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THE EFFECT OF PRIMING INTELLIGENCE MALLEABILITY ON
STEREOTYPE THREAT AND PERFORMANCE

A Thesis Presented

by

KATHLEEN C. BURNS

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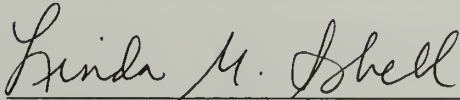
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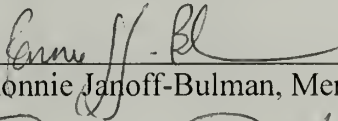
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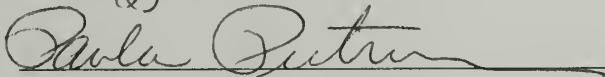
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ABSTRACT

THE EFFECT OF PRIMING MALLEABILITY ON STEREOTYPE THREAT AND
PERFORMANCE

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It was hypothesized that women who were primed with malleable theories of intelligence would be less likely to show stereotype threat effects in math performance than women who were not primed. Fifty-seven female participants completed a math and a verbal test, as well as measures of potential moderating and mediating variables. Stereotype threat effects were not found in this study, nor was there support for any of the moderators or mediators. While malleability did not affect actual test performance, it effectively reduced participants' test anxieties. Implications and possible reasons for these findings are discussed.

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CHAPTER I

INTRODUCTION

Men are better at math than women—that is the accepted stereotype. However, this stereotype seems to come true starting in junior high as boys perform better on standardized math tests (Quinn & Spencer, 2001). This trend continues into college and beyond with women earning only 22% of the B.S. degrees and 13% of the Ph.D.s in physical science, math, and engineering (Steele, 1997). Some researchers have attempted to explain these inequities by turning to biology, suggesting that there are innate ability differences between the sexes (e.g. Benbow & Stanley, 1983). However, the picture seems more complex than that. Researchers have found that certain testing conditions can eliminate gender differences in math performance (e.g. Spencer, Steele, & Quinn, 1999). This finding suggests that women can not only perform comparably to men in math, but may actually be underperforming due to situational rather than biological factors.

Steele (1997) has explained women's underperformance on math tests as a result of stereotype threat. Stereotype threat occurs when there is a negative stereotype about a group and group members feel the threat of being evaluated according to the stereotype, which adversely impacts their performance. This can happen even if the individual does not accept the stereotype. Initially, this concept was used to explain racial differences in academic performance (e.g. Steele, 1997; Steele & Aronson, 1995), but has been extended to several groups and domains, including women's math performance (e.g. Spencer et al., 1999), people with low socioeconomic status' performance on verbal tests (Croizet & Claire, 1998), older adults' memory abilities (Rahhal, Hasher, & Colcombe,

2001), and men's ability to process affective information (Leyens, Desert, Croizet, & Darcis, 2000).

Researchers have identified three conditions necessary for stereotype threat to occur (Wheeler & Petty, 2001). First, a person must be the target of a stereotype and aware of the negative implications of the stereotype. Second, the domain should be important to the individual, as measured by his or her strong skills and level of identification with it. Finally, the stereotype must be applicable to the situation by being diagnostic of the person's true abilities. This last condition is often accomplished in experimental research by having participants take a difficult test, since such tests are considered more diagnostic of people's abilities. If the test is too difficult, however, participants are likely to give up, and consequently, will not experience stereotype threat. Thus, for this reason, a test should be at the upper limits of the participants' abilities.

Past research has examined women's math performance under stereotype threat conditions (e.g. Spencer et al., 1999). Stereotype threat is usually induced experimentally by telling women that a math test is gender biased; however, bias is not a necessary condition. In one study, when women were given a difficult math test without explicit bias instructions, they still performed worse than men (Spencer et al., 1999). Importantly, women and men performed equally well when they were told the test was gender fair. Women were also less able to generate problem-solving strategies than men under stereotype threat conditions (Quinn & Spencer, 2001). For example, women were unable to formulate a strategy 14% of the time whereas men were unable to formulate a strategy only 2% of the time. This difference was also eliminated when participants were told the test was gender fair.

The evidence reviewed above indicates that stereotype threat can be eliminated by changing the situation. As described earlier, simply telling participants that a test is gender fair allows women to perform as well as men. When participants believe that the test is gender fair, the stereotype is no longer relevant to the situation and thus, stereotype threat is not activated. The intent of the proposed research is to examine other ways to negate stereotype threat effects. If women believe the math stereotype, they may focus on the idea that gender differences in math performance are biological and that there is little that they can do to change their performance. In other words, their performance is predetermined. In contrast, if women are led to focus on the malleability of math abilities, they may not be affected by stereotype threat. That is, if they believe that their math abilities could improve with further effort they would not be confined to the limits of the gender stereotype.

CHAPTER II

IMPLICIT THEORIES OF INTELLIGENCE

Perceptions of the malleability of intelligence have been investigated by Carol Dweck and her colleagues (e.g. Dweck & Leggett, 1988). They proposed that people hold implicit theories about intelligence, with some believing that intelligence is fixed (“entity” theorists) and others believing that intelligence is malleable (“incremental” theorists). People’s goals generally follow from their theories of intelligence. People with entity theories tend to have performance goals in which they focus on gaining positive outcomes and avoiding negative ones. On the other hand, people with incremental theories have learning goals and try to increase their abilities and focus on effort. When individuals with different theories face failure, entity theorists respond negatively because failure indicates a lack of ability rather than a lack of effort. However, incremental theorists respond more adaptively because they believe that they can exert additional effort in order to improve their future performance. Therefore, an incremental theory of intelligence may protect people from stereotype threat because they are less likely to believe that intelligence is biologically determined. Instead, intelligence, including math skills, should be malleable through effort and environmental changes.

