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The Role of Attributions in Stereotype Threat Effects: Female Achievements in STEM Domains

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THE ROLE OF ATTRIBUTIONS IN STEREOTYPE THREAT EFFECTS: FEMALE ACHIEVEMENT IN STEM DOMAINS

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INTRODUCTION

The underrepresentation of women in science, technology, engineering, and mathematics (STEM) is a familiar problem, but the reasoning behind this gender gap is the subject of ongoing study. Although the gender gap in STEM subjects among students has been closing (Buchmann & DiPrete, 2006; Hyde, Lindberg, Linn, Ellis, & Williams, 2008), discrepancies remain on high-stakes exams such as the Scholastic Aptitude Test, Graduate Record Exam, and Advanced Placement tests. On these tests, males out-perform females consistently in science and mathematics (Halpern et al., 2007; Lubinski & Benbow, 2008). It is under the pressure and anxiety of such major diagnostic evaluations that male and female students begin to separate, with women falling behind. These gender differences on critical exams are mirrored in the continuing gender gap in college major selection. Although women are more likely than men to earn a college degree (Buchmann & DiPrete, 2006), there has been little change in female participation in STEM areas, where males typically dominate (Legewie & DiPrete, 2011). Specifically, men are significantly more likely to select engineering, computer science, and mathematics as a college major than are women (Peter & Horn, 2005).

Gender differences in college major selection also translate to fewer women in STEM careers. For example, women only make up 5.9% of mechanical engineers and 29.5% of environmental scientists (US Department of Labor, 2010). This pattern holds in academia as well, where 92% of engineering professors and 87% of computer science professors are male (National Science Foundation, 2004). What are the driving forces behind this ongoing gender disparity?

One explanation for this continuing gender gap is a cultural environment in which gender stereotypes are particularly pervasive and influence not only perceptions of male and female ability in STEM areas, but also students' performance in these domains. The stereotype that "math is male", for example, has recently been shown to be acquired as early as second grade (Cvencek, Meltzoff, & Greenwald, 2011). Not only did young students associate math with male, but female elementary students had a much weaker identification with math than did males even at this early age. Studies such as this one indicate that the gender stereotypes related to STEM domains are understood very early and may then contribute to performance on high-stakes exams as well as interest in STEM fields later in life, where STEM gender stereotypes persist (Nosek & Smyth, 2011; Nosek et al., 2009). The internalization of such gender stereotypes can have severe consequences that lead to disengagement from the domain. In order to preserve self-esteem, it is common for individuals to selectively place less value on domains for which their group is stereotyped (Crocker & Major, 1989; Nieva & Gutek, 1981). Therefore, the pervasiveness gender STEM stereotypes can lead to disengagement from an early age, resulting in the gender disparities observed throughout secondary education and in the work force.

In general, stereotypes can be debilitating in terms of performance and are influential in the gender STEM problem. Specifically, the phenomenon of stereotype threat can be strong enough to inhibit performance in several different domains, including important diagnostic tests such as the SAT and GRE that students pursuing these fields must take.

Stereotype Threat

Stereotype threat is defined as "the concrete, real-time threat of being judged and treated poorly in settings where a negative stereotype about one's group applies (Steele, Spencer, & Aronson, 2002, p. 389)." Feeling threatened by a salient stereotype about one's group can hinder performance in different domains compared to when no stereotype threat is present.

Stereotype threat effects have been observed with various social groups and with many different skills. For example, athletic performance of White participants was impaired compared to Blacks when a sports task was defined as diagnostic of natural ability (Stone, Lynch, Sjomeling, & Darley, 1999). In this case, White participants were threatened by the negative stereotype that Whites as a group are less skillful in athletics than are Blacks, which subsequently interfered with their ability to perform well.

Useful skills for the workplace are also affected by stereotype threat. Men's ability to decode nonverbal cues showed impaired performance when they were told this was a test of social sensitivity, on which women generally score higher (Koenig & Eagly, 2005). The stereotype that women are more sensitive and understanding served as a threat to the male participants, showing that stereotype threat can occur even with typically non-marginalized groups. Similarly, women's ability to negotiate successfully was impaired when gender was made salient, indicating that females had an existing stereotype of men as superior negotiators (Kray, Galinsky, & Thompson, 2001).

Perhaps the most often studied form of stereotype threat is in intellectual or academic domains. This research began with experiments showing that the possibility of confirming a negative racial stereotype about intellectual ability impaired Black students'

performance on difficult verbal reasoning and math tests (Aronson, Quinn, & Spencer, 1998; Steele, 1997; Steele & Aronson, 1995). This effect was observed even when individual skills and level of preparation were accounted for, indicating that although the two racial groups were equally qualified, the negative stereotype present at the time of the test was enough to impair performance. This effect has been replicated with different tasks as well as with different target groups.

White males who were highly identified with and proficient in math experienced impaired performance on a math test when comparisons were made with Asians, who are stereotyped as exceling in mathematics (Aronson, Lustina, Good, Keough, Steele, & Brown, 1998; Smith & White, 2002). Furthermore, when a difficult math test was described as producing gender differences, women performed much worse than men even though the two groups were equally qualified (Spencer, Steele, & Quinn, 1999; Walsh, Hickey, & Duffy, 1999). This effect was also shown with young girls whose performance was hindered when gender was made salient before a math test (Ambady, Shih, Kim, & Pittinsky, 2001). Through these many stereotype threat studies, specific components have been identified that must be in place for stereotype threat effects to occur.

Stereotype Threat Contingencies

In order for a stereotype to pose a threat and affect one's performance, the situation must be one in which the stereotype is applicable (Steele, Spencer, & Aronson, 2002). For example, a difficult math test creates a situation in which the gender and math achievement stereotype applies. Performance must also be relevant to the stereotyped group; that is, the stereotype has to be specific to the task at hand, not a stereotype that is

indirectly tied to achievement (Spencer, Steele, & Quinn, 1999). Furthermore, stereotype threat effects emerge more often when the tests are characterized as diagnostic of ability. In this case, the target has an investment in performing well on the task, making the stereotype particularly influential on his/her performance expectations.

Domain identification is the degree to which one's self-regard depends on the outcomes one experiences in the domain (Steele, Spencer, & Aronson, 2002). The more identified one is with the domain of interest, the more influence the stereotype will have on performance. It is necessary to establish domain identification by connecting the particular task with a field of study or a skill that is particularly important to the individual. Similar to the necessity of test diagnosticity, high domain identification makes the test something the individual sees as important, increasing motivation to perform well. If the motivation to perform well is absent, outcomes in the presence of stereotype threat will not differ from outcomes when there is no stereotype threat present.

It is important for individuals to be highly identified with the group to which the stereotype applies. One's identity must be directly linked to the stereotype itself, or else it loses its applicability to that individual (Steele, Spencer, & Aronson, 2002). In the case of gender stereotypes, group membership is often made salient simply by indicating gender before the task. This reminder of group membership leads the individual to think about how his/her membership in the stereotyped group will affect how they perform on the upcoming task (Steele, Spencer, & Aronson, 2002).

Finally, the difficulty of the test is often a critical component of stereotype threat. When the test is difficult, the individual may experience increased pressure and frustration. These elements are then likely to lead to more thoughts about the

implications of the negative stereotype about their group, which may affect performance. Stereotype threat effects have been observed with both highly difficult (Croizet & Claire, 1998; Schmader, 2002; Davies, Spencer, Quinn, & Gerhardstein, 2002) and moderately difficult tests (Lawrence, Marks, & Jackson, 2010).

The stereotype threat phenomenon has been shown in several different capacities with different target groups, but what are the causal mechanisms that lead to these performance decrements?

Causal Explanations for Stereotype Threat Effects

There are different factors that may mediate the relationship between stereotype threat and performance. The threat of confirming a negative stereotype can cause anxiety, which influences one's ability to perform adequately. Stereotype threat may also lower one's expectations of success and lead to a decrease in task specific self-efficacy. Finally, the attributional information implied by stereotypes may influence the degree to which the threat negatively impacts performance.

Anxiety and Working Memory. In a stereotype threat situation, the focus is taken away from the task at hand because of one's anxiety in disconfirming the threatened stereotype (Schmader & Johns, 2003; Steele, 1997; Steele, Spencer, & Aronson, 2002). Working memory is being used to suppress thoughts of the stereotype and avoid confirming it, instead of being dedicated to task performance (Beilock, Rydell, & McConnell, 2007). One study found that anxiety partially mediated the relationship between stereotype threat and performance in a nationally representative sample (Osborne, 2001). Furthermore, anxiety due to stereotype salience leads to lowered ability to regulate behavior and attention resources. When the stereotype is nullified, however,

behavior can be regulated effectively and performance is not affected (Inzlicht, McKay, & Aronson, 2006; Smith & White, 2002).

Performance Expectancies. Stereotype threat situations cause participants to lower their expectations of success, compromising individuals' belief in their ability to do well (Kray, Thompson, & Galinsky, 2001). This process can lead to the negative impact on performance often observed in response to stereotype threat. Lowered performance expectancies following stereotype threat have also been observed after participants received positive feedback on a previous trial of the test (Stangor, Carr, and Kiang, 1998). These results indicate that regardless of past performance, stereotype threat was capable of decreasing expectancies for a future task. Although the findings regarding expectancies as a mediator between stereotype threat and performance have been inconsistent (Steele, Spencer, & Aronson, 2002), it is possible that this variable plays more of a role in situations where the task is more ambiguous or moderately difficult, making reliance on outside information (i.e., the negative stereotype) more likely.

Attributions

Attributions have historically been critical in understanding achievement, but they should also be a primary focus in the study of stereotype threat and STEM performance. The current research seeks to integrate attributions and stereotype threat to better understand the role of stereotypes in the STEM gender gap. In order to achieve this, it is necessary to review attribution theory itself as well as how attributions serve as a causal explanation in stereotype threat.

Attribution theory proposed by Heider (1944; 1958) provided a model for how people gain control of their environment by understanding the causes of behaviors or

outcomes. Specifically, Heider introduced two attributional dimensions: locus (internal; external) and stability (stable; unstable). Weiner (1979; 1984; 1985) introduced a third dimension of controllability, which focuses on to whom the responsibility is assigned for a certain behavior or outcome.

The study of attributions has continued since being introduced by Heider and Weiner through many different constructs and paradigms. Specifically, attributions have been linked to several factors that are influenced by stereotype threat, including performance, persistence, and self-efficacy. In the following section, a review of the literature regarding the role of attributions in these dimensions as well as an integration of attributions and stereotypes will be discussed. This deconstruction of the multi-faceted influence of attributions will allow further exploration of the combined role of stereotypes and attributions on factors that contribute to the current gender gap in STEM domains.

Attributions and Performance

In one study, an attributional intervention was introduced to retrain students to attribute academic difficulties to unstable factors (Wilson & Linville, 1982). This change in attributional perspective resulted in higher GPAs and better performance on sample GRE items. Therefore, students who saw their troubles as unstable, or susceptible to change, were much more likely to succeed than those who did not undergo the attribution intervention. In a similar, more recent attribution intervention study, fewer instances of failure in a psychology course were observed in a group of students whose attributions for failure were reframed as having controllable causes (Stewart, Clifton, Daniels, Perry, Chipperfield, & Ruthig, 2011). Specifically, researchers trained students to view poor

performance as a result of effort and strategy (controllable) rather than ability or intelligence (uncontrollable). These studies demonstrate that the attributions of different behaviors or outcomes can significantly influence performance.

Attributions and Persistence

Persistence is also influenced by attributions and is closely tied to one's performance in a given domain, particularly the likelihood that disengagement will occur over the long term (Weiner, 2010). In a series of achievement tasks, participants were more likely to persist in the face of failure when attributions were unstable (e.g., luck; effort) than when they were stable (Weiner, Heckhausen, Meyer, & Cook, 1972). The instability of the performance indicates that future performance may lead to more favorable outcomes, making persistence valuable.

Differences in persistence also emerge when participants derive their own attributions for performance outcomes. Those who are higher in achievement motivation persist longer given failure because they attribute failures to lack of effort. In contrast, those who have low motivation attribute failure to an ability deficiency, leading to lower rates of persistence (Weiner & Kukla, 1970). The effort attribution can be characterized as internal, controllable, and unstable, indicating that future behavior may yield better results, leading to greater persistence. Ability deficiency is internal, uncontrollable, and stable, which indicates a permanency that is likely to apply to future performance, making those who apply this attribution less willing to persist following failure.

