the experimenters if you have further questions about this study or your participation. (The debriefing document will be on this page, see **Appendix G**)

Click continue to receive your unique completion code that you will use to receive compensation from Amazon Mechanical Turk

Page 9: Participants will be shown their unique completion code that they will use to receive compensation from Amazon Mechanical Turk.

Appendix B
Informed Consent Agreement
Project Title: Reading and Writing on Math Performance

This informed consent document contains a brief description of the purpose of this project, what procedures will be used, and the potential benefits and risks of participating. Please read this document and contact the researchers if you have any questions about the study. You should keep a copy of this form for your records.

*Background: T*his study addresses how reading and writing comprehension tasks affect mathematical reasoning.

What you will do in this study: If you agree to participate, you will be asked to engage in either a writing exercise about some past experience or a reading comprehension exercise before completing an eight-item mathematical reasoning assessment. You will be asked several questions before and after the math assessment. This study should take about 35 to 40 minutes.

Risks and Benefits: Participants in previous studies of this nature have not reported or indicated any discomfort, but some people do not enjoy testing situations. Your participation will allow a Bard College student to produce a senior project.

Compensation: In exchange for your participation on this Mechanical Turk task, you will be compensated 2 dollars over Amazon Mechanical Turk. This study should only take you about 35 to 40 minutes to complete. Once you are compensated for your time, and before your responses are analyzed, your email in connection with your response and participation will be deleted. All of your responses will be kept in the Bard Psychology lab on a password protected laptop and will only be seen by the experimenters.

Your rights as a participant. Your participation is completely voluntary. You are free to stop the experiment at any time and simple close out the internet browser with no questions asked. However, in order to be compensated, you will need to complete online survey so that the experimenter may approve your participation and approve payment. If you choose not to continue the experiment, or you do not complete the survey fully, you may be denied payment by the researcher after you submit or close out of the survey. In order to receive compensation, you must provide the unique completion code given at the end of the survey to submit to Amazon Mechanical Turk for approval.

Confidentiality. The researcher will only be able to access your Mechanical Turk ID number and your location. If you have inquiries about the survey or problems getting approved for payment without finishing the survey, you will have to contact the experimenter by email or through

Amazon Mechanical Turk, in which case the experimenter will see your name, if you choose to provide it, and your email. Your identification information will only be accessed and kept on a password protected laptop and only seen by the experimenters. Your survey responses will be identified with randomized, serially generated participant codes. All your identification information will be stored separately from your answers to ensure confidentiality.

The final published version of this research will be permanently and publicly available as a Senior Project at the Stevenson Library of Bard College

You must be 18 years or older to participate in this study. By continuing this survey, I affirm that I have read and understood the above information and voluntarily agree to participate in the research project described above. I accept the risks of harm described as well as the benefits described above. By continuing this survey, I acknowledge that I am 18 years or above.

_____

Sign here

The experimenter will give you more information regarding the study after it has ended. If you have questions or would like to know more about this subject or the experiment, please contact the primary researcher, Eva Frishberg at evafrishberg@gmail.com. If you have questions about the Bard Psychology Program, you may contact Associate Professor Thomas Hutcheon, advisor to this project, a, at thutcheo@bard.edu. If you have questions or concerns about your rights as a participant, please contact the Bard College Institutional Review Board at irb@bard.edu

Appendix C
Personalized Theories of Intelligence Measure -
(De Castella & Bryne, 2015)

Instructions: Next, you will asked several questions about your beliefs about your ability to change your intelligence level. There are no right or wrong answers. We are just interested in your views. Using the scale below, please indicate the extent to which you agree or disagree with the following statements.

(Participants will rate the extent that they agree with each statement on a likert scale from 1 (disagree very much) to 6 (agree very much)).