There is limited research connecting stereotype threat with people’s implicit theories of intelligence (Aronson, Fried, & Good, 2002; Good, 2001; Lewis, 1999). Researchers have examined the extent to which participants’ own theories of intelligence protect them from stereotype threat; however, this research has failed to find a relationship between the two. Several methodological problems might be to blame.

First, most of the studies are inconsistent with past stereotype threat literature. For example, Lewis (1999) was unable to replicate Steele and Aronson's (1995) finding of race priming impairing African Americans' test performance. Good (2001) studied gender differences in math among 4th through 6th graders. However, gender differences in math (and thereby stereotype threat effects) do not usually appear until high school (Smith & White, 2001). More importantly, nearly all of the past research has *measured* rather than *manipulated* participants' implicit theories of intelligence to determine their impact upon stereotype threat. Manipulating these theories would give researchers a more powerful way of determining whether malleability is useful in eliminating stereotype threat.

Only one study has been conducted in which participants' implicit theories of intelligence were manipulated (Aronson et al., 2002). Aronson and his colleagues were interested in whether teaching the concept of malleability would positively affect African American and Caucasians' academic performance. During three lab visits, participants acting as pen pals repeatedly emphasized to young students that intelligence was "like a muscle" and capable of growth. At the end of the semester, participants were called as part of an unrelated study in order to assess their self-reported levels of enjoyment of academics, identification with academics, and experience of stereotype threat. Stereotype threat was assessed by asking participants to indicate the extent to which they agreed with the following two items: "people make judgments about my abilities based on my race" and "people make judgments about my racial group based on my performances." Participants who were led to believe that intelligence is malleable reported more enjoyment and identification with school, as well as a higher end-of-the-semester grade

point average than control participants. While the malleability manipulation positively influenced participants' academic experience, it had no effect on stereotype threat.

Although the results of Aronson et al.'s (2002) study are encouraging, their study could be improved to better test whether manipulating malleability eliminates stereotype threat. Importantly, their lack of findings may be an artifact of the way stereotype threat was measured. Specifically, people could easily hold the belief that intelligence is malleable and at the same time recognize that others evaluate them based on their race. To better assess whether manipulating implicit theories of intelligence reduces stereotype threat, participants' performance should be examined rather than participants' self-reported experience of stereotype threat. In addition, it would be useful to determine whether a more specific intervention could work for women's math performance (i.e. emphasizing the malleability of math intelligence instead of general intelligence). Dweck and her colleagues note that implicit theories of intelligence may be domain-specific (Dweck, Hong, & Chiu, 1993). For example, people may believe that math skills are fixed, but intelligence as a whole is malleable. Therefore, a domain-specific manipulation would better ensure that the intervention was targeting the specific beliefs that were related to performance.

CHAPTER III

OVERVIEW OF THE CURRENT STUDY

In the current study, I primed a malleable implicit theory of intelligence in order to examine the extent to which such manipulations eliminate stereotype threat in female college students who are identified and skilled in math. Based upon past research, it was hypothesized that women would answer more questions correctly on a difficult math test under conditions in which they were told that the test is gender fair than under conditions in which they were told it is gender biased. This prediction is consistent with the general stereotype threat effect reported in the literature (e.g. Spencer et al., 1999). In addition, it was hypothesized that women primed with malleable theories of intelligence would not show stereotype threat effects. That is, these participants were expected to answer the same number of math questions correctly regardless of whether they were told that the test is gender fair or gender biased. Further, I expected these participants should perform as well as those in the no stereotype threat condition.

As a secondary focus, verbal performance was also assessed. It is an open question as to whether stereotype threat would impact female participants' verbal scores. Inzlicht and Ben-Zeev (2000) found no deficits in women's verbal abilities under stereotype threat; however, they did not directly manipulate stereotype threat, but instead manipulated the ratio of women and men taking the test at the same time. However, if stereotype threat is a more general instead of domain-specific phenomenon, there may be deficits in verbal performance as well. On the other hand, women are typically stereotyped as having better verbal skills than men. Thus, this positive stereotype may potentially enhance women's performance. Importantly, however, some research

suggests that positive stereotypes only enhance performance if they are activated subtly instead of blatantly (e.g. Shih, Ambady, Richeson, Fujita, & Gray, 2002). Given that the current study's means of activating gender stereotypes is rather blatant, there may be no effect on verbal scores. The current study considers these possibilities.

Finally, this study also examines potential mediators and moderators of stereotype threat. Although no clear mediators of stereotype threat have been found, anxiety has often been suggested as a likely mediator (see review by Wheeler & Petty, 2001). In order to better measure anxiety, I utilized both direct and indirect measures. Given that participants may not be aware of or willing to admit their anxiety, indirect measures are useful. For moderators of stereotype threat, I examined both direct and indirect endorsement of the women and math stereotype. While it has been suggested that stereotype endorsement is not necessary for stereotype threat to occur (e.g. Steele & Aronson, 1995), other research suggests that there is significant variability in the endorsement of the gender and math stereotype (Blanton, Christie, & Dye, 2002), which could potentially predict people's susceptibility to stereotype threat. On the other hand, some research suggests that people are less willing to explicitly endorse the gender and math stereotype (see Nosek, Banaji, & Greenwald, 2002), so indirect measures of stereotype endorsement were also utilized. It was hypothesized that participants who do not endorse the women and math stereotype would not be as prone to stereotype threat as those who do.