Attributions and Self-Efficacy

Different attributions for success or failure can be used as tools to enhance and protect self-efficacy for those who are motivated to perform well. For example, those

who attributed failure in a foreign language course to effort had higher self-efficacy than those who did not make effort attributions (Hsieh & Schallert, 2008). This indicates that effort as an internal, controllable, unstable attribution is protecting self-efficacy by implying that, due to the temporally inconsistent nature of the failure, it can be reversed in future circumstances. Furthermore, self-efficacy is enhanced when success is attributed to stable factors, such that successes are viewed as consistent and therefore improve self-esteem (Simon & Feather, 1973). Similarly, attributing failure to more unstable factors is a self-esteem defense strategy, so that the failure seems to be as a result of a fluke or momentary disadvantage, not due to something that will persist over time (Simon & Feather, 1973).

Attributions and Stereotypes

Attributions and stereotypes have also been linked because of their symmetrical impact on performance, persistence, and self-efficacy. Some research has explored attributions and stereotypes simultaneously, specifically in stereotype threat paradigms. Dar-Nimrod and Heine (2006) investigated the reduction of performance-based stereotype threat effects by manipulating attributions for gender differences. When gender differences between men and women in math performance were said to be malleable rather than fixed, stereotype threat effects were reduced. This study demonstrated that when the salient stereotype is thought to be unstable and changeable (e.g., effort-based), it does not pose a threat to the stereotyped group as it does when gender differences are attributed to fixed factors (e.g., ability).

In another study that investigated attributions in the context of racial intelligence stereotypes, researchers manipulated attributions for intelligence itself; with one group

told that intelligence is malleable (i.e., internal, controllable, unstable) rather than fixed (i.e., internal, uncontrollable, stable; Aronson, Fried, & Good, 2002). African American participants who viewed intelligence as malleable exhibited better performance than those in the other conditions as well as greater enjoyment of the task. Although this study does combine attributions and stereotypes, it does not deal with the attributions related to the stereotype itself, but rather the content of the stereotype: intelligence.

When a stereotype that men are better than women in math was attributed to natural ability (internal, uncontrollable) or when no specific threat was presented (implicit stereotype), women exhibited impaired math performance (Thoman, White, Yamawaki, & Koishi, 2008). However, when the same stereotype was attributed to effort (internal, controllable), the stereotype threat performance effects were substantially decreased. This study provides preliminary support for the idea that the attributional information within the stereotype can be instrumental in the stereotype threat process, but does not explore the full breadth of attribution combinations.

It is clear that both stereotypes and attributions can influence performance as well as other psychological variables, but where do attributions and stereotypes intersect? Something that is missing in the current literature is how stereotypes themselves convey attributional information and how that information can be the driving force in influencing performance differences, particularly between men and women in STEM domains.

Attributional Model of Stereotypes

The attributional model of stereotypes provides a structure from which to study attributions in the context of stereotypes themselves in order to better understand how the stereotype attribution package works to influence performance. This model integrates the

three dimensions of traditional attribution theory (stability, controllability, and locus) and how they apply to stereotypes specifically (Brandt & Reyna, 2011; Henry, Reyna, & Weiner, 2004; Reyna, 2000; Reyna, 2008).

Theoretically, the stability dimension remains constant in the context of stereotypes due to the relatively stable nature of stereotypes themselves (Anderson, Krull, & Weiner, 1996). Therefore, with stability relatively unchanged there are three overarching combinations of the remaining two attribution dimensions, locus and controllability, that may be conveyed through a given stereotype.

An internal, controllable attribution combination is largely effort-based. In the context of the gender gap in academic achievement, this stereotype attribution would imply that if women put in as much effort as men do, they would be equally successful in STEM areas (e.g., "women do not measure up to men in STEM domains because they do not try as hard as men do"). The perceived controllability of the outcome may inspire motivation and persistence. Because success is based on effort, more effort would be exerted to obtain the desired outcome. This would also manifest in greater persistence, even during a struggle. In this case, self-esteem would not necessarily be threatened because even if success is not achieved immediately, this attribution implies that the individual is in control of her success and therefore can eventually meet the desired goal.

An ability-based stereotype attribution has internal, uncontrollable causes, which implies that the individual is incapable of reversing the given stereotype. Whereas the internal, controllable attribution could potentially lead to disengagement and harm to self-esteem, a stereotype implying internal, uncontrollable causes has more immediate effects. In this case, the stereotype would convey that regardless of the amount of effort women

invest, they will not be able to perform as well as men in STEM areas because they lack the necessary inherent ability that men have. This attributional stereotype is particularly debilitating because of the permanency implied by the attribution, leading to little motivation to persist in the task or domain cited in the stereotype from the outset. The ability-based implication is also more likely to compromise self-esteem immediately, which influences performance as well.

The final attributional stereotype is the external, uncontrollable combination. This attribution implies that the individual is not at fault for female underperformance, but systemic inequities have held women back in math and are responsible for the gender difference stereotype. This attribution information may cause the individual to exhibit anger and disapproval of the social institutions and culture that remain outside of their control, but are seemingly to blame for their inequality compared to men in terms of STEM achievement. Negative outcomes are blamed on external factors, so self-esteem is preserved in this case. However, if changing or overcoming the stereotype seems too overwhelming given the societal context, withdrawal may result as in the other attribution combinations.

This model provides a direct link between stereotypes about female underperformance in STEM domains and the attributions that seem to play a role in the current disparities observed between men and women in these areas. With this model at the center, it is possible to take a more detailed approach while simultaneously exploring a broader range of attributional possibilities that could be contributing to the gender gap.

Rationale

Although previous research has investigated the role of attributions in stereotype threat performance effects, some questions remain unexplored. What is necessary to bridge the gaps between previous studies is the use of all possible stereotype attributions so that the specific influence of each can be examined. In the past, researchers have focused, for example, on effort-based performance attributions compared to ability-based, but have not explored the society-based reasoning implied by the external, uncontrollable stereotype. Therefore, one goal of this study is to incorporate all three of these attributional signatures in order to gain perspective into how each of them differentially influences performance as well as persistence and task-based self esteem. The attributional model of stereotypes fosters this comprehensive investigation of stereotype attributions, allowing a better understanding of how attributions contribute to performance deficits often seen in the face of stereotype threat.

Another primary goal of the current research is to incorporate each causal attribution in the context of the stereotype itself. Whereas past studies have included attributions for other factors such as intelligence (i.e., intelligence is fixed and cannot be changed), the aim of the current study is to connect the attribution to the stereotype (i.e., women are poor at logical reasoning compared to men because they lack the necessary innate ability). Although these two examples imply an internal, uncontrollable attribution, the latter relates specifically to the stereotype that women do not measure up to men in logical reasoning. In contrast, the former is relating to intelligence, which is a peripheral factor that is not tied directly to the stereotype. By using an attributional stereotype, a more direct link will be made between the two rather than requiring an

inference to be made between the attribution of a related factor and the relevant stereotype.

This research will also add a new perspective by making use of a task that is attributionally flexible to be able to measure not only how the attribution information influences participants' willingness to persist on a task, but also to identify instances of attribution changes or adaptations that serve to protect self-efficacy. Previous studies have primarily focused on how math tasks relate to the current STEM gender gap, but the literature is lacking in the use of other skills that can be convincingly applied to STEM domains. Also needed is a task novel enough to introduce attributions that do not already have a history in a given individual. With math tasks, most individuals presumably enter the study with a highly developed domain-specific self-efficacy as well as attributions for instances of success or failure based on many different experiences with mathematics over their lifetime. Specifically, higher individual perceptions of capability may deflect the application of the stereotype to oneself (Steele, Spencer, & Aronson, 2002). In a more attributionally flexible task such as logical reasoning, perceptions of capability are being shaped by the task at hand, not by one's history of past performances. Therefore, it is expected that the attributional information conveyed through stereotypes will actually influence performance and new attributions may be adopted to adequately explain or reconcile task success or failure.

In this study, participants will be randomly assigned to one of four conditions: a stereotype implying an internal, controllable attribution (I/C), a stereotype implying an internal, uncontrollable attribution (I/UC), a stereotype implying an external uncontrollable attribution (E/UC), and a nullified stereotype condition. The stereotype

will state that women do not perform as well as men in the logical reasoning skill being tested here. Before completing the test, participants' task self-efficacy will be measured. After the test, participants will be given the option to earn extra credit, which will act as a persistence measure. Finally task self-efficacy and domain identification will be measured again to see if any differences within and between groups emerged as a result of the attribution conditions.

In the internal, controllable condition, participants will be told that women do not perform as well as men on tests of logical reasoning because women do not try as hard as men and do not put forth the same amount of effort as men do on logical reasoning tasks. The internal, uncontrollable condition will state the women do not perform as well as men because women do not have the necessary innate abilities that men have. In contrast, the external, uncontrollable attribution states that women do not perform as well as men because girls grow up getting less attention and encouragement in logical thinking than do boys. Finally, in the nullified stereotype condition, participants will be told that there are no gender differences in performance of logical reasoning tests.

Statement of Hypotheses

Hypothesis I. Participants will differ in performance based on attribution condition such that those in the nullified stereotype and internal/controllable conditions will have the highest levels of performance followed by those in the external/uncontrollable group and the internal/uncontrollable group.

Hypothesis II. Participants will differ in persistence based on attribution condition such that those in the nullified stereotype and internal/controllable conditions will have

the highest levels of persistence followed by those in the external/uncontrollable group and the internal/uncontrollable group.

Specifically, it is expected that women in the nullified stereotype condition will be helped by learning that no gender differences exist on this task and will therefore not have the worry of confirming a negative stereotype. For this reason, participants in this condition are expected to have the best performance as well as persistence out of the four experimental groups. The internal/controllable (effort-based) group is expected to be comparable to the nullified stereotype group in terms of both performance and persistence. It is predicted that effort will be put forth by these participants to do well given the controllability implied by the stereotype, making them focused on performing well. For the same reason, those in the I/C condition are also expected to persist on the experimental task with a frequency similar to that seen in the nullified stereotype group in order to earn extra credit points.

These two reactions are different from that expected of participants in the internal/uncontrollable (ability-based) condition, who are led to believe that gender differences in performance are something out of their control. Because the stereotype is thought to be unchangeable despite any effort they may apply, their performance will not reflect the motivation and effort seen in the I/C group. Instead, this group may be discouraged by the finality and immutability implied by the stereotype and therefore may be less willing to put forth effort. This will be observed in their weaker performance as well as in their lower rate of persistence in the task compared to the I/C and nullified stereotype groups.

The temporal limitations of this study make it difficult to simulate the frequent real world discrimination messages that are critical to the external, uncontrollable (society-based) attribution implied by the stereotype. A message implying environmental barriers may prevent participants from making low ability attributions, but at the same time may not point to effort as a viable path to success. Given the novel environment of the experimental setting, it is difficult to predict how participants will interpret the negative stereotype with this external attribution. Previous research has shown that an external attribution may act as a buffer and therefore be less impactful in terms of performance. For this reason, it is likely that participants in this E/UC condition will fall somewhere between those in the I/C and I/UC conditions by putting forth more effort than those in the I/UC condition while exhibiting persistence levels comparable to or somewhat lower than those of the I/C condition.

Hypothesis III. Participants will differ in self-efficacy based on the attribution conditions such that those in the nullified stereotype condition will maintain the highest level of self-efficacy at the post-test, followed by those in the I/C (effort-based) condition, the E/UC (society-based) group, and lastly, the I/UC (ability-based) condition.

Hypothesis IV. Participants will differ in level of domain identification based on the attribution conditions such that those in the nullified stereotype condition will maintain the highest level of domain identification at the post-test, followed by those in the I/C (effort-based) condition, the E/UC (society-based) group, and lastly, the I/UC (ability-based) condition.

Participants in the nullified stereotype group are expected to maintain the task-based self-esteem and domain identification that they report at the pre-test. A similar

pattern is thought to occur with those in the I/C condition, whose self efficacy and domain identification may remain unchanged. Participants in this case will be focused on applying the effort that is implied as necessary to combat the stereotype and would not necessarily consider poor performance on the task a reflection of their own ability, but rather something that could be improved with more opportunities to exercise a sufficient amount of effort.

Those in the I/UC condition are expected to show lowered self-efficacy at the post-test because of the lack of control implied by the attribution. Because the task is difficult and requires more time than is available, participants will struggle to do well on the test and may feel that they have no control in avoiding poor performance, which may impair self-efficacy. Unlike in the I/C condition where the negative impact of the effort-based attribution would not lead to disidentification in an immediate time period, the I/UC attribution implies that there is no remedy for the negative stereotype and therefore is more likely to lead to not only lowered self-efficacy but also greater likelihood of disidentification in the short term. This disidentification may result as a mechanism for protecting self-esteem by minimizing the importance of the domain, in this case logical reasoning.