1.   I don't think I personally can do much to increase my intelligence.
2.   My intelligence is something about me that I personally can't change very much.
3.   To be honest, I don't think I can really change how intelligent I am.
4.   I can learn new things, but I don't have the ability to change my basic intelligence.
5.   With enough time and effort, I think I could significantly improve my intelligence level.
6.   I believe I can always substantially improve on my intelligence.
7.   Regardless of my current intelligence level, I think I have the capacity to change it quite a bit.
8.   I believe I have the ability to change my basic intelligence level considerably over time.

Appendix D

Manipulation Prompts:

Modified from McAdams 2008 Life Interview

Source: (https://www.sesp.northwestern.edu/foley/instruments/interview/)

Growth Narrative:

Please spend the next five minutes writing about an event in your life in which you displayed growth or improvement in some area over a period of time, as a result of dedication and effort. The skill could be something physical or athletic, like getting better at a sport, or academic, like becoming more comfortable with writing analytical essays. Please describe your initial capabilities, or lack thereof, what you did to get better at this skill, what obstacles you faced, and how you overcame them. What does this growth or improvement say about you as a person?

High Point Narrative:

Please spend the next five minutes writing about a time in your life that stands out as an especially positive experience. This would be a very positive, happy memory from any period in your life . What happened, where and when did this experience take place, who was involved, and what were you thinking and feeling? Explain why this experience stands out as positive to you and what this experience says about you. Please provide as much detail as possible.

Incremental Article:

Next, you will be presented with a research article. Please read the article at your own pace for comprehension. Once you finish reading, you will be given a test made up of several open ended questions. The open-ended questions will ask you to tie together your personal experience with concepts presented in the article. Please scroll down to read the entire page.

Reading Comprehension Questions:

a. Briefly summarize the main point of this article.

b. Describe the evidence that you find most convincing and why.

c. Describe an example form your own experience that fits with the main point of the article.

** the article will be on the next page

CROSSTALK

The Origins of Intelligence:

Is the Nature-Nurture Controversy Resolved?

BY JEROME BERGLUND

Adam Steagal is gifted. Although he is just eighteen months old, he can understand over 2000 words, has a speaking vocabulary of 500 words, and is even able to identify five different species of birds. Early in his life, Adam's parents had a hunch that he was unusual.

At the age of 8 months he was crawling and investigating everything in the Steagal household. All babies are curious, but Adam's curiosity led him to heights of baby creativity. He was not simply banging on pots and pans; Adam had learned to dismantle a toy camera and put it back together again. He had the coordination to handle small objects, the ability to remember how parts fit together, and could concentrate on the camera for almost an hour. Most children can't do what Adam was doing until they are at least three or four.

When he was ten months old, Adam's parents brought him to University of Michigan's Unit for Intelligence Research (UIR). Paula Rescorla, the director of UIR, found that Adam had an IQ of 185. Experts consider an IQ of 130 "very superior." Adam's IQ is so extreme that only one person in a million has an IQ that even comes close. Researchers like Rescorla are keenly interested in what made Adam so smart.

The traditional "is it heredity or is it environment?" question is batted around the halls of UIR on a daily basis. But, people who take the side that intelligence is genetically determined are going to be believed less and less. Current research shows that intelligence can be increased substantially by environmental factors.

In the past decade, a number of comprehensive studies have been published in the United States and in Europe. These studies provide the clearest answers so far in the ongoing debate. The most significant of these studies will be published this fall in Psychological Review, a prestigious
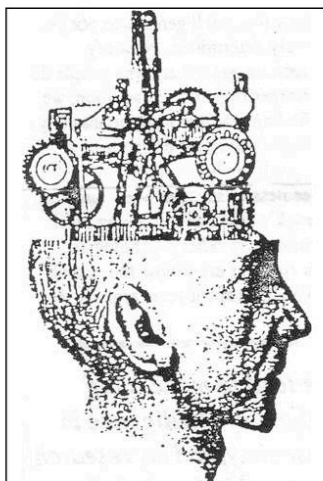
psychological journal published in the United States.