CHAPTER IV

METHOD

A. Participants

Fifty-seven female undergraduates participated in this study in exchange for course credit. One participant was dropped from the analyses due to technical difficulties and another was dropped from some analyses due to incomplete data. Participants were solicited via phone and e-mail based on criteria collected from a mass prescreening session (N=952) at the beginning of the semester. Eligible participants had math SAT scores between 550 and 740 and strongly agreed with the statements, “I am good at math” and “It is important to me that I am good at math” (6 to 8 on a 9 point scale, 0=strongly disagree, 8=strongly agree). Participants had a mean math SAT score of 625.5 and a mean verbal score of 574.6. They were randomly assigned to one of four conditions, reflecting the primed theory of intelligence (malleable vs. control) by test bias (gender biased vs. gender fair) experimental design.

B. Procedure and Materials

Participants were greeted by a female experimenter in groups of one to four. They were brought into individual rooms and told that they would be completing several separate studies relating to educational psychology on the computer (using MediaLab software). In the first part of the study (priming manipulation), participants were instructed to read a passage about intelligence from a new educational psychology textbook. In the next part of the study, they were told that the University of Massachusetts was selected to take part in a national study looking at gender differences in math. Participants were told that they were selected for the study based on their strong

math background and were asked to give a strong effort in order to help the researchers better analyze the participants' math ability. Participants then completed a verbal test without any additional bias instructions and, finally, completed several additional measures to be described below. All participants were debriefed at the end of the study.

1. Implicit Theory Measures

Participants completed a six-item questionnaire measuring their implicit theories of intelligence as part of the initial prescreening session. Three of the questions were borrowed from an established scale (Hong et al., 1999) and tapped general theories of intelligence ($\alpha=.92$, e.g., “You have a certain amount of intelligence and you really can’t do much to change it”). (See Appendix 1 for questions measuring implicit theories.) Three additional questions were designed to target participants’ domain-specific implicit theories (two math ($\alpha=.68$) and one verbal, e.g. “No matter how hard you work in math, you can’t improve your basic math abilities”). Participants indicated their agreement with each of the items using a 7-point scale ranging from 0 (strongly disagree) to 6 (strongly agree). Responses were coded so that higher scores indicate entity theories and lower scores indicate incremental theories.

2. Implicit Theory Manipulation

Participants’ implicit theories of intelligence were manipulated by priming them with either a malleable or general view of math intelligence. To do this, participants were randomly assigned to read a textbook excerpt that focused on (a) how math abilities can be changed by different environments or (b) how math abilities are rather fixed and that math is just one of multiple forms of intelligence. (See Appendix 2 for these passages). After reading the passage, participants evaluated it on several variables,

including how interesting and comprehensible they found the passage to be (1=not at all to 7=very). (See Appendix 3 for a complete list of these questions.) In order to promote systematic processing of the material, participants were then asked to summarize the reading in one sentence and state the evidence they found to be most convincing (Hong et al., 1999).

3. Stereotype Threat Manipulation

To manipulate stereotype threat, participants were randomly assigned to read one of the following versions of instructions before completing the math test: “The test you will be taking today has been shown to produce [no] gender differences in the past. That is, men performed better than women [men and women performed equally well] on this test in the past.” These instructions were modeled after past stereotype threat work (Spencer, Steele, & Quinn, 1999). Participants, regardless of which math instructions they received, received the same instructions for the verbal test. Specifically, they were told, “There has also been controversy about whether there are gender differences in verbal ability”. This was stated briefly and simply in order to leave it ambiguous as to whether or not bias was present in the verbal test.

4. Pre-test Questions

Participants were given a sample test question and the correct answer before completing each test in order to better answer the anxiety and expected performance questions. (See Appendix 4 for a complete list of questions.) For example, participants were asked to differentiate their test anxiety as a function of their group membership (i.e. women) and themselves (i.e. “I am worried that my performance will negatively reflect on women as a whole”, “I am worried I will let myself down if I don’t do well on this

test”; 1=strongly disagree to 7 strongly agree). These components were separated because other researchers have suggested that they may be distinct sources of anxiety (Aronson et al., 1999). For the expected performance questions, participants predicted how their score would compare to other UMass students on 7-point rating scales (1=a lot worse, 4=about the same, 7=a lot better), as well as how they expected to do in general (1=not very well, 7=very well).

5. Test Items

Twenty-three math and 23 verbal questions were taken from the Graduate Record Examination (GRE) and pre-tested for level of difficulty using a separate sample of participants who did not complete the main study. The math test was rather difficult with the participants (N=9) only getting about 28% of the questions correct. The verbal test was slightly easier; participants answered 40% of the questions correctly. Fifteen questions were selected from each pre-test and were used in the main study. Participants in the main study were given 15 minutes to work on each test. Each question had five answer choices, as well as an “I don’t know” response, in order to dissuade guessing (See Appendix 5 for test items). All participants received the math test first, followed by the verbal test.

6. Implicit Theory Manipulation Check

In order to check that the malleable prime manipulation was successful, participants answered questions about their test performance following each test. Participants were asked about their actual performance using questions similar in form to those they completed when predicting their performance (e.g. by comparing themselves to other UMass students). (See Appendix 6 for these questions.) Participants were also

asked to judge how much they believed that their performance was attributable to several factors, including effort and ability. Participants used a 7-point rating scale (1=not at all to 7=very much so) to make these judgments. They were also asked if they were to take the test again how much they would prefer simple and easy questions to relatively difficult and challenging ones. Past research has found that these measures are effective in discerning manipulated theories of intelligence (Hong et al., 1999). That is, participants primed with the malleable view of intelligence are more likely to attribute their test performance to effort and are more likely to prefer challenging problems in the future.