Self-efficacy in the E/UC (society-based) condition may not be threatened because the attribution implies that the individual is not to blame for any shortcomings in this domain. Because the blame is outside of the individual, it is unlikely that self-esteem would be affected and is therefore expected to stay consistent regardless of task performance. This is different from the other two attributional stereotype conditions where the attributions imply an internal cause that may directly affect self-esteem.

However, the potential of disidentification is present if participants view logical reasoning as a skill that society does not value for women. In that case, disidentification would coincide with undermining the importance of the domain as something that is not worth pursuing because of its insignificance in society (see Appendix A for an overview of the hypotheses).

CHAPTER II

METHOD

Participants were 72 female undergraduates recruited from the DePaul University psychology subject pool. Participants had an average age of 20 years (SD = 4) and were mostly first-year students. All participants read an information sheet describing the study and giving participants the right to leave the study at any time without penalty. All participants received partial course credit for their participation. A female experimenter administered the study, but there was a male confederate present during all sessions. This acted as a situational cue to further connect the female participants' gender with the given stereotype and to prevent a feeling of solidarity that may arise in a room of all women and no men.

Procedure

The researcher began by presenting the logical reasoning task, framing it as representative of an important skill that is crucial for success in several disciplines including psychology. This was necessary to ensure that a broad variety of domains with which the students may identify will be ostensibly related to this logical reasoning skill being tested. The researcher continued by explaining how more research is needed to decipher how people perform on this task because it is instrumental in such a wide variety of domains.

Domain Identification

Next, participants were given a survey measuring domain identification. Domain identification was measured by asking how participants felt about logical reasoning in general and how it relates to different parts of their life. The items used are adaptations

from those created by Smith & White (2001). The original items were modified in order to specifically relate to the logical reasoning domain as opposed to the math and English domains for which the scale was originally created (Cronbach's $\alpha = .78$). For example, participants rate how much they agree with the following statement: "Having strong logical reasoning skills is important for my discipline." All items were also modified to follow the 7-point scale format consistent with other scales used in this study (Appendix B). Previous research has demonstrated that high identification with the task domain leads to a higher likelihood of being influenced by stereotype threat effects (Steele, Spencer, & Aronson, 2002). Therefore, the connection between one's degree concentration and logical reasoning must be made so that the stereotype later presented is more likely to influence behavior.

Attribution Manipulation

Participants were then randomly assigned to one of four experimental conditions. Three of the conditions presented the stereotype that males exhibit better performance than females on this logical reasoning task, but the attributional information varied: internal/controllable (effort: try harder); internal/uncontrollable (ability: innate, biological, genetic differences); external/uncontrollable (structure: preferential treatment, societal expectations). Participants in the final condition were presented with a nullified stereotype stating that men and women do not differ on tests of logical reasoning.

The attributional stereotype information was embedded within an article given to participants, which they read silently to themselves (Appendix C). These articles were largely constructed based on a popular science article regarding gender and math skills (Tenenbaum, 2010). Each of the four articles was modified to convey a message

consistent with the condition to which it corresponds. Therefore, three of the articles suggest that women are worse than men in logical reasoning skills but provide different reasoning depending on the stereotype attribution, while the fourth article concludes that gender differences do not exist (nullified stereotype).

After reading these articles, participants were asked some questions to ensure that the manipulation presented in the article was successfully administered (Appendix D): "According to the article, have gender differences in logical reasoning been found?" Participants also responded to standard demographic questions including gender in order to make this variable salient as a necessary component of the stereotype threat paradigm (Appendix E).

Self-Efficacy

Self-efficacy (task based self-esteem) was then measured to determine how confident participants felt about their ability to complete the upcoming task after reading the research article provided. These items are adapted from the performance category of the State Self Esteem Scale (SSES; Heatherton & Polivy, 1991). Items were amended slightly to refer specifically to the experimental task rather than to performance in general (Cronbach's $\alpha = .82$). For example, "I feel confident about my logical reasoning abilities". Each of the 5 items is scored on a 7-point scale and can be found in Appendix F.

Task Performance

The majority of previous research on stereotype threat in academic settings has focused on mathematics. In the current study, one goal was to use a test that is different but still representative of the STEM domains, adding to the non-mathematics oriented

stereotype threat literature. The task for this study was a test of logical reasoning ability using questions taken from a Graduate Record Exam preparation book (Bobrow, 2000; Appendix G).

The test was administered in a way that made it nearly impossible for participants to complete all of the items within the given amount of time (20 minutes). Combined with the difficulty of the test, it is possible that this time limit created anxiety and inhibited participants' performance. Although the questions are not from an actual exam from the Educational Testing Service, the questions are representative of the difficulty and type that would have been found in the logical reasoning section of the GRE at that time (Benbow, 2000).

When the testing time was up, the researchers collected participants' answer sheets and then gave them an option to earn more points and improve their score by continuing to work on the test. The researcher allowed participants seven minutes to continue the test while she graded the initial test items (participants did not know they were being timed at this point). Those participants who chose not to persist simply sat at their desk and waited for further instruction. Persistence was measured with a continuous item: "If you could continue on this task, how much would you like to?" In addition, the number of additional items attempted and answered correctly was examined to determine how much participants persisted on the task.

Performance was assessed by accuracy (i.e., number correct divided by number attempted) as well as by the number of correct answers. Previous research has suggested that accuracy is a better measure of performance and may be more likely to reveal

stereotype threat effects (Lawrence, Marks, & Jackson, 2010; Shih, Pittinsky, & Ambady, 1999).

Exit Survey

Following the additional testing time, all participants completed a second survey. In this post-task measure, participants completed a self-efficacy measure similar to the measure used before the test, but modified to be consistent with a retrospective evaluation of performance (Cronbach's $\alpha = .89$). A global self-esteem measure was also included (Rosenberg, 1965) to examine whether self-esteem in general was influenced by the task or manipulations (Cronbach's $\alpha = .86$).

There were also items measuring how participants perceived logical reasoning ability (e.g., "Logical reasoning is something you are born with."). Participants may have coped with the stereotype by discounting or disagreeing with the conclusions of the article. It is also possible that participants may have protected self-esteem by disengaging from logical reasoning as an important skill or from their own discipline. The degree of enjoyment experienced by the participants was also measured as the nature of the logical reasoning problems may have made them feel more relaxed despite the high degree of difficulty. All items to be included in the exit survey can be found in Appendix H.

After collecting all of the participant responses, the researchers gave a verbal debriefing of the experiment, including positive feedback regarding participants' test performance. This served to assuage any negative feelings participants may have been experiencing following this very difficult test. Researchers also emphasized that the stereotype information in the articles that they read was falsified and that there is no

evidence to support the notion that gender differences in logical reasoning exist. They explained that the true purpose of the study was to see how the explanatory information about gender stereotypes would affect performance on a difficult test. Participants were assured that the test they completed was highly difficult (i.e., from a GRE preparation book) and was not something that would have been possible to complete in the amount of time they were given—this unrealistic time limit was an intentional and critical part of the study. Participants were welcomed to ask any questions of the researcher regarding the experiment.

CHAPTER III

RESULTS

Manipulation Check

To ascertain that the attributional stereotype manipulation was successful, a manipulation check was performed. One manipulation check item stated "There are no gender differences in logical reasoning," to which participants had to respond true or false. There were 3 participants in the no stereotype condition that answered "false" to this question, and were therefore excluded from further analyses.

The second critical manipulation check item required participants to select the correct multiple choice response to the question "Gender differences in logical reasoning exist because…" Several participants answered this item incorrectly: 3 in the I/C condition, 8 in the E/UC condition, and 1 in the I/UC condition. The individual who responded incorrectly in the I/UC condition cited effort as the cause, whereas all of those participants who responded incorrectly in the I/C and E/UC conditions indicated that differences in innate ability were the cause of the proposed gender gap in logical reasoning. This large number of incorrect responses may be due to a general tendency for people to assume dispositional attributions rather than situational ones. Particularly for the E/UC group, they may have thought that differential treatment awarded to boys and girls may be based on an actual inherent difference, causing them to cite this attribution as driving the gender gap. Again, all participants who answered incorrectly to this item were excluded from the analyses[1], reducing the overall number of participants to

[1] Analyses were also conducted with all participants included. Unless otherwise noted, the patterns are consistent with what is reported.

55 and the number of participants per condition as follows: No stereotype = 14; I/C = 14; E/UC = 10; I/UC = 17.

Performance

The first experimental hypothesis stated that participants would differ in performance on the logical reasoning test based on attribution condition. Specifically, it was expected that those in the no stereotype and I/C conditions would perform at the highest levels, those in the I/UC would have the worst performance, and finally that those in the E/UC condition would fall somewhere between the I/C and I/UC groups in performance. To test this first hypothesis, the number of correct responses, number of attempted responses, and the ratio of correct over attempted responses were examined between groups (*see* Table 1). Because the of the large standard deviations present in each of the performance outcomes, a square root transformation was applied before conducting the appropriate analyses. Unless otherwise noted, the results remained the same with this transformation applied.

An Analysis of Variance (ANOVA) revealed that there was no significant difference in the number of problems that were attempted by participants, $F(3, 51) = 1.31$, $p = .28$. To determine if there were any differences between groups in the frequency of attempted problem, a chi-square analysis was performed and did not reveal an overall difference, $\chi(24) = 50.06$, $p = .39$. Similarly, there was no overall effect for the number of correct responses, $F(3, 51) = .40$, $p = .76$.

However, there was a marginal effect for the ratio of correct to attempted responses, $F(3, 51) = 1.99$, $p = .13$ (*see* Figure 1)[2]. When a square root transformation is applied, the differences between groups becomes slightly stronger, but is still marginally significant, $F(3, 51) = 2.22$, $p = .10$ (*see* Figure 2). Contrary to what was hypothesized, those in the I/C condition had the lowest levels of performance ($M = 34.76$, $SD = 19.94$), which was marginally significantly worse than that of the E/UC group ($M = 51.60$, $SD = 25.60$). The I/UC group also had performance levels higher than expected ($M = 46.90$, $SD = 15.24$), greater than those of the no stereotype group ($M = 42.84$, $SD = 11.41$).

Table 1

Means and standard deviations of the number of attempted/correct problems

	Problems Attempted		Correct Answers	
	Raw Score	Sq. Rt. Trans.	Raw Score	Sq. Rt. Trans.
No Stereotype	16.79 (4.56)	4.06 (0.57)	6.93 (1.98)	2.61 (0.38)
I/C	19.21 (4.28)	4.36 (0.51)	6.50 (3.57)	2.48 (0.62)
E/UC	16.30 (5.83)	3.97 (0.75)	7.90 (4.33)	2.73 (0.72)
I/UC	15.88 (5.13)	3.93 (0.65)	7.06 (2.66)	2.62 (0.48)
Total	17.04 (4.97)	4.08 (0.63)	7.04 (3.07)	2.60 (0.54)

Note. Sq. Rt. Trans. = square root transformation.

[2] This omnibus test becomes significant when all participants are analyzed using the square root transformation, $F(3, 69) = 3.28$, $p = .03$, as well as the difference between the I/UC and I/C groups ($p = .02$).