John Knowles, the author of the article and a professor at Harvard, concludes that, "intelligence seems to

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"The brilliance of Leonardo da Vinci and Albert Einstein was probably due to a challenging environment. Their genius had little to do with their genetic structure."

---

have a minimal genetic component. People may be born with a given level of intelligence, but we see increases in IQs up to 50 points when people enter stimulating environments."

Knowles spent the last decade tracing identical twins who were raised apart. In

a relentless search through Latin America, Africa, and North America, he was able to locate 83 pairs of twins who were raised separately. These twins ranged in age from 7 to 51 and came from all economic levels.

Knowles had an ideal sample to study the nature-nurture question. The twins in his study were often reared in different cities by parents of different social classes. The various pairs of twins came from different countries, spoke different languages, were different ages, and he followed them for ten years. Knowles tested the subjects individually with the best "culture-fair" intelligence tests available.

Culture-fair tests measure intelligence by having people identify relationships between shapes and objects. Because the tests use only shapes and objects—not words—to measure intelligence, cultural factors don't influence people's scores. Consequently, they provide a much more accurate measure of intelligence than most other intelligence tests. In addition, culture-fair tests don't discriminate against any ethnic groups. Because Knowles used these sophisticated measures of intelligence, he was able to make stronger conclusions than have been possible in the past.

He found that twins raised in different environments had very different levels of intelligence. According to his results, up to 88 percent of a person's intelligence is due to environmental factors. In his study, if twins were raised in stimulating environments with motivated parents, they tended to have high IQs. Twins raised in unstimulating environments tended to have lower IQs. In an extreme case, a young girl adopted by a college professor and his wife had an IQ of 138. The genetically identical twin was raised by the real mother who was a prostitute. This girl had an IQ of only 85.

Although this evidence is very strong,

CROSSTALK

Knowles has even more evidence which may convince skeptics. He found that people in challenging environments showed substantial increases in their intelligence during the ten year study. Children and adults who were in stimulating environments had increases in IQ ranging from 15 to 48 points. People who were in unstimulating environments showed slight drops in their IQ.

According to Knowles, his results suggest that "the brilliance of Leonardo da Vinci and Albert Einstein was probably due to a challenging environment. Their genius had little to do with their genetic structure. These men are truly admirable because they were challenged and worked to overcome obstacles."

Other researchers are finding similar results. Hans Eysenck recently published an article supporting Knowles research. Eysenck's studies show that a person's level of motivation can have a profound effect on intelligence. He found that bright children placed in "dull" environments tended to become less intelligent unless they were motivated to learn. Relatively dull children placed in stimulating environments seemed to get much smarter, especially if they were rewarded for learning new things.

Needless to say, Knowles' and Eysenck's research is drawing much attention from other psychologists. Their findings are widely praised by researchers who have been trying for years to prove that intelligence is not genetically determined.

Leo Kamin of Princeton University is one such researcher. In the 1960s and '70s, he argued strongly that there was no good evidence to show the link between intelligence and genetics. He helped prove that Sir Cyril Burt, a now infamous researcher, faked his data to show that intelligence was inherited. When Burt was alive, the Queen of England knighted him for his "brilliant" research. When Kamin examined Bun's results, he discovered serious flaws that could only have resulted by faking the data.

This has led Kamin to be a bit careful before accepting any intelligence findings as the "truth." Consequently, he carefully examined Knowles' study. He found "no flaws in [Knowles'] methods or his analysis. Finally, the best available research shows what I have been arguing for for 25 years. Knowles' research is simply the best, and it shows that intelligence can be increased by stimulating environments."