7. Indirect Measure of Anxiety

After the manipulation checks, participants read a scenario about Jen, a female college intern who had a history of both successes and failures at a company (See Appendix 7). The company needed to lay off one of its interns in order to increase the salaries of the remaining interns. Participants were given ten minutes to decide what happened next by writing three paragraphs “focusing on what Jen will do, say, think, and feel as the story continues.” This task was described as a writing sample and as another way to measure participants’ verbal abilities, but it was designed as an indirect way to measure anxiety. Responses were coded for the presence (1) or absence (0) of several variables, including anxiety in the main character and negative ending to the story.

8. Stereotype Endorsement

After completing their stories about Jen, participants answered direct and indirect questions designed to assess the degree to which they endorse the stereotype about women and math. For the direct question, participants were asked, “Do you believe that

men are better at math than women? Please explain". Responses were coded as yes or no, regardless of the reasons given. In order to assess stereotype endorsement indirectly, participants answered factual questions about the percentages of men and women in several different university degree programs. Included within these questions were items asking about the percentage of women who are pursuing undergraduate and graduate math degrees (i.e. What percentage of people earning bachelor's degrees [Ph.D.s] in math are women? a) 0-9%, b) 10-19%, c) 20-29%, d) 30-39%, e) 40-49%, f) 50-59%, g) 60-69%, h) 70-79%, i) 80-89%, j) 90-100%). These questions were designed so that participants' attitudes could be inferred from the deviation of their response from the correct answer. Responses that are lower than the correct answer were indicative of negative attitudes whereas those that were higher than the correct answer were indicative of more positive attitudes. Because explicit attitudes toward women and math may produce socially desirable responding, this "fact-based" technique should diminish this tendency and provide a more indirect way to determine participants' attitudes.

9. Bias Manipulation Check

Finally, to ensure that participants had read the math test bias manipulation, they were asked to recall it using a multiple choice format (i.e. men have performed better on the test in the past, women have performed better, or have performed equally).

CHAPTER V

RESULTS

A. Manipulation Checks

1. Malleability Manipulation

Consistent with expectations, participants in the malleable condition were more likely to make attributions of effort for their math test performance than were control participants (4.60 vs. 3.75), $F(1, 48)=4.42, p=.04$. There were no significant differences across conditions for the other math manipulation check question. Specifically, participants in the malleable condition were not significantly more likely to prefer difficult over simple problems if given another math test in the future (3.65 vs. 3.10), $F(1, 48)=2.53, p=.12$. Results were also mixed for the verbal test manipulation check. As predicted, participants in the malleable condition were more likely than those in the control condition to prefer difficult over easy verbal problems in a re-test (3.68 vs. 2.95), $F(1, 48)=4.86, p=.03$. However, malleable participants were not significantly more likely than control participants to make effort attributions for their verbal performance (4.56 vs. 4.07), $F(1, 48)=1.65, p=.20$.

2. Bias Manipulation

Seven participants failed to correctly recall the direction of the test bias. Six participants reported the test was gender fair when it was actually biased toward men and one participant reported the test was biased towards men when it was actually gender fair. Preliminary analyses revealed that the results were similar regardless of whether these seven participants were included in the analyses. Thus, they were not excluded from the reported analyses.

B. Stereotype Threat

1. Math Performance

A 2 (primed theory of intelligence) X 2 (test bias) analysis of variance (ANOVA) was conducted on the number of math questions answered correctly. There was no main effect of bias, suggesting that participants did not experience stereotype threat. In fact, women who were told the math test was gender biased performed non-significantly better than those who believed the test was gender fair (3.80 vs. 3.43), $F < 1$. In contrast to expectations, the intelligence manipulation X bias interaction was nonsignificant ($F < 1$). As shown in Table 1, participants in the lowest threat condition (malleable/gender fair) performed nonsignificantly worse than participants in the other three cells.

2. Verbal Performance

A 2 (primed theory of intelligence) X 2 (test bias) ANOVA was also conducted on the number of correct verbal answers. Verbal performance did not vary as a function of the previous math test bias instructions. Participants in the math gender bias condition performed non-significantly better than those in the math gender fair condition (5.05 vs. 4.80), ($F < 1$). Therefore, stereotype threat also did not affect verbal performance. However, it is not surprising that there was no main effect of bias given that the verbal bias instructions were rather ambiguous and were the same for all participants. Participants may or may not have assumed that the direction of the verbal test bias was the same as the math test. There were no other differences across condition for verbal performance.

C. Mediators of Stereotype Threat

Given that no stereotype threat effects were found in this study, anxiety could not be tested as a mediator. Instead, the indirect and direct measures of anxiety were analyzed as dependent measures to assess differences across conditions. There were no differences found for the indirect measure of anxiety. Participants reported an equal amount of anxiety for the main character in the story they wrote, as well as the story outcome (i.e. being fired or receiving a raise), in all conditions. In contrast, however, there were reliable differences for the direct measures of anxiety, which will be discussed below as a function of the math and verbal tests.

1. Math Test Anxiety

The malleability intervention seemed to decrease math performance anxiety even though it had no effect on actual math performance. Participants' anxieties about their performance reflecting poorly on themselves and their gender had been conceptualized as distinct due to past research; however, they were found to be highly correlated in the present study ($r(57)=.70, p<.001$) so these measures were averaged together. Participants were less worried that they would let themselves and their gender down if they did poorly on the math test if they were in the malleable condition than if they were in the control condition, (2.90 vs. 3.91), $F(1, 48)=4.66, p=.036$.