Table 2

Frequencies of problems attempted and correct by group

		Frequency				
	M (SD)	0-5	6-10	11-15	16-20	21-25
Problems Attempted						
No Stereotype	16.79 (4.56)	0	1	4	6	3
I/C (Effort)	19.21 (4.28)	0	1	1	6	6
E/UC (Society)	16.30 (5.83)	0	1	5	2	2
I/UC (Ability)	15.88 (5.13)	0	3	4	8	2
Total		0	6	14	22	13
Problems Correct						
No Stereotype	6.93 (1.98)	5	9	0	0	0
I/C (Effort)	6.50 (3.57)	7	9	0	0	0
E/UC (Society)	7.90 (4.33)	3	5	1	1	0
I/UC (Ability)	7.06 (2.66)	7	4	2	0	0
Total	7.04 (3.07)	22	27	3	1	0

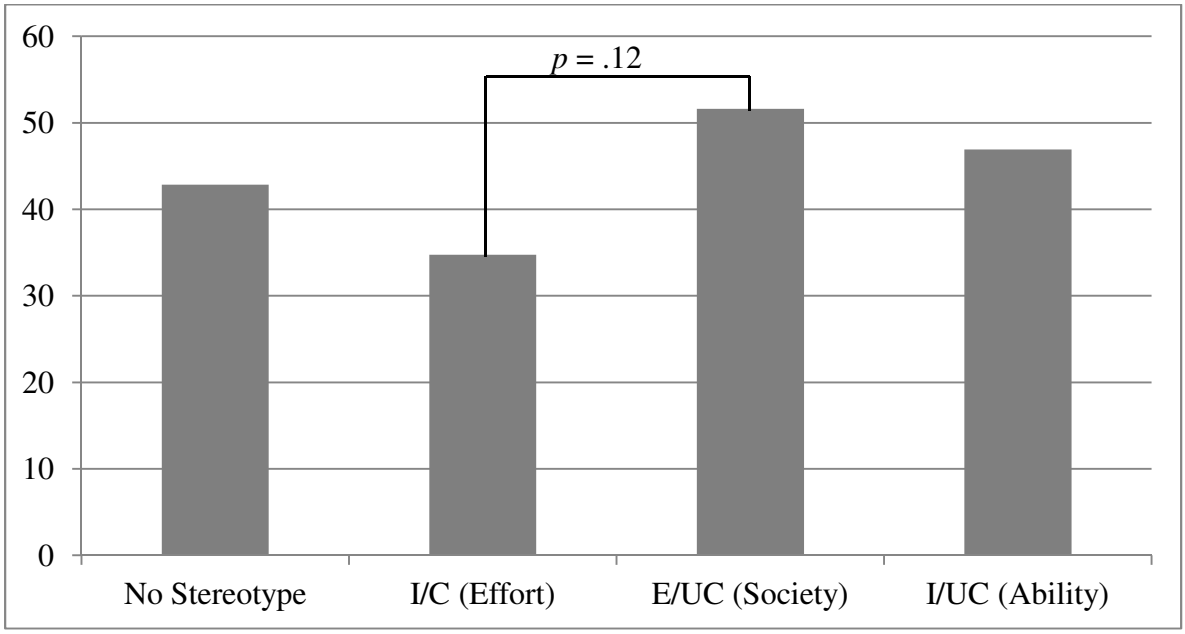

Figure 1. Ratio of number of problems correct over number of problems attempted (raw data).

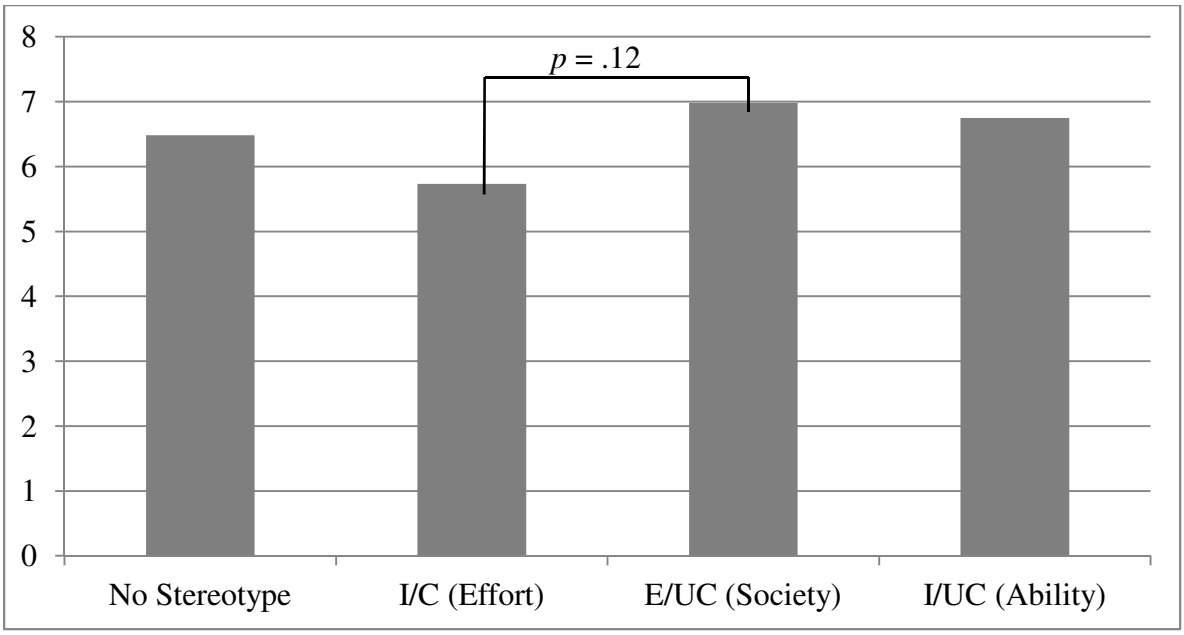

Figure 2. Ratio of number of problems correct over number of problems attempted (values after square root transformation).

Therefore, it appears that despite having an internal and controllable attribution that suggests sufficient effort can eliminate gender differences, participants in this condition performed the worst in terms of correct relative to attempted items. However, although this hypothesis was not supported, it does appear that the I/C group attempted the most number of problems (albeit not significantly more than other groups), which suggests that participants were working on more problems, but that accuracy was compromised as a result. These results are questionable, however, given the small sample sizes within each condition and the resulting variability within each group on the different measures.

Persistence

In addition to differing in performance, it was also hypothesized that participants would differ in the degree to which they chose to persist depending on the attributional

signature of the stereotype. Similar to the performance hypotheses, it was anticipated that those in the no stereotype and I/C condition would have the greatest rates of persistence because of no threat being applied and the controllable nature of the attribution, respectively. It was also expected that participants in the I/UC condition would persist the least, given the immutability implied by this type of attribution (uncontrollable). Again, the E/UC group was thought to be in between the I/UC and I/C conditions in terms of persistence.

An overall ANOVA revealed no significant differences between groups in the average number of problems attempted when given the opportunity to persist on the task, $F(3, 51) = .26$, $p = .85$. In addition, a chi-square analysis was conducted to determine whether participants in each group differed in the frequency of attempted problems (ranging from 0 to 8). This difference was also non-significant, $\chi^2(24) = 14.53$, $p = .93$, indicating that the number of problems participants were attempting did not differ between groups (see Table 3 for means, standard deviations, and frequencies). The pattern of responses do seem to differ slightly between groups, however, so a median split was applied to the frequency to determine if groups differed in the number of participants persisting on a low (0-4) versus high (5-8) number of problems. This test was also non-significant, $\chi^2(3) = 4.35$, $p = .23$. However, the frequencies do suggest that those in the E/UC group are mostly persisting on a high number of problems compared to those in the I/UC group, who tended to fall at the low end of the spectrum, with those in the I/C group falling in the middle to high end.

Table 3

Means, standard deviations, and frequencies for number of additional problems attempted

		Number Attempted								
	M (SD)	0	1	2	3	4	5	6	7	8
No Stereotype	4.36 (2.47)	2	0	1	1	3	2	2	2	1
I/C (Effort)	3.86 (2.74)	3	1	0	1	3	2	1	2	1
E/UC (Society)	4.40 (2.72)	2	0	1	0	0	2	3	2	0
I/UC (Ability)	3.71 (2.31)	2	1	2	2	5	2	0	2	1
Total										

In addition to actual persistence behavior, a single continuous persistence item was examined to see if participants differed in how much they would expect themselves to continue on the task if given the chance: "If you could continue on this task, how likely is it that you would continue? (1 = very probably not, 7 = definitely)." There was a slight overall difference in response to this item ($F(3, 51) = 1.91$, $p = .14$), which was driven by a marginally significant difference between the I/UC group ($M = 4.82$, $SD = 1.70$) and the I/C group ($M = 3.29$, $SD = 1.68$; Figure 2).

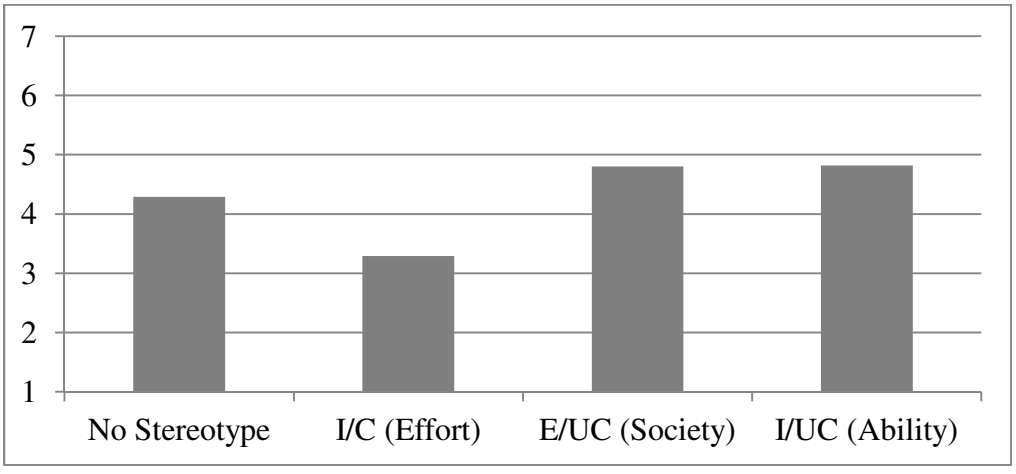

Figure 3. Mean responses by group on desire to persist.

These results were inconsistent with the hypothesis, but may be explained by motivated reactance by the I/UC group. When confronted with an extreme attribution that implies that a given stereotype is permanent and not susceptible to change, participants may disagree with the proposed reasoning and react to combat it, minimizing its ability to explain the stereotype. This explanation may also be pertinent to the E/UC condition, given that an uncontrollable cause is posited, participants may be particularly motivated to react against such an extreme claim by persisting to a greater extent. It is also possible that those in the I/C group did not desire to persist because they had already gone through all of the items. As stated previously, the participants in this group attempted the most number of problems overall and by the time they had also completed the persistence measure, may not have had any problems left on which to persist.

Self Efficacy

Participants' self efficacy was also expected to differ based on attribution condition. Self efficacy was hypothesized to be preserved in the no stereotype group because there was no explicit threat. A similar result was anticipated for the I/C condition, where self efficacy would not be affected because one's ability to perform the logical reasoning task is being presented as controllable. However, the I/UC attribution was predicted to have the most negative impact on self-efficacy since it implies that the cause is within the individual, but also not susceptible to change, which could lead to reduced performance expectancies among participants in this group. In contrast, the E/UC condition was expected to have little to no change in self efficacy because of the external locus implied by the attribution: although the stereotype is affecting women as a

group, the reasoning behind the gender gap does not have to do with the individual per se, but rather the behavior of society members as a whole.

First, differences in pre-test self efficacy were analyzed. An ANOVA revealed that there were no overall differences in how participants felt about their logical reasoning abilities, $F(3, 51) = .71$, $p = .55$. Similarly, there were no differences in this measure after the test had been completed, $F(3, 51) = .88$, $p = .46$ (see Table 4 for self efficacy means and standard deviations). A repeated measures analysis was also conducted to see if self-efficacy changed significantly within groups from pre- to post-test. Because the items for these two measures used different scales, responses were re-coded into z-scores so that they could be compared. There was no main effect of time (pre/post), $F(1, 51) = .01$, $p = .92$ or a time by condition interaction, $F(3,51) = .20$, $p = .90$ (see Figure 2). These results indicate that self-efficacy was largely unaffected by the manipulations or by the testing situation itself. It is possible that this is an artifact of the novelty of this task, such that none of the participants felt very certain how they would perform, irrespective of the specific condition to which they were assigned.

Table 4

Means and standard deviations of self-efficacy pre- and post-test

	Pre-test	Post-test
No Stereotype	3.49 (.61)	3.11 (1.42)
I/C (Effort)	3.63 (.59)	3.64 (1.01)
E/UC (Society)	3.76 (.63)	3.88 (1.45)
I/UC (Ability)	3.79 (.65)	3.66 (1.12)
Total	3.67 (.61)	3.56 (1.24)

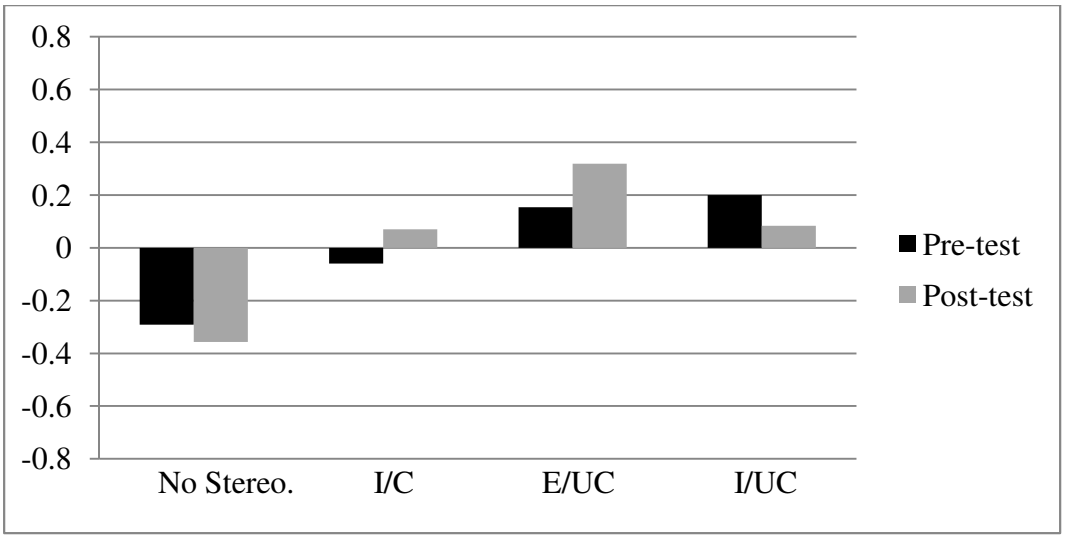

Figure 4. Standardized comparison of pre- and post-test self efficacy scores.