Paula Rescorla at University of Michigan's UIR is also excited about Eysenck's and Knowles' results. "I think something crucial has come out of these studies – we now know that intelligence is something that motivated people can acquire. I think this idea will definitely

"I think something crucial has come out of these studies – we now know that intelligence is something that motivated people can acquire. I think these ideas will definitely revolutionize education in the twenty-first century. We can help motivated children find environments that will help them increase their intellectual abilities.

revolutionize education in the twenty-first century. We can help motivated children find environments that will help them increase their intellectual abilities."
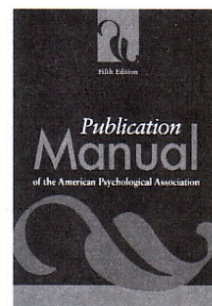
The eighteen month-old genius Adam Steagal seems to be in an ideal environment right now. His young brilliance isbeing challenged by fascinating toys and games. But apparently, whether or not he will be brilliant when he grows up is largely his choice. □

Jerome Berglund is a free-lance writer from Ann Arbor, Michigan. He is a frequent contributor to Psychology Today.

Appendix E

Mathematical Reasoning Assessment

For the following questions, you are welcome to use a calculator and scratch paper as you need. Partial credit for questions will not be awarded. However, if you cannot determine the answer to a question, simply guess. Answer as many questions as you can. You may take as long as you wish to answer each question.

1. A digital watch displays hours and minutes with AM and PM. What is the largest possible sum of the digits in the display?

2. Fourteen white cubes are put together to form the figure on the right. The complete surface of the figure, including the bottom, is painted red. The figure is then separated into individual cubes. How many of the individual cubes have exactly four red faces?
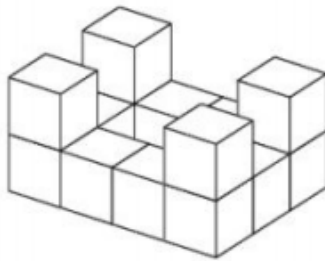

3. Six trees are equally spaced along one side of a straight road. The distance from the first tree to the fourth is 60 feet. What is the distance in feet between the first and last trees?

4. Ten red socks and ten blue socks are all mixed up in a dresser drawer. The 20 socks are

exactly alike except for their color. The room is in pitch darkness and you want two

matching socks. What is the smallest number of socks you must take out of the drawer in

order to be certain that you have a pair that match?

a. 2

b. 3

c. 4

d. There is no way to definitely know

5. The 8x18 rectangle ABCD is cut into two congruent hexagons, as shown below, in such a

way that the two hexagons can be repositioned without overlap to form a square. What is

Y?
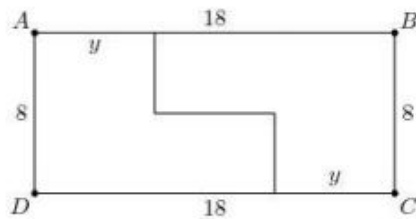
a. 6

b. 7

c. 8

d. 9

6. Which of the following is equivalent to $(x)(x)(x)(x^3)$, for all x?

a. $4x^3$

b. $6x$

c. x^6

d. x^9

7. How many square yards of carpet are required to cover a rectangular floor that is 12 feet long and 9 feet wide? (There are 3 feet in a yard.)

a.   12

b.   36

c.   108

d.   324

e.   972

8. The ratio of Mary's age to Alice's age is 3:5. Alice is 30 years old. How old is Mary?

a.   15

b.   18

c.   20

d.   24

e.   50

Math Reasoning Answer Key:

1.   *Answer:* 23

This is 9 in the hours section and 59 in the minutes section (thus adding those individual digits,

9+5+9). Note that the "AM and PM" implies that the watch is not using military time.

Source: 2006 AMC 10A problem 4 http://artofproblemsolving.com/school/course/maa-

Amc10

2   *Answer:* 6

This is the number of cubes that are adjacent to another cube on two sides. The bottom

corner cubes are connected on three sides, and the top corner cubes are connected on one.

The number we are looking for is the number of middle cubes, which is 6.

Source: 2003 AMC 8 Problem 13

http://www.artofproblemsolving.com/wiki/index.php/Main_Page

3. *Answer*: 100 feet

There are 3 spaces between the 1st and 4th trees, so each of these spaces has 60/3=20 feet.