2. Verbal Test Anxiety

The malleability manipulation also had positive benefits for verbal test anxiety. Participants' anxieties about their performance reflecting poorly on themselves and their gender were also correlated for the verbal test ($r(57)=.67, p<.001$) and were subsequently averaged together. Participants in the malleable condition were less worried about letting

themselves and their gender down if they did not perform well on the verbal test in comparison to control participants (2.88 vs. 3.97), $F(1, 48)=5.04, p=.029$. Malleability also enhanced participants' expected performance (3.86 vs. 3.13), $F(1, 48)=6.55, p=.014$, as well as their perceived actual performance (3.52 vs. 2.94), $F(1, 48)=5.23, p=.027$, when compared to control participants.

D. Moderators of Stereotype Threat

1. Indirect Measure of Stereotype Endorsement

In order to test whether stereotype endorsement moderated stereotype threat, participants' estimates of the percentage of women earning undergraduate and graduate degrees were averaged to form a single index of indirect stereotype endorsement. This centered value was entered along with the bias manipulation and their interaction into a regression equation. None of the factors significantly predicted math performance, suggesting that stereotype endorsement at a more implicit level does not moderate stereotype threat.

While stereotype endorsement did not moderate stereotype threat, there were group differences when endorsement was treated as a dependent variable. The estimated percentage of women earning graduate degrees varied as a function of the malleability condition. People in the malleable condition were more likely to overestimate the number of women earning math Ph.D.s whereas those in the control condition were more likely to be accurate or underestimate the number, $\chi^2(1)=6.71, p=.035$, (See Table 2). Although this effect was not predicted, the malleability intervention seemed to increase positive attitudes toward women and math at this more implicit level.

2. Direct Measure of Stereotype Endorsement

As far as the explicit measure of stereotype endorsement, fourteen participants believed the gender and math stereotype. These participants' math scores were compared to participants who did not endorse the math stereotype under stereotype threat conditions in a 2 (stereotype endorsement) X 2 (test bias) ANOVA. Participants who did not believe the stereotype performed nonsignificantly better on the math test than those who did (3.83 vs. 3.27), $F < 1$. In addition, there was no test bias X stereotype endorsement interaction, $F < 1$. Participants who did not believe the stereotype, but had been told the test was gender biased, performed nonsignificantly better than their counterparts in the other three cells. Therefore, explicit endorsement of the gender and math stereotype did not moderate stereotype threat.

3. Relationship between Indirect and Direct Measures of Stereotype Endorsement

There was no significant relationship between participants' implicit and explicit endorsement of the stereotype about women and math. Specifically, participants who endorsed the stereotype did not differ in their estimation of the number of women pursuing undergraduate and graduate degrees in math than those who did not endorse the stereotype, $\chi^2(4) = 6.33$, $p = .18$, (See Table 3). This indicates that there was some dissociation between the indirect and direct measures of stereotype endorsement.

E. Participants' Reported Implicit Theories of Intelligence

Participants' own implicit theories of intelligence were also examined to determine if they predicted test performance. Participants' responses to the three general implicit theories of intelligence questions were averaged in order to determine their general view of intelligence. Participants tended to have more incremental than entity

implicit theories of intelligence, $M=2.47$, $SD=1.59$. In order to determine participants' implicit theories about math, their responses to the two math-focused theory questions were averaged. In comparison to the general theory average, participants' domain-specific implicit theories of intelligence were even more focused on malleability (Math: $M=1.81$, $SD=1.34$, Verbal: $M=1.36$, $SD=1.23$).

1. Effects on Math Performance

A relationship between math implicit theories and math performance was apparent, but failed to reach conventional levels of significance, $r(56)=.22$, $p=.11$. Participants who viewed intelligence as fixed tended to perform better on the math test. I also conducted a hierarchical regression in order to determine whether participants' implicit theories of intelligence interacted with the experimentally manipulated variables (i.e. malleability and test bias) to influence math performance. No interactions were found.

2. Effects on Verbal Performance

A relationship between verbal implicit theories and verbal performance was apparent, but failed to reach conventional levels of significance, $r(56)=-.22$, $p=.11$. In contrast to math performance, participants with more incremental theories of intelligence performed better on the verbal test than those with more entity theories of intelligence. Participants' implicit theories of intelligence did not interact with either the bias or the malleability manipulation when entered into the regression equation.

CHAPTER VI

DISCUSSION

Overall, stereotype threat did not impair either math or verbal performance of the participants in this study. These findings failed to support the overall hypothesis that stereotype threat should occur in math performance for women who are skilled in and highly identified with math. In addition, since the verbal test also had null findings, it is unclear whether this supports the domain-specificity hypothesis that stereotype threat only affects domains in which participants are negatively stereotyped, or whether it is simply a result of other issues (e.g. the ambiguous bias manipulation, blatant instead of subtle stereotype activation). While priming malleability seemed to reduce participants' anxieties, it did not have any effects on actual performance nor did it interact with the bias manipulation as was predicted. In addition, participants' implicit and explicit endorsement of the women and math stereotype were unrelated and failed to moderate stereotype threat. This dissociation follows along the lines of other research in the prejudice domain showing weak or no correlations between implicit and explicit measures (e.g. Dasgupta & Greenwald, 2001).