Domain Identification

The degree to which participants remain identified with logical reasoning as a domain that is important to their self-concept was expected to differ between groups. There was no difference expected in domain identification initially because it was measured before the manipulation or any other measures. However, after the manipulation and testing experience, participants were expected to diverge from one another in how much they identified with logical reasoning as a domain.

As anticipated, the pre-test measure of domain identification did not differ between groups and mean levels were above the midpoint for all groups, $F(3, 51) = 1.08$, $p = .37$. However, contrary to what was hypothesized, there were no overall differences between groups during the post-test evaluation of domain identification, $F(3, 51) = 1.28$, $p = .29$ (see Table 5). A repeated measures analysis was also conducted to determine if there were within-group changes between pre-and post-testing sessions. There was an overall main effect of time, $F(1, 51) = 61.83$, $p < .01$, indicating that in general,

participants' level of domain identification significantly decreased from pre- to post-test. The time by condition interaction was not significant, $F(3, 51) = 1.64$, $p = .19$, but the largest drop in domain identification from pre- to post-test occurred in the no stereotype condition (*see* Figure 3).

Table 5

Means and standard deviations of domain identification pre- and post-test.

	Pre-test *M* (*SD*)	Post-test *M* (*SD*)	Mean Difference [95% CI]
No Stereotype	5.77 (.78)	4.27 (1.16)	1.50 [.99, 2.01]
I/C (Effort)	5.94 (.53)	5.16 (1.24)	.77 [.28, 1.30]
E/UC (Society)	5.60 (1.02)	4.80 (1.48)	.80 [.97, 1.4]
I/UC (Ability)	5.47 (.73)	4.45 (1.36)	1.02 [.56, 1.49]
Total	5.69 (.76)	4.65 (1.31)	

Note. All pre- to post-test differences are significant, $p < .01$.

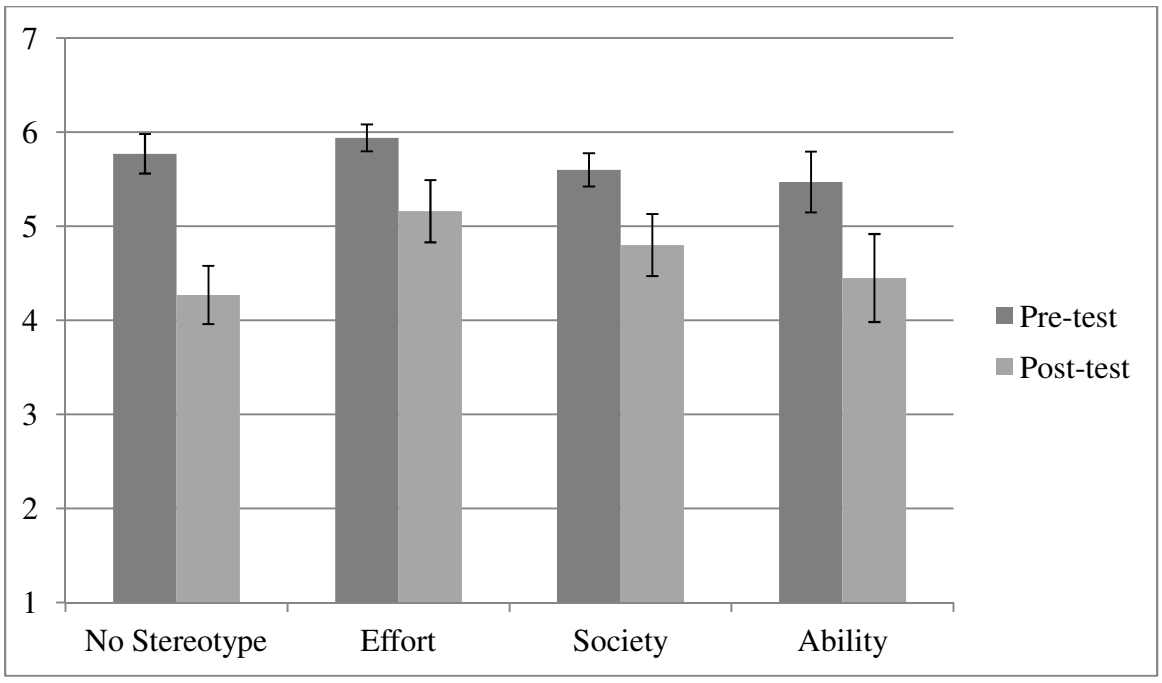

Figure 5. Domain identification pre- and post-test.

Although there was an overall decrease among all of the groups in domain identification from pre- to post-test, this could be an artifact of depletion, given that this measure was completed at the end of an arduous testing session. As anticipated, the I/UC group had one of the largest drops in domain identification from pre- to post-test. Furthermore, the largest drop occurred in the no stereotype condition, which is not consistent with the original hypotheses. It could be that those who were told that men and women are equal, but then experienced a struggle with the difficult test, saw the greatest contrast between how they were expected to perform and how they actually thought they did on the test. This may have in turn led to a pattern of disidentification with the domain so as to preserve their self-concept while explaining the less than desirable performance. Another reason why this group may have exhibited the lowest post-test domain identification is because the other groups were reacting against the negative stereotype and therefore sought to maintain identification in order to discount the stereotype or corresponding attribution.

Additional Analyses

At the end of the experiment, participants were asked to indicate their personal attributions for logical reasoning abilities. All items were measured on a 1 (strongly disagree) to 7 (strongly agree) scale (see Figure 5). When asked how much they agreed with the statement "Logical reasoning is something you are born with," participants were significantly different in their responses ($F(3, 51) = 4.78$, $p < .01$), with those in the no stereotype group ($M = 4.21$, $SD = 1.25$) and I/UC ($M = 3.94$, $SD = 1.48$) endorsing this significantly and marginally significantly more, respectively, than those in the E/UC ($M = 2.50$, $SD = 1.35$) and I/C ($M = 2.71$, $SD = 1.54$) groups (*see* Figure 6). When responses

to this question were analyzed with all participants included (not excluding based on manipulation check accuracy), this difference became non-significant, $F(3, 69) = 1.29$, $p = .26$ (*see* Figure 7). This change appears to be due to those in the E/UC group endorsing this attribution more ($M = 3.50$, $SD = 1.82$) than when some subjects were excluded ($M = 2.50$, $SD = 1.35$). This reflects the excluded participants' tendancy to indicate that according to the article they read, gender differences were innate, rather than the attribution that was actually given to them (E/UC).

In regards to the statement "Logical reasoning skills can be achieved with practice and effort," there was a marginally significant difference in responses ($F(3, 51) = 1.87$, $p = .15$), where the largest difference is between those in the I/C (effort; $M = 6.57$, $SD = .76$) and I/UC (ability; $M = 6.00$, $SD = .79$) conditions, consistent with the manipulation. This difference becomes stronger when all participants are included in the analyses, $F(3, 69) = 2.34$, $p = .08$, with slight decreases in the average endorsement of the no stereotype ($M = 5.79$, $SD = 1.62$) and E/UC groups ($M = 6.33$, $SD = 0.59$) and a slight increase among those in the I/C group ($M = 6.05$, $SD = 0.78$).

There was a significant difference in endorsement of the statement "Gender differences in logical reasoning are due to discouragement of women by society," ($F(3, 51) = 4.38$, $p < .01$). Those in the no stereotype group displaying significantly more agreement ($M = 6.00$, $SD = 1.11$) than those in the I/C ($M = 4.14$, $SD = 1.61$) and I/UC ($M = 4.41$, $SD = 1.37$) groups and marginally significantly more than those in the E/UC group ($M = 4.80$, $SD = 1.87$). However, when considering all participants, this difference becomes marginal, $F(3, 69) = 2.37$, $p = .08$, which is driven by slight decreases among the no stereotype ($M = 5.63$, $SD = 1.74$) and E/UC ($M = 4.67$, $SD = 1.78$) groups and

slight increases among those in the I/C (M = 4.24, SD = 1.72) and I/UC (M = 5.58, SD = 1.43) groups.

Finally, when faced with the statement "Men and women are equal in logical reasoning," there were significantly different responses across groups ($F(3, 51) = 7.78$, $p < .001$), with those in the no stereotype group (M = 6.71, SD = .47) endorsing this significantly more than the I/C (M = 4.36, SD = 1.99) and I/UC (M = 4.65, SD = 1.54) groups. Those in E/UC group (M = 5.80, SD = 1.40) had marginally significantly more endorsement than those in the I/C group. This pattern remained the same, but was slightly weaker, when all participants were included in the analysis, $F(3, 69) = 3.01$, p = .04.

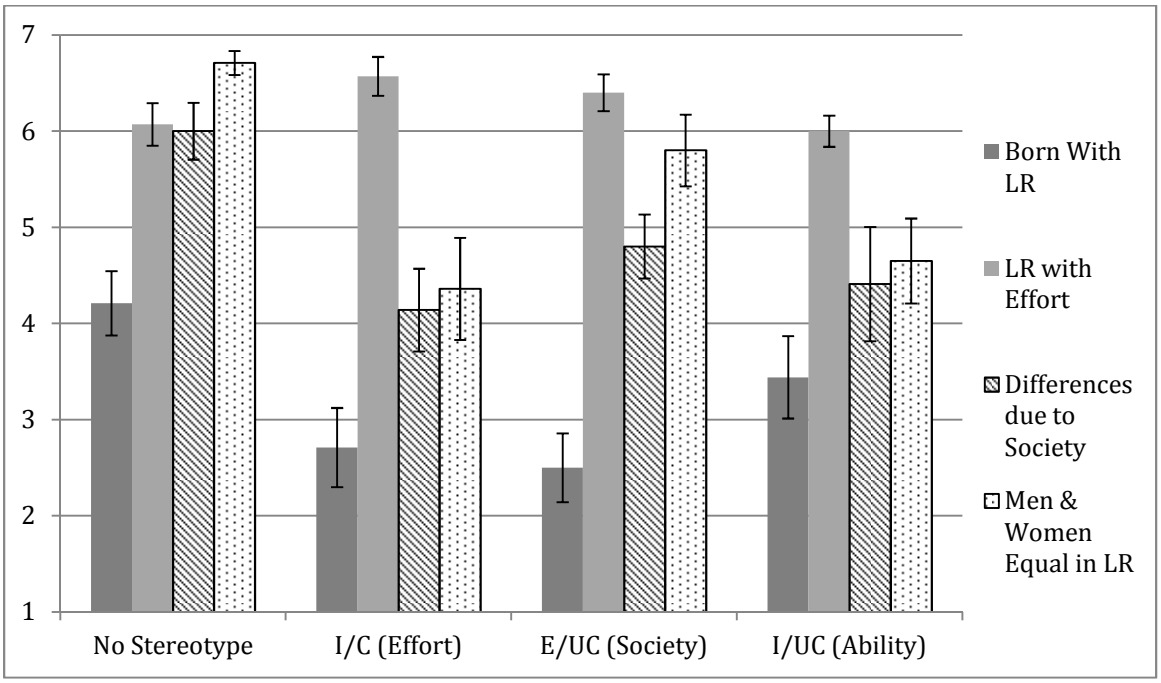

Figure 6. Post-test endorsement of logical reasoning attributions by condition.