Between the first and last threes there are 5 spaces, so the distance between them is 20x5=100

feet.

Source: 2001 AMC 8 Problem 6

http://www.artofproblemsolving.com/wiki/index.php/Main_Page


4. *Answer*: B (3 socks)

With two socks it is possible to have one red and one blue. But with three there is always a

matching pair since either you will have chosen three of the same colour, or a matching

pair and an odd one out.

Source: http://www.theguardian.com/science/alexs-adventures-in-

numberland/2014/oct/27/solutions-to-martin-gardners-best-mathematical-puzzles

5. *Answer:* A

Since the two hexagons are going to be repositioned to form a square without overlap, the

area will remain the same. The rectangle's area is 18x8=144. This means the square with

have four sides of length 12.
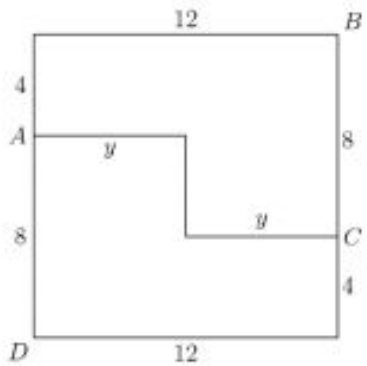
The line segment denoted as y is half the length of the side of the square, which leads to

y=12/2=6.

Source: 2006 AMC 12A Problem 6

http://www.artofproblemsolving.com/wiki/index.php/Main_Page

6. Answer: C (x6)

Source: http://www.onlineselftest.com/which-of-the-following-is-equivalent-to-xxxx3-

For-all-x

7. Answer: A. 12.

Solution 1: First, we multiply 12 times 9 to get that you need 108 square feet of carpet you need

to cover. Since there are 9 square feet in a square yard, you divide 108 by 9 to get 12 square

yards.

Solution 2: Since there are 3 feet in a yard, we divide 9 by 3 to get 3, and 12 by 3 to get 4. To

find the area of the carpet, we then multiply these two values together to get 12.

 Source: 2015 AMC 8 Problems, Problem 1

http://artofproblemsolving.com/wiki/index.php?title=2015_AMC_8_Problems/Problem_1

8. Answer: Let m be Mary's age. Then $m/30 = 3/5$. Solving for m, we obtain $m = 18$. The answer

is b.

Source: 2006 AMC 12A problem 3

http://artofproblemsolving.com/wiki/index.php?title=2006_AMC_12A_Problems/Problem_3

Appendix F

Measures of Task Involvement, Effort, and Enjoyment

(Elliot & Harackiewicz, 1996**)**

Instructions: Read each of the following statements carefully and indicate your agreement with it using the scale below. There are no "right" or "wrong" answers. Answer in the way that is right for you, being as truthful as possible.

(each item will be presented on a likert scale from 1 (disagree very much) to 6 (agree very much) and the participant will choose the number they most identify with).

<u>Task Involvement</u>

1. While working on the task, I was totally absorbed in the task.

2. While working on the task, I lost track of time.

3. While working on the task, I concentrated on figuring out the answers to the questions.

4. While working on the task, I had trouble focusing my attention on the task.

5. While working on the task, I felt self-conscious.

6. While working on the task, I thought about things unrelated to the task and this study.

<u>Task Effort</u>

1. I put a lot of effort into completing the task.

2. I tried very hard to complete the task.

<u>Task Enjoyment</u>

3. I enjoyed completing the task.

4. I think that completing the task was boring.

5. The task was fun.

Appendix G
Debriefing Form

Reading and Writing on Math Performance Debriefing Form

Thank you so much for your time and your participation in this study!

Important Information: This study sought to determine whether recalling and describing an episode of growth in some subject or skill would increase performance on a math test. There were three conditions that you could have been placed in. One asked you to remember and describe a time where you showed growth over time in some area or skill. Another asked you to recount a particularly positive experience in your life. The final condition included an article presenting the ideas that intelligence and ability are changeable and can grow over time, and was followed by several questions about the article's content. We hypothesized that narrating a personal experience about growth would be most effective in combating stereotype threat for women on math tasks, and cause the best performance on the math assessment task.