There are several possible reasons for why stereotype threat was not found in this study. First, the bias manipulation was weak in comparison to the malleability manipulation. The bias manipulation did not cite specific studies or researchers and was only two sentences long. In contrast, the malleability passage was two pages long, appeared to come from a textbook, and cited specific research evidence. Participants may not have found the bias manipulation to be as convincing, though this was not assessed during the study. In fact, telling the participants that the math test was gender

biased seemed to motivate them causing them to do nonsignificantly better than those who were told the test was gender fair. In addition, this study was different than past stereotype threat studies involving women and math because it was conducted entirely on the computer. Perhaps the participants felt less threat because their responses seemed more anonymous and they were not as conscious of being evaluated according to the stereotype. The methodology also did not allow participants to look ahead at future questions or return to previous questions. This may have allowed participants to better focus on the problems and therefore be less susceptible to stereotype threat. This possibility should be investigated in future research.

The malleability manipulation was useful in other respects, despite its failure to impact actual test performance. For example, participants reported being less worried about letting themselves or their gender down for both the math and verbal tests. This may have been due to the attributions that were made in the malleable condition. A failure would have indicated a lack of effort rather than a lack of ability, and would therefore be less threatening and less stable. Overestimating the number of women earning Ph.D.s in math may have been another attempt at self-protection for the people in the malleable condition. It is interesting that the malleability manipulation also increased participants' expectations for success and their perceived actual performance for the verbal test. This may be because participants' verbal SAT scores, on average, were lower than their math scores, representing more room for improvement. Expending more effort may be a more satisfying strategy when one is less skilled and identified with a subject area. However, it is important to note that there were no actual verbal performance gains as a result of this increased effort.

The results of the current study may also have implications for Aronson et al.'s (2002) study. While their study attempted to change participants' implicit theories of intelligence to be more malleable over the course of several sessions, the people who they most wanted to change may have been the most resistant. In fact, changing from a fixed to a malleable perspective may not always have academic benefits. In this study, participants with entity theories tended to perform better on the math test than those with incremental theories. If a person is highly skilled in a domain and believes that ability is fixed, it may actually be threatening to start believing that anyone can be skilled in a domain if he or she simply works hard enough. Abilities may no longer be seen as special if anyone can reach the same level of achievement through hard work. Clearly, promoting malleability may not be a one-size-fits-all remedy for stereotype threat.

This study suggests several areas for future research. Most people reported malleable implicit theories of intelligence in this study. In the future, participants could be selected according to their implicit theories of intelligence in order to better capture the variability across this dimension. Participants could also be solicited according to their levels of stereotype endorsement. Only fourteen participants endorsed the stereotype about gender and math in this study. This was a more stringent test of stereotype endorsement since it was coded as a categorical variable (yes or no). It would be better measured on a continuum in the future to understand the magnitude of people's beliefs. Finally, it would be interesting to explore more about how people's implicit theories of intelligence affect their performance. In this study, those with math entity theories performed better on the math test whereas those with verbal incremental theories performed better on the verbal test. Perhaps priming participants with an entity theory of

intelligence could actually boost performance in domains in which the participants are highly identified and skilled. This may be a way of reminding them of the special nature of their abilities; however, this strategy may only be adaptive for those who have entity theories of intelligence. Participants with incremental theories of intelligence may respond even more negatively to this type of intervention. Interventions that manipulate people's implicit theories of intelligence may need to be fit to the person in order for them to be most effective.

Table 1: The Effects of Priming Malleability and Bias on Math Performance

Intelligence Manipulation	Instructions	
	Bias	Fair
Malleable	3.79	3.20
Control	3.81	3.66

Table 2: Effects of Malleability on Estimated Percentage of Female Math Ph.D.s
 (Represented in Percentage of Responses)

Percentage of Women Earning Math Ph.D.s				
<u>Intelligence Manip.</u>	<u>0-19%</u>	<u>20-29%</u>	<u>30-69%</u>	<u>Total</u>
Malleable	17.2	24.1	58.6	100%
Control	35.7	39.3	25	100%

Table 3: Relationship Between Explicit Stereotype Endorsement and Estimated Average Percentage of Women Pursuing Math Degrees at Undergraduate and Graduate Level (Represented in Percentages)

Average % Women Earning Math Degrees	Believe Stereotype	
	Yes	No
0-19%	21.4	9.3
20-29%	28.6	20.9
30-39%	42.9	30.2
40-49%	0	30.2
50-69%	7.1	9.3
Total	100%	100%

APPENDIX A

IMPLICIT THEORIES OF INTELLIGENCE MEASURES

- | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|--------------------------|--------------------------|--------------------------|----------------|-----------------------|-----------------------|-----------------------|
| Strongly Disagree | Somewhat Disagree | Slightly Disagree | Neutral | Slightly Agree | Somewhat Agree | Strongly Agree |
1. You have a certain amount of intelligence and you really can't do much to change it.
 2. Your intelligence is something about you that you can't change very much.
 3. You can learn new things, but you can't really change your basic intelligence.
 4. You can learn new things **in math**, but you can't really change your basic **math** intelligence.
 5. No matter how hard you work **in math**, you can't improve your basic **math** abilities.
 6. You can substantially change your **English** abilities, such as writing and reading.

APPENDIX B

MALLEABLE AND CONTROL MANIPULATION PASSAGES

Malleable Intelligence Passage

John Knowles, a psychologist at Yale, has spent the last decade tracing identical twins that were raised apart. According to his results, up to 88 percent of a person's math ability is due to environmental factors. In an extreme case, a young girl adopted by a college professor and his wife had a math IQ of 138. The genetically identical twin was raised by the real mother, who was a prostitute. This girl had a math IQ of 85. One empirical fact is well established: IQ is not fixed and unchanging, but is amenable to modification by environmental interventions. Researchers often find that children who are adopted into enriching intellectual environments show increases in IQ scores, especially in the mathematics domain.