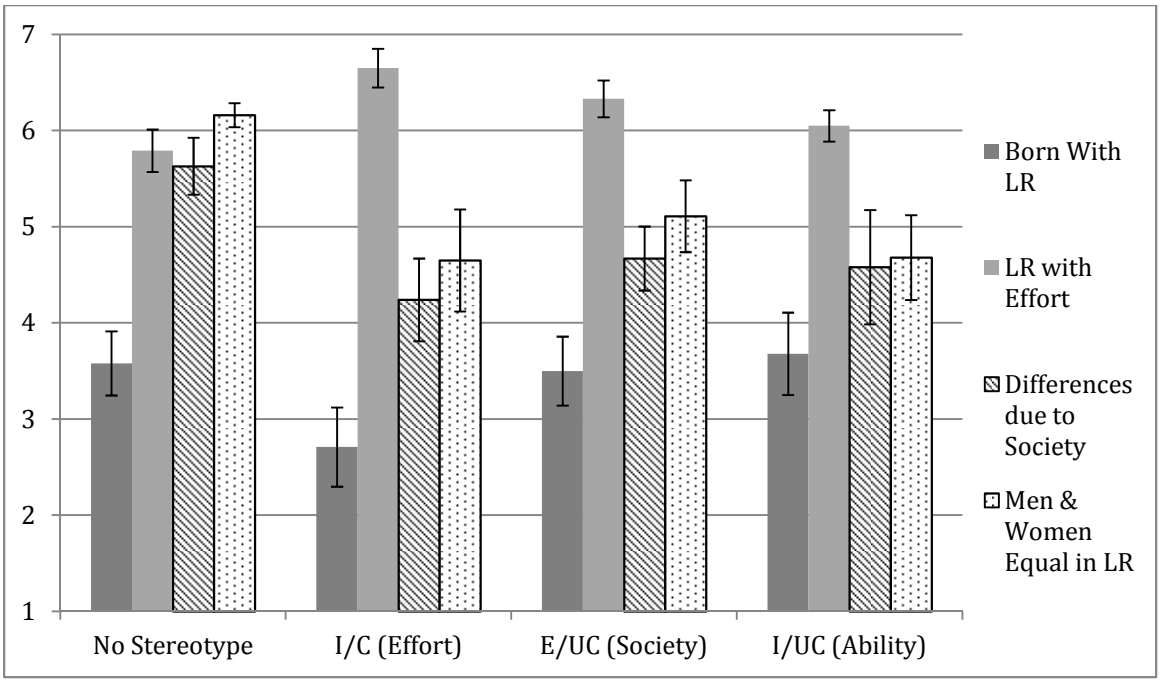

Figure 7. Post-test endorsement of logical reasoning attributions by condition (all participants included in analysis).

It appears that the no stereotype group was endorsing several different attributions, indicating that although they believe men and women are equal in logical reasoning, there are still differences due to societal influences, but these differences can be minimized with effort. However, they also somewhat endorsed the notion that logical reasoning is something people are born with. Across all conditions, however, participants were strongly endorsing the idea that logical reasoning can be achieved with practice and effort, which is encouraging given that this attribution implies controllable causes to the perceived gender gap, making it possible to combat over time. However, as discussed in the performance and persistence results, endorsement of this type of attribution does not necessarily lead to a universal form of success, and may lead some to favor completion of a task over accuracy in completing a task.

To determine if participants' attributions for logical reasoning were related to their actual performance measures (i.e., number of problems attempted, correct, ratio), simple correlations were calculated (Table 6). There was a significant negative correlation between the number of problems that were attempted on the test and participants' endorsement of the statement "Men and women are equal in their logical reasoning abilities," $r = -.24$, $p = .08$. This would suggest that the fewer problems that were attempted, the more participants believed the nullified stereotype. This may be related to the ability of those participants who did attempt fewer problems (I/UC, E/UC groups) to capitalize on their accuracy, making them feel more confident that women and men are in fact equal in logical reasoning abilities. There was also a marginally significant positive correlation between endorsement of the notion that men and women are equal in logical reasoning and the number of problems that were attempted in the persistence measure, indicating that those who persisted more were also more likely to believe that men and women are equal ($r = .23$, $p = .02$). Although there were no significant differences between groups in the number of problems attempted when given the chance to persist, those who did persist more may have felt more confident about their performance given that they were able to complete more of the problems. This may have bolstered their impressions of women's logical reasoning performance in general.

Finally, the more problems on which the participants persisted, the more they endorsed the sentiment that logical reasoning can be achieved with practice and effort ($r = .25$, $p = .02$). This relationship makes sense given that those who actually put forth more effort when given the chance more strongly believe that their effort will pay off.

Table 6

Correlations between attribution endorsement and achievement outcomes

	Post-test Attribution Endorsement			
	Born With LR	LR with effort	Discouragement from society	Men and Women Equal
Correct Answers	.06	-.06	-.01	.03
Number Attempted	.00	-.06	.12	-.24*
Ratio correct/attempted	.10	-.01	-.10	.18
Number Persisted	-.10	.25*	-.08	.23*
Desire to Continue	.12	.14	.14	.09

Note. $p < .10$*

However, different associations emerged when all participants were included in the analysis (*see* Table 7). First, the correlations that were significant as stated above became non-significant when all responses were considered. In addition, there came to be signfiicant correlations between desire to continue on the test (continuous persistence item) and beliefs that logial reasoning can be achieved with practice and effort ($r = .21$, $p = .07$), logical reasoning is due to discouragement from society ($r = .26$, $p = .03$), and men and women are equal in logical reasoning ($r = .25$, $p = .03$). These alternative findings suggest that overall, it was the desire to continue that had a greater impact on post-test attributions than participants' actual engagement in persisting on the test. However, these results should be interpreted with caution given that they reflect responses of those who did not pass the initial manipulation check.

Table 7

Correlations between attribution endorsement and achievement outcomes with all participants included

	Post-test Attribution Endorsement			
	Born With LR	LR with effort	Discouragement from society	Men and Women Equal
Correct Answers	.01	-.06	-.04	.02
Number Attempted	-.02	.03	.03	-.14
Ratio correct/attempted	.04	-.09	-.07	.13
Number Persisted	-.17	.03	-.15	.11
Desire to Continue	.02	.21*	.26**	.25**

Note. $p < .10$*, $p < .05$**

CHAPTER IV

DISCUSSION

The goal of the current research was to examine the role of attributions implied by a gender stereotype in influencing female students' performance, persistence, domain identification, and self efficacy. Although previous research has shown a link between attributions and stereotypes, the current work applied the attributional model of stereotypes as a framework for uncovering the unique contribution of different attributional signatures to the stereotype itself.

It was expected that those who were told that there were no gender differences in logical reasoning as well as those who were given an internal/controllable (effort) attribution associated with the gender stereotype would have the best performance and persistence and be the least affected in terms of degree of domain identification and feelings of self-efficacy. In contrast, those who faced an internal/uncontrollable (ability) attribution were expected to have the most difficulty in performance and persistence and also exhibit compromised domain identification and self efficacy. Finally, participants in the external/uncontrollable condition were expected to show some performance and persistence decrements, but this attribution was not expected to be as harmful as the internal/uncontrollable one. Because this was the only attribution with an external locus, self efficacy was not expected to change and domain identification was only thought to decrease to the degree that participants were not happy with their performance.

The hypotheses for this study were based on both the theory associated with the attributional model of stereotypes as well as the many stereotype threat studies that have been conducted involving women's academic performance. However, the results of the

current work depart somewhat from what has previously been found and also suggest that the attributions associated with a stereotype have a unique influence on performance that is distinct from other manifestations of the attribution-stereotype links seen in the literature.

First, those in the E/UC condition answered the most number of correct problems, followed closely behind by the I/UC and no stereotype groups, whereas those in the I/C group answered the least number of problems correctly. This pattern was also reflected in the ratio of correct to attempted problems, where the I/C group did significantly worse than the E/UC group. However, it appears that the number of problems participants were attempting may explain this unexpected finding: those in the I/C group attempted the most number of problems compared to the three other groups. This critical difference suggests that the attributional signatures may elicit different problem solving strategies, with the I/C attribution leading participants to complete as many problems as possible within the restricted time frame, while those in the other groups completed fewer problems, but took a slower approach so as to preserve accuracy.

These different problem solving strategies can also be seen in the persistence results, where there were no significant differences in the number of problems that were attempted when given the chance to continue, but the E/UC and I/UC groups desired to persist more than those in the I/C condition. This suggests that being faced with an effort attribution may lead to a desire to finish the task quickly, but not necessarily to take the time to ensure accuracy. Because those in the I/C condition were attempting the most problems to begin with, when asked if they desired to persist, there were not many problems (if any) left to persist on, since they had gotten through the items so quickly.

Therefore, this low desire to persist may be due to the feeling that the task had already been completed, even if accuracy was compromised, and there was no reason to persist.

Another possible explanation for the E/UC and I/UC groups' high desire to persist compared to the other groups is a reactance effect against the manipulation. When confronted with a strong and seemingly immutable cause for a gender gap in a task that they have already indicated is important to their self-concept, it is possible that a motivation was elicited to combat the proposed explanations. In fact, participants who attempted more problems when given the chance to persist showed greater endorsement of the belief that men and women are equal in logical reasoning as well as that logical reasoning can be achieved with practice and effort (Table 6). Therefore, although the attribution assigned to the E/UC and I/UC groups did not suggest that effort would lead to success, these participants did put forth more effort, which was then related to their own adopted attributions for logical reasoning performance. Particularly, these groups' willingness to take more time and carefully work through fewer problems, but achieve greater accuracy, subsequently led to more effort-based attributions.

This pattern is fascinating because it may reflect fundamental differences in interpretations of what it means to be successful: is it getting the job done quickly or getting the job done correctly? This paradox can easily be applied to STEM domains in particular, where productivity may be favored, praised, and recognized more so than slow, but precise steps toward an end goal. Women who do enter STEM fields may feel pressure to perform quickly and to complete tasks on time in order to remain competitive with their male colleagues and to prove themselves as deserving of their position despite their minority status. However, this may not apply to men, who are in the majority in

these domains and therefore may not feel as much pressure to quickly complete tasks, but have the opportunity to take the necessary time to capitalize on accuracy. Therefore, men and women in STEM fields may perceive success in different ways: women as quickly completing tasks to prove themselves in a male-dominated field; men as having the opportunity to take the time to complete tasks with high quality in mind.

Furthermore, this pattern suggests that the effects of stereotype threat may have different manifestations depending on the attribution that is implied by a stereotype. Because this study included attributions within the stereotype itself, different stereotype threat effects were able to emerge, pointing to an important distinction between attributions in general to explain behaviors or characteristics related to the stereotype (e.g., intelligence), and attributional stereotypes that explain why the stereotype itself exists. For example, when intelligence is said to be malleable rather than fixed, stereotype threat effects in women's math performance are typically attenuated (Aronson, Fried, & Good, 2002). When a similar attribution was applied to the gender stereotype in this study (i.e., internal, controllable; effort), performance did not result in greater accuracy compared to those with an internal, uncontrollable attribution (i.e., analogous to an entity theory of intelligence), who were able to more accurately complete problems. It is possible that women in STEM may believe that intelligence is malleable, but also believe that women underperform compared to men in logical reasoning because they do not put forth enough effort. These attributions may lead to improved accuracy and improved productivity, respectively, in different contexts, each of which would ultimately lead to different outcomes.

Although the patterns suggested by the results presented here are interesting, the small sample size of this study cannot be ignored. This limitation does call into question the results that were obtained and also requires that more data be examined to determine if these results and the corresponding conclusions are reliable. Further research using this paradigm may be particularly useful, however, given that these preliminary results do not reflect those of typical stereotype threat studies. The examination of attributional stereotypes in a stereotype threat context may, therefore, represent an area of unexplored research that deserves further attention.

In conclusion, although this study lacked a large number of participants to be able to completely understand the patterns that emerged, the data do suggest stereotype threat effects that are unique. In futures studies, replication of this paradigm using that attributional model of stereotypes as a framework is essential. With a better understanding of these results, they can be more readily applied to the persisting gender gap in STEM, where attributional stereotypes may be a primary contributing factor.

CHAPTER V

SUMMARY

The ongoing gender gap in science, technology, engineering, and math (STEM) domains has been an important and popular area of study in recent years. Although male and female students do not necessarily show differences in terms of grades, disparities continue to emerge on high-stakes tests, college major selection, and in the workforce. Stereotype threat has been cited as a debilitating phenomenon in terms of performance in both academic and non-academic arenas and may be one of the driving forces behind the pervasive gender gap. The attributions that accompany negative stereotypes give an individual insight into why a particular stereotype exists and may contribute to performance deficits.

In the current research, the attributional model of stereotypes (Reyna, 2000; 2008) acted as a framework to explore the specific role of attributions in the stereotype threat process and its influence on behavior. Each of the three attributional signatures that accompanied the stereotype had a locus and a controllability component: internal/controllable (effort), external/uncontrollable (society-based), and internal/uncontrollable (ability). Each of these attributions was expected to lead to a different behavior pattern in persistence, performance, task specific self-esteem, and domain identification.