Mathematical Reasoning Assessment: The items on this assessment were taken from various sources such as the GRE and the SAT practice tests. They were intentionally challenging, but were not meant to be outside the realm of knowledge that most people in our sample would have. They were, however, ambiguous in the sense that many answers seem reasonable to most of the questions. Your performance on this task does not have implications for your abilities. The answer key will be made available if you are interested.

Narratives: Maintaining a stable sense of self while navigating a variety of situations that may contradict our own self perception can be difficult and emotionally taxing. Autobiographical narratives are used to counter threats to the self-concept by recalling and personally recounting events that provide evidence of our characteristics (Jennings & McCarthy, 2013). In other words, narratives help bring to mind and prove aspects of ourselves that can sometimes be threatened. If someone were to tell you that you were greedy, you could bring to mind instances that you have been generous in order to refute that statement. Most women have the belief that men are inherently better at math, to the point that even telling women they are about to take a math exam will make them aware of their stereotyped inferiority in math. In this study, we asked women to provide narratives about growth and improvement in order to combat the fixed mindset that most women possess around mathematics.

Mindset Manipulations: Research has shown that there are two main types of thinking about intelligence. Those with fixed mindsets about intelligence usually believe that they are born with a set amount of intelligence and cannot really get smarter over time. Those with growth mindsets

believe that intelligence is malleable, and can increase with effort (Dweck et al., 1986). Studies have shown that people with growth mindsets tend to persist more on difficult tasks, perform better academically, and respond better to criticism or failure (Hong et al.,1999; Dweck & Leggett, 1988; Molden & Dweck, 2006). Mindset interventions thus far have focused on showing students information that coincides with growth tenants, which increases persistence, and subsequently performance (Dweck et al., 1986). This study combines growth mindset tenants with the use of narratives to cause an internalization of growth mindset in women, in order to help them persist on a math task that may threaten their self-concept.

Women and Science, Technology, Engineering, and Mathematics (STEM) Fields: There is a well-known stereotype that women are less talented at subjects like science, technology, engineering, and math, which has led to a significant gap between the number of men and women who pursue STEM fields. Women are less likely to hold STEM undergraduate degrees, are less likely to go into STEM fields, and are more likely to hold lower-paying, non-tenured faculty positions within STEM subjects compared to their male counterparts (US Department of Commerce, 2011; National Science Foundation, 2015). The stereotype threat that women face in educational settings plays a large part in this discrepancy, so finding effective interventions to combat the negative effects of stereotype threat is of vital necessity. We predict that women who internalize growth mindset through recalling examples of their own improvements will extend to other STEM subjects and help them persist on difficult tasks.

If you have any questions about your performance on this assessment, how we coded your narratives, how we graded your performance, or would like to know more about this subject, please feel free to contact the primary researcher, Eva Frishberg at evafrishberg@gmail.com.

If you have any questions about the Bard Psychology Program, you can reach Associate Professor Thomas Hutcheon, advisor to this project thutcheo@bard.edu.

If you have questions or concerns regarding your rights as a research participants, please contact the Bard College Institutional Review Board at irb@bard.edu

References

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological review*, *95*(2), 256

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IRB Approval Appendix H

Bard College   Institutional Review Board

22 November 2016

Re: Can Autobiographical Narratives about Growth Combat Stereotype Threat in Women and Increase Math Performance?

DECISION: APPROVED

Dear Eva,

The Bard Institutional Review Board has reviewed the revisions to your proposal. Your project is approved through 3 May 2017. Your case number is 2016NOV22-FRI.

Please notify the IRB if your methodology changes.

We wish you success with your Senior Project research.

Sincerely,

Simeen Sattar
sattar@bard.edu
IRB Chair

cc: Thomas Hutcheon