Extensive data on the magnitude of individual score changes in intelligence test performance were first provided by the California Guidance Study. An analysis of retest data on 222 cases from this study found individual IQ changes of as much as 50 points. Over the period from 6 to 18 years, 59% of the children changed by 15 or more IQ points, 37% by 20 or more points, and 9% by 30 or more. Most of these changes were not random or erratic in nature. On the contrary, children exhibited consistent upward or downward trends over several consecutive years; and these changes were related to environmental characteristics. In the California Guidance Study, detailed investigation of home conditions and parent-child relationships indicated that large upward or downward shifts in IQ were associated with the cultural milieu and emotional climate in which the child was reared. For example, coming from supportive home environments, children were more likely to flourish in their math and English classes.

Other research has focused on how children's math scores can be improved by modifying the child's environment. Three specific ways have been tested: 1) giving rewards for progress, 2) encouraging effort, and 3) creating expectations for success. While there is controversy as to whether or not rewarding performance undermines intrinsic motivation, the other two factors have been supported. More specifically, teaching children to keep trying and persevering when frustrated is effective in maximizing their math abilities. These results have been found for college students as well. This suggests the importance of motivational and effort variables instead of strictly ability in determining a person's intelligence. However, these variables are not usually measured on standard intelligence tests even though they are better predictors of people's math and verbal performance.

Based on these findings, an increasing number of colleges and universities are beginning to look beyond students' test scores and consider the student "as a whole." Students who exhibit a love of learning, face challenges head-on, and work hard are better than those who simply have high SAT scores. It is rare for people to encounter success the first time they attempt something new or difficult. College is full of many

such learning experiences. Students who can appreciate this are better equipped to “dust themselves off” after encountering failure and “get back on the horse”.

In sum, research on the factors associated with increases and decreases in intelligence test scores throws light on the conditions determining intellectual development in general. It also suggests that prediction of subsequent intellectual status can be improved if measures of the individual’s emotional and motivational characteristics and of his or her environment are combined with initial test scores. From still another viewpoint, the findings of this type of research point the way to the kind of intervention programs that can effectively alter the course of intellectual development in the desired directions.

Control Passage

John Knowles, a psychologist at Yale, has spent the last decade tracing identical twins that were raised apart. According to his results, up to 88 percent of a person’s math ability is due to genetic factors. Therefore, a person’s math intelligence can be increased by only about twelve percent over the course of a person’s lifetime. Most of the change in math abilities is seen in young children as they first start learning math so the actual change in abilities for adolescents and college students is very minimal. In the math domain, people are either skilled or not, and motivation and hard work do little to change this.

Extensive data on the stability of intelligences was first provided by the California Guidance Study. An analysis of retest data on 222 cases from this study found individual IQ changes of as much as 30 points, but this only happened for 5% of the sample. These five percent had drastic changes to their environment which could account for the increase. However, most participants’ IQs remained within 5 points of their original scores which is not a statistically significant change. This provides further evidence for the idea that intelligence is fairly fixed and based on a large genetic component. Clearly, genetics does not explain everything, but researchers have found stronger evidence for the role of heredity than for the environment in recent years.

Recent research has also focused on the idea of multiple intelligences. Often times people whose IQ scores are only average have exceptional abilities in one specific area. For example, research has focused on whether children’s performance on intelligence tests can be changed by encouraging the concept of multiple intelligences. More specifically, encouraging children to focus on domains that they are uniquely skilled in is effective in maximizing their innate abilities. For example, children with high body-kinesthetic intelligence may turn into dancers, athletes, or neurosurgeons with the proper encouragement. These results have been found for college students as well. This seems to suggest the importance of considering multiple domains of intelligence instead of just math and verbal skills. However, these variables are not usually measured on standard intelligence tests even though they are better predictors of people’s performance.

Based on these findings, an increasing number of colleges and universities are beginning to look beyond students' test scores and consider the student "as a whole." Students who are involved in several extracurricular activities are better than those who simply have high SAT scores. College is full of many learning experiences. Students who are skilled in many domains are better equipped to succeed in college than those who simply have good test scores.

In sum, research on the factors associated with intelligence test scores throws light on the conditions determining intellectual development in general. It also suggests that prediction of subsequent intellectual status can be improved if measures of multiple intelligence domains and heritability estimates are combined with traditional test scores. From still another viewpoint, the findings of this type of research point the way to how to better chart the course of intellectual development.

APPENDIX C

IMPLICIT THEORIES OF INTELLIGENCE MANIPULATION FOLLOW-UP QUESTIONS

1. How interesting was the passage you just read? (Not at all interesting—very interesting)
2. Please rate the readability of the passage. (Not at all readable—very readable)
3. How would you rate your comprehension level of the information? (I understood very little of the information—I understood nearly all of the information)
4. How much did this passage generate interest in this topic for you? (Not at all—very much)
5. Please summarize the passage in 1 sentence (free response)
6. What evidence did you find most convincing? (free response)

APPENDIX D

MATH AND VERBAL PRE-TEST QUESTIONS

1. How well do you expect to do on this test? (1=not very well 7=very well)
2. How do you think your score will compare to other UMass **women**? (1=a lot worse
4=about the same 7=a lot better)
3. How do you think your score will compare to other UMass **men**? (1=a lot worse
4=about the same 7=a lot better)
4. I am worried about taking this test (1=strongly disagree 7=strongly agree)
5. I am anxious about taking this test (1=strongly disagree 7=strongly agree)
6. I am worried that my performance will negatively reflect on women as a whole.
(1=strongly disagree 7=strongly agree)
7. I am worried I will let **myself** down if I don't do well on this test. (1=strongly disagree
7=strongly agree)

APPENDIX E

SAMPLE AND TEST MATH AND VERBAL ITEMS

(Answers are in bold)

Math Questions

** Sample Question: Saplings are to be planted 30 feet apart along one side of a straight lane 455 feet long. If the first sapling is to be planted at one end of the lane, how many saplings are needed?