There were four experimental conditions: one for each of the three attributional combinations as well as one where the stereotype was nullified. The three attributions were conveyed in the context of a stereotype that women are not as proficient as men in tests of logical reasoning, a skill that can be tied to STEM domains. After being exposed

to the stereotype and attribution, participants were required to complete a difficult logical reasoning test. Persistence was measured by the rate at which participants were willing to continue on the test to supplement their original score and performance was measured by the ratio of correct to attempted logical reasoning problems. Task specific self-esteem and domain identification were both measured before and after the test, making it possible to compare both between and within groups on these two variables.

The results were inconsistent with the hypotheses in that those in the attribution conditions that were expected to be the most negatively affected by the manipulation (E/UC and I/UC) actually exhibited the greatest levels of performance and were more willing to persist on the task. Although this finding does not reflect typical stereotype threat effects, it does suggest that stereotype threat may play out differently depending on the attributional information associated with the stereotype at hand. Specifically, the E/UC and I/UC attributions prompted participants to slow down and carefully work through fewer problems, where as the I/C (effort) attribution led participants to get through more problems during the time allotted, but this speed came at a cost to their accuracy.

These findings can be understood in the context of STEM environments, where success may imply working hard to get the job done on time (consistent with the I/C attribution) rather than slowing down to get the job done right (consistent with the E/UC and I/UC attributions). People may gain more recognition and praise for meeting a deadline than for passing a deadline and submitting a higher quality product. Women in STEM who are faced with stereotypes about their performance may use different strategies depending on the attribution associated with that stereotype, influencing their

ability to perform on the job. If the results of this study can be replicated, they would suggest that stereotype threat does not apply to all situations in the same way and that attributions associated with stereotypes do, in fact, change the types of achievement outcomes that will prevail.

The primary shortcoming of this study was the small number of participants, particularly in the E/UC condition. In future research, this paradigm should be replicated with more participants to see if the patterns observed here are consistent. If consistent results do emerge, a significant contribution to the literature would be gained in the form of re-thinking the attribution-stereotype link and how attributions specifically tied to stereotypes can influence stereotype threat effects.

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Appendix A

Hypotheses

Attribution Condition	Performance	Persistence	Task Based Self-Esteem	Domain Identification
Nullified Stereotype (no gender differences)	Highest score on logical reasoning test	Greatest rate of persistence (completion of extra credit assignment)	Highest levels of post-test self-esteem	Highest levels of domain identification at post-test
Internal/Controllable (effort-based)	Higher test score than E/UC and I/UC conditions (comparable to nullified stereotype condition)	Greater persistence then E/UC and I/UC conditions (comparable to nullified stereotype condition)	Higher post-test self-esteem than I/UC condition (similar to nullified stereotype and E/UC conditions)	Higher post-test domain identification than E/UC and I/UC conditions
External/Uncontrollable (society-based)	Higher test score than I/UC condition; may be similar to or lower than nullified stereotype and I/C conditions	Greater persistence than I/UC condition; may be similar to or lower than nullified stereotype and I/C conditions	Higher post-test self-esteem than I/UC condition (similar to nullified stereotype and I/C condition)	Higher post-test domain identification than I/UC condition; lower than nullified stereotype and I/C conditions
Internal/Uncontrollable (ability-based)	Lowest score on logical reasoning test	Lowest rate of persistence	Lowest levels of post-test self-esteem (may preserve self-esteem by reporting lower domain identification at post-test)	Lowest levels of post-test domain identification (used as self-esteem preservation)

Appendix B

Domain Identification Measure

Please indicate the number that best describes how much you agree with each of the statements below.

1. "I have strong logical reasoning skills."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

2. "Having strong logical reasoning skills is important for my major."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

3. "Scoring well on tests of logical reasoning ability is important to me."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

4. "Logical reasoning skills are important for my future career."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

5. "I enjoy logical reasoning problems."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

Appendix C

Attribution Manipulation

LARGE STUDY SHOWS FEMALES ARE EQUAL TO MALES IN LOGICAL REASONING SKILLS

October 11, 2010 by David Tenenbaum

The logical reasoning skills of boys and girls, as well as men and women, are substantially equal, according to a new examination of existing studies in the current online edition of the journal *Psychological Bulletin*.

One portion of the new study looked systematically at 242 articles that assessed the logical reasoning skills of 1,286,350 people, says chief author Janet Hyde, a professor of psychology and women's studies at the University of Wisconsin-Madison.

These studies, all published in English between 1990 and 2007, looked at people from grade school to college and beyond. A second portion of the new study examined the results of several large, long-term scientific studies, including the National Assessment of Educational Progress.

In both cases, Hyde says, the difference between the two sexes was so close as to be meaningless.

Sara Lindberg, now a postdoctoral fellow in women's health at the UW-Madison School of Medicine and Public Health, was the primary author of the meta-analysis in *Psychological Bulletin*.

The fact that men and women have equal logical reasoning abilities is widely accepted among social scientists, Hyde adds, but word has been slow to reach teachers and parents, who can play a negative role by guiding girls away from sciences and engineering requiring logical reasoning. "One reason I am still spending time on this is because parents and teachers continue to hold stereotypes that boys are better in logical reasoning, and that can have a tremendous impact on individual girls who are told to stay away from engineering or the physical sciences."

"Parents and teachers give implicit messages about how good they expect kids to be at different subjects," Hyde adds, "and that powerfully affects their self-concept of their ability. When you are deciding about a major in physics, this can become a huge factor."

The new findings reinforce a recent study that ranked gender dead last among nine factors, including parental education, family income, and school effectiveness, in influencing the logical reasoning performance of 10-year-olds.

Hyde acknowledges that women have made significant advances in technical fields. Half of medical school students are female, as are 48 percent of undergraduate math majors. "If women can't do logical reasoning, how are they getting these majors?" she asks.

Because progress in physics and engineering is much slower, "we have lots of work to do," Hyde says.

"This persistent stereotyping disadvantages girls. My message to parents is that they should have confidence in their daughter's performance. They need to realize that women can do logical reasoning just as well as men. These changes will encourage women to pursue occupations that require logical reasoning."

Note: This article serves as the manipulation for the nullified stereotype condition

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In both cases, Hyde says, the difference between the two sexes was clear.

Sara Lindberg, now a postdoctoral fellow in women's health at the UW-Madison School of Medicine and Public Health, was the primary author of the meta-analysis in *Psychological Bulletin*.

The fact that men and women differ in logical reasoning abilities is accepted among social scientists, Hyde adds, but more research is needed to understand this issue. "One reason I am still spending time on this is because it is not differences in ability, but for some reason girls do not put in as much effort as boys in logical reasoning, which appears to be the driving force behind the gender gap that we're seeing. Parents and teachers need to be aware that girls lag behind boys in logical reasoning, but that this problem may be reversed with more dedication and effort from female students in this area."

The new findings reinforce a recent study that ranked gender near the top among nine factors, including parental education, family income, and school effectiveness, in influencing the logical reasoning performance of 10-year-olds.

Hyde acknowledges that women have made minimal advances in technical fields. Only one quarter of medical school students are female, as are 20 percent of undergraduate science majors. "If women utilize new techniques and more study time in logical reasoning, there could be even more females in these majors," Hyde says.

Because progress in physics and engineering is even slower, "we have lots of work to do," Hyde says.

"This persistent lack of effort disadvantages girls. My message to parents is that they encourage their daughter's performance. They need to realize that women can do logical reasoning just as well as men with the right amount of dedication. These changes will encourage women to pursue occupations that require logical reasoning."

Note: This article serves as the manipulation for the internal/controllable (effort) attribution condition

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The fact that men and women differ in logical reasoning abilities is accepted among social scientists, Hyde adds, but more research is needed to understand this issue. "One reason I am still spending time on this is because the negative messages that girls and women receive from educators, peers, and parents in regards to logical reasoning appears to be the driving force behind the gender gap that we're seeing. Parents and teachers need to be aware that girls lag behind boys in logical reasoning, but that these negative messages and attitudes are deeply rooted, making it difficult to break the pattern of inequality we're seeing."

The new findings reinforce a recent study that ranked gender near the top among nine factors, including parental education, family income, and school effectiveness, in influencing the logical reasoning performance of 10-year-olds.

Hyde acknowledges that women have made minimal advances in technical fields. Only one quarter of medical school students are female, as are 20 percent of undergraduate science majors. "If society does not value women in fields requiring logical reasoning, it will be difficult for women to overcome such substantial hurdles," Hyde says.

Because progress in physics and engineering is even slower, "we have lots of work to do," Hyde says.

"Society-wide favoritism toward boys in logical reasoning disadvantages girls. My message to parents is that they encourage their daughter's performance. They need to realize that unless we start to change our minds about women's logical reasoning abilities, men will continue to dominate. These changes will encourage women to pursue occupations that require logical reasoning."

Note: This article serves as the manipulation for the external/uncontrollable (society-based) attribution condition

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In both cases, Hyde says, the difference between the two sexes was clear.

Sara Lindberg, now a postdoctoral fellow in women's health at the UW-Madison School of Medicine and Public Health, was the primary author of the meta-analysis in *Psychological Bulletin*.

The fact that men and women differ in logical reasoning abilities is accepted among social scientists, Hyde adds, but more research is needed to understand this issue. "One reason I am still spending time on this is because genetic differences between males and females appear to be the driving force behind the gender gap that we're seeing. Parents and teachers need to be aware that girls lag behind boys in logical reasoning, and this problem may not be reversible if an inherent difference in ability is the cause."

The new findings reinforce a recent study that ranked gender at the top among nine factors, including parental education, family income, and school effectiveness, in influencing the logical reasoning performance of 10-year-olds.

Hyde acknowledges that women have made minimal advances in technical fields. Only one quarter of medical school students are female, as are 20 percent of undergraduate science majors. "The consistency of fewer women in these domains compared to men over the several decades points to a hard-wired difference between the sexes," Hyde says.

"This difference in ability really poses a disadvantage for girls. My message to parents is that this gender gap is not going to disappear any time soon. It is important to encourage girls in other areas such as English and literature where they have typically succeeded rather than pushing fields that are out of reach and require a logical reasoning ability that is dominant in boys."

Note: This article serves as the manipulation for the internal/uncontrollable (ability) attribution condition

Appendix D

Manipulation Check

Please answer the following reading comprehension questions pertaining to the article you just read.

1. Women have made some advances in technical fields.
    a. True
    b. False

2. The researchers believe there are no gender differences in logical reasoning.
    a. True
    b. False

3. According to the article, gender differences in logical reasoning
    a. do not exist.
    b. arose because of teacher and parental favoritism to boys rather than girls.
    c. are due to inherent gender differences.
    d. exist because of lack of effort among women.

4. Social scientists are in disagreement regarding the nature of gender differences in logical reasoning.
    a. True
    b. False

Appendix E

Demographics Questionnaire

Please answer the following demographic questions.

1. Age: _____

2. Your current standing in college:
A. First year
B. Second year
C. Third Year
D. Fourth Year
E. Fifth Year
F. Graduate student.

3. In what category does your major fall?
A. Music
B. Theatre
C. Commerce (*Management, Economics, Finance, Marketing, etc.*)
D. Communication (*Journalism, Media Studies, Public Relations, etc.*)
E. Computing & Digital Media (*Computer Science, Telecommunications, etc.*)
F. Education (*Counseling, Physical Education, Teaching & Learning, etc.*)
G. Liberal Arts & Sciences (*Foreign Language, Geography, Philosophy, Sociology, Women & Gender Studies, etc.*)
H. Science & Health (*Biology, Chemistry, Psychology, Nursing, Mathematics, etc.*)

4. Sex:
A. Male
B. Female

Appendix F

State Self Esteem Scale

Please rate the following statements according to ***what is true for you at this moment****.*

1. "I feel confident about my logical reasoning abilities."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

2. "I feel as smart as others in terms of logical reasoning."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

3. "I feel confident that I will understand the logical reasoning test items."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

4. "I feel that I have less logical reasoning ability right now than others." (R)

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

5. "I feel like I will not do well on a logical reasoning test." (R)

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

Note. (R) indicates reverse scoring.

Appendix G

Logical Reasoning Test

Instructions

You will have twenty minutes to complete the following logical reasoning questions. You may use the scratch paper provided. If you are stuck on a question, please feel free to skip it and move on to the next question.

Questions 1—5

A botanical garden has four greenskeepers: Wilson, Xavier, Yussef, and Zachary. The manager of the garden often has trouble scheduling the greenskeepers to his satisfaction. He must follow these conditions:
One or more of these greenskeepers must trim the greens each day, but none of them does so for two or more days in a row.
The greenskeepers work only Monday through Friday.

1. If Wilson, Xavier, and Yussef trim the greens working together three times from Monday through Friday, which of the following must be true?

I. Zachary trims the greens on Tuesday.
II. Zachary trims the greens on Wednesday.
III. Zachary trims the greens on Thursday.

A. I only
B. II only
C. III only
D. I and III only
E. I, II, and III

2. Which of the following is possible during the period from Tuesday through Friday?

A. All four greenskeepers work together on Friday.
B. Three greenskeepers work together three of the four days.
C. Xavier works twice as many days as Yussef.
D. Zachary works three times as many days as Wilson.
E. Both Wilson and Zachary work three times as many days as Xavier.

3. If Wilson, Xavier, and Yussef work together on Monday, and Wilson, Xavier, and Zachary work together on Thursday, which of the following must be true?

I. Zachary works alone on Tuesday.
II. Yussef works alone on Wednesday.
III. Yussef works alone on Friday.

A. I only
B. II only
C. III only
D. I and II only
E. I, II, and III

4. Suppose Wilson works alone on Wednesday, and exactly two greenskeepers work Monday, Tuesday, Thursday, and Friday. It must be true that

A. the same two greenskeepers work Tuesday and Thursday.
B. Yussef works with Wilson at least one day during the week.
C. Xavier works exactly two days during the week.
D. Zachary works with Wilson on Monday or Friday.
E. the same two greenskeepers work Monday and Friday.

5. If a fifth greenskeeper, Quincy, joins the staff and works only on Tuesday, during that same week of Monday through Friday, what is the maximum number of greenskeepers that can work on Wednesday?
A. 1
B. 2
C. 3
D. 4
E. 5

Questions 6—9

An apartment building has eight floors with one apartment on each floor. Seven families — the Abrams, the Bakers, the Cabots, the DeLeons, the Elgars, the Fertittas, and the Grants — occupy each of the apartments, with one apartment vacant.
The number of floors between the Abrams and the Bakers is exactly the same as the number of floors between the Cabots and DeLeons.
The Elgars are on a floor immediately adjacent to the Fertittas.
The apartment on the bottom, the first floor, is occupied.
The Grants live on a lower floor than the Elgars.

6. Which of the following is a possible arrangement of families, from bottom floor to top floor?
A. Vacant, Grants, Abrams, Cabots, Bakers, DeLeons, Elgars, Fertittas
B. Grants, Abrams, Elgars, vacant, Fertittas, Bakers, Cabots, DeLeons
C. Grants, Bakers, Abrams, Fertittas, Elgars, DeLeons, Cabots, vacant
D. Abrams, Bakers, Cabots, Grants, vacant, DeLeons, Elgars, Fertittas
E. Cabots, DeLeons, Elgars, vacant, Grants, Fertittas, Bakers, Abrams

7. If the Fertittas live on the second floor, which of the following must be true?
A. The top floor is vacant.
B. The Elgars live on the bottom floor.
C. The Grants live on the bottom floor.
D. The Bakers live on the top floor.
E. The vacant floor is not the top floor.

8. If the Abrams live on the sixth floor, the Bakers live on the seventh floor, and the Fertittas live on the fourth floor, which of the following must be true?
I. The Cabots live on the first floor.
II. The Elgars live on the fifth floor.
III. The DeLeons live on the second floor.
IV. The top floor is vacant.

A. I and II only
B. I, II, and III only
C. II and III only
D. II and IV only
E. I, II, III, and IV

9. If the Abrams and Bakers live on the second and fourth floors, respectively, all of the following can be true EXCEPT
A. The Cabots live on the sixth floor.
B. The DeLeons live on the third floor.
C. The Fertittas live on the seventh floor.
D. The Grants live on the first floor.
E. The Elgars live on the seventh floor.

Questions 10—13

A chef working at a Mr. Eggs franchise is preparing Mr. Eggs' famous giant breakfast omelets. These omelets require not only the finest grade AA eggs, but also at least two of the following specially prepared ingredients: tomatoes, diced ham, onions, mushrooms, cheese, and shrimp. These ingredients are measured in cups. When the chef cooks an omelet, she must follow Mr. Eggs' strict recipes:
She can never use onions and mush- rooms in the same omelet.
For every cup of diced ham, she must also use a cup of mushrooms, but if mushrooms are used, she does not have to use diced ham.
If cheese is included in the omelet, the number of cups she uses must be greater than the total number of cups she uses for all the other specially prepared ingredients combined in that omelet.
For every cup of tomatoes used, she must use two cups of onions.
No omelet uses all of the specially prepared ingredients.
She cannot use any ingredients other than the ones listed above.

10. Which of the following combinations of ingredients can never be used together?
A. Tomatoes and diced ham
B. Tomatoes and onions
C. Tomatoes and cheese
D. Tomatoes and shrimp
E. Cheese and shrimp

11. If one more cup of onions is added to the following ingredients, which of the following would conform to a Mr. Eggs recipe?

A. Eggs, 2 cups onions, 1 cup mushrooms, 3 cups cheese, 2 cups shrimp
B. Eggs, 2 cups diced ham, 1 cup onions, 4 cups cheese, 3 cups shrimp
C. Eggs, 1 cup diced ham, 1 cup onions, 1 cup cheese, 2 cups shrimp
D. Eggs, 1 cup tomatoes, 2 cups onions, 2 cups cheese, 1 cup shrimp
E. Eggs, 1 cup tomatoes, 1 cup onions, 5 cups cheese, 1 cup shrimp

12. Which complete recipe below conforms to the restrictions of a Mr. Eggs omelet?

A. Eggs, 3 cups onions, 3 cups tomatoes
B. Eggs, 2 cups diced ham, 2 cups tomatoes
C. Eggs, 1 cup tomatoes, 1 cup cheese
D. Eggs, 4 cups mushrooms, 4 cups diced ham
E. Eggs, 5 cups cheese, 5 cups diced ham

13. Of the following, which one ingredient could be added to ingredients already containing two cups onions and one cup cheese to make it conform to a Mr. Eggs omelet?

A. 2 cups cheese
B. 2 cups onions
C. 1 cup mushrooms
D. 1 cup diced ham
E. 1 cup tomatoes

Questions 14-17

Mrs. Gold goes to the local pet store and purchases eight newly born puppies. Before she decides which ones to give her grand- children, she wants to sort the puppies to make sure each grandchild gets what they wanted. As she starts to sort the puppies she notices the following:
Five of the puppies are female. Seven of the puppies are brown.
Four of the puppies are spotted in color; the others are solid.

14. Which of the following must be true?

I. All of the females are brown.
II. At least one of the spotted puppies is female.
III. Three of the brown puppies are male.

A. I only
B. II only
C. III only
D. I and II only
E. II and III only

15. Which of the following must be FALSE?
A. All the spotted females are brown.
B. One of the females is not brown.
C. One of the males is not brown.
D. All the males are spotted and brown.
E. All the females are spotted and brown.

16. Which of the following must be true?
A. At least one spotted puppy is not brown.
B. At least three spotted puppies are not male.
C. At least three brown puppies are not female.
D. At least three brown puppies are not spotted.
E. At least one male puppy is not spotted.

17. Which of the following must be FALSE?
A. All the male puppies are brown and spotted.
B. Four brown puppies are all female.
C. All the non-spotted puppies are male.
D. All the spotted puppies are female.
E. All the non-spotted puppies are female.

Questions 18—21

Eight antique airplanes are being considered for storage in two warehouses (East and West). The airplanes are single-wing (Dino, Kressna, Bonner, and Lear) and double-wing (Rickenbacher, Airheart, Orville, and Wilbur).
Neither of the two warehouses may go unoccupied.
The Dino and the Kressna may not be stored in the same warehouse.
The Lear and the Airheart are owned by the same pilot and must be stored together in the same warehouse.
The Dino and the Rickenbacher are serviced by the same mechanic and must be stored together in the same ware- house.
At least seven of the airplanes must be stored in the warehouses.

18. Which of the following could comprise the total storage of the East warehouse?
A. Kressna, Lear, Rickenbacher, Airheart, Orville, Bonner
B. Rickenbacher, Orville, Wilbur, Dino, Bonner
C. Rickenbacher, Airheart, Orville, Dino
D. Kressna, Lear, Orville, Dino, Bonner
E. Lear, Rickenbacher, Dino, Bonner

19. All of the following are suitable storage arrangements for the West warehouse EXCEPT
A. Kressna, Orville, Bonner
B. Kressna, Lear, Airheart, Orville, Wilbur, Bonner
C. Kressna, Lear, Airheart, Wilbur, Bonner
D. Kressna, Lear, Airheart, Orville
E. Kressna, Lear, Rickenbacher, Airheart, Bonner

20. If the Kressna is the only single-wing airplane stored in the East warehouse, which of the following must be true?
A. The East warehouse contains exactly two airplanes.
B. All the double-wing airplanes are stored.
C. Both warehouses each contain two double-wing airplanes.
D. Five or fewer airplanes are stored in the West warehouse.
E. At least three single-wing airplanes are stored.

21. Only the Dino and one other airplane are stored in the East warehouse. If the Kressna is stored, then the West warehouse must contain
A. the Kressna, Wilbur, Orville, and at least two more.
B. the Kressna, Lear, Airheart, and at least two more.
C. the Kressna, Airheart, Lear, Orville, but not the Wilbur.
D. the Kressna, Wilbur, Lear, Airheart, but not the Orville.
E. the Kressna, Wilbur, Lear, Airheart, and Orville.

Questions 22—25

Nine baseball players are chosen for the All- Star squad. Four represent the Atlanta team, three from the Baltimore team, and two from the Chicago team.
In the batting order there are 9 spots, numbered from 1 through 9.
The manager arranges the batting order so that all four players from Atlanta bat consecutively, and the two Chicago players bat consecutively.

22. If an Atlanta player bats in spot number 6, and a Baltimore player bats in spot number 8, in which spot must a Chicago player bat?
A. 1
B. 2
C. 3
D. 5
E. 7

23. The three players from Baltimore will bat consecutively if a player from Chicago bats in which spot number?
A. 1

B. 3
C. 5
D. 7
E. 9

24. Suppose one team has players batting in spot number 3 and spot number 6. Which one of the following must be a player from Atlanta?
A. 9
B. 8
C. 7
D. 4
E. 3

25. If the players batting in spot numbers 2 and 3 are from Baltimore and Chicago, respectively, a Baltimore batter could also be batting in which of the following spot numbers?
A. 4
B. 5
C. 6
D. 7
E. 8

Appendix H

Exit Survey

"If you could continue on this task, how likely is it that you would continue?"

1	2	3	4	5	6	7
Very Probably Not	Probably Not	Possibly	Unsure	Probably	Very Probably	Definitely

*Please rate the following statements according to **what is true for you at this moment**.*

1. "I feel confident about my logical reasoning abilities."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

2. "I feel as smart as others in terms of logical reasoning."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

3. "I feel confident that I understood the logical reasoning test items."

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

4. "I feel that I have less logical reasoning ability right now than others." (R)

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

5. "I feel like I did not do well on the logical reasoning test." (R)

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

(Rosenberg Self-Esteem Scale)

6. I feel that I'm a person of worth, at least on an equal plane with others.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

7. I feel that I have a number of good qualities.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

8. All in all, I am inclined to feel that I am a failure (R).

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

9. I am able to do things as well as most other people.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

10. I feel I do not have much to be proud of (R).

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

11. I take a positive attitude toward myself.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

12. On the whole, I am satisfied with myself.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

13. I wish I could have more respect for myself (R).

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

14. I certainly feel useless at times (R).

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

15. At times I think I am no good at all (R).

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

Please indicate the number that best describes how much you agree with each of the statements below.

16. Logical reasoning is something you are born with.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

17. Logical reasoning skills can be achieved with practice and effort.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

18. Men and women are equal in their logical reasoning abilities.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

19. Gender differences in logical reasoning are due to the discouragement of women by society.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

20. I have strong logical reasoning skills.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

21. Having strong logical reasoning skills is important for my major.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

22. Scoring well on tests of logical reasoning ability is important to me.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

23. Logical reasoning skills are important for my future career.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

24. In general, I enjoy logical reasoning problems.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

25. My field of study (i.e., your major; concentration) is important to who I am as a person.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree

26. I enjoyed the logical reasoning test.

1	2	3	4	5	6	7
Strongly Disagree	Disagree Moderately	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Moderately Agree	Strongly Agree