- A) 18
- B) 16**
- C) $15 \frac{1}{6}$
- D) 15
- E) 14

1. If the circumference of a circle is less than 10π , which of the following could be the area of the circle?

- A) 20π**
- B) 25π
- C) 36π
- D) 81π
- E) 100π

2. A widow received $\frac{1}{3}$ of her husband's estate, and each of her three sons received $\frac{1}{3}$ of the balance. If the widow and one of her sons received a total of \$60,000 from the estate, what was the amount of the estate?

- A) \$90,000
- B) \$96,000
- C) \$108,000**
- D) \$135,000
- E) \$180,000

3. If a rectangular block that is 4 inches by 4 inches by 10 inches is placed inside a right circular cylinder of radius 3 inches and height 10 inches, the volume of the unoccupied portion of the cylinder is how many cubic inches?

- A) $6\pi - 16$
- B) $9\pi - 16$
- C) $160 - 30\pi$
- D) $60\pi - 160$
- E) $90\pi - 160$**

4. For each of n people, Margie bought a hamburger and a soda at a restaurant. For each of n people, Paul bought 3 hamburgers and a soda at the same restaurant. If Margie spent a total of \$5.40 and Paul spent a total of \$12.60, how much did Paul spend just for hamburgers? (Assume that all hamburgers cost the same and all sodas cost the same.)
- A) \$10.80
 - B) \$9.60
 - C) \$7.20
 - D) \$3.60
 - E) \$2.40
5. What is the perimeter, in meters, of a rectangular playground 24 meters wide that has the same area as a rectangular playground 64 meters long and 48 meters wide?
- A) 112
 - B) 152
 - C) 224
 - D) 256
 - E) 304
6. Joan earned twice as much as Bill, and Sam earned \$3 more than half as much as Bill. If the amounts earned by Joan, Bill, and Sam are j , b , and s , respectively, which of the following is a correct ordering of these amounts?
- A) $j < b < s$
 - B) $j < s < b$
 - C) $b < j < s$
 - D) $b < s < j$
 - E) **It cannot be determined from the information given.**
7. The average (arithmetic mean) of five numbers is 25. After one of the numbers is removed, the average (arithmetic mean) of the remaining numbers is 31. What number has been removed?
- A) 1
 - B) 6
 - C) 11
 - D) 24
 - E) It cannot be determined from the information given.
8. If $3x + 1$ represents an odd integer, which of the following represents the next larger odd integer?
- A) $3(x + 1)$
 - B) $3(x + 2)$
 - C) $3(x + 3)$
 - D) $3x + 2$
 - E) $3(x + 2) + 1$

9. If t tablets cost c cents, then at this rate how many cents will 5 tablets cost?

- A) $5ct$
- B) $5c/t$**
- C) $c/5t$
- D) $5t/c$
- E) $t/5c$

10. If a , b , and c are consecutive positive integers and $a < b < c$, which of the following must be an odd integer?

- A) abc
- B) $a + b + c$
- C) $a + bc$
- D) $a(b + c)$
- E) $(a + b)(b + c)$**

11. A certain integer n is a multiple of both 5 and 9. Which of the following must be true?

- I. n is an odd integer
- II. n is equal to 45.
- III. n is a multiple of 15.

- A) III only**
- B) I and II only
- C) I and III only
- D) II and III only
- E) I, II, and III

12. If $a + b = 10$, then $(a + b/2) + (b + a/2) =$

- A) 5
- B) 10
- C) 15**
- D) 20
- E) 25

13. A board of length L feet is cut into two pieces such that the length of one piece is 1 foot more than twice the length of the other piece. Which of the following is the length, in feet, of the longer piece?

- A) $(L + 2)/2$
- B) $(2L + 1)/2$
- C) $(L - 1)/3$
- D) $(2L + 3)/3$
- E) $(2L + 1)/3$**

14. The buyer of a certain mechanical toy must choose 2 of 4 optional motions and 4 of 5 optional accessories. How many different combinations of motions and accessories are available to the buyer?

- A) 8
- B) 11
- C) 15
- D) 20
- E) 30**

15. A distillate flows into an empty 64-gallon drum at spout A and out of the drum at spout B. If the rate of flow through A is 2 gallons per hour, how many gallons per hour must flow out at spout B so that the drum is full in exactly 96 hours?

- A) $\frac{3}{8}$
- B) $\frac{1}{2}$
- C) $\frac{2}{3}$
- D) $\frac{4}{3}$**
- E) $\frac{8}{3}$

Verbal Questions

**Sample Question: Science advances in _____ spiral in that each new conceptual scheme _____ the phenomena explained by its predecessors and adds to those explanations.

- A) a discontinuous...decries
- B) a repetitive...vitiates
- C) a widening...embraces**
- D) an anomalous...captures
- E) an explosive...questions

1. People frequently denigrate books about recent catastrophes as morally _____ attempts to profit from misfortune, but in my view our desire for such books, together with the venerable tradition to which they belong, _____ them.

- A) inopportune...encourages
- B) fortuitous...fosters
- C) treacherous...safeguards
- D) despicable...legitimizes**
- E) corrupt...generates

2. Aalto, like other modernists, believed that form follows function; consequently, his furniture designs asserted the _____ of human needs, and the furniture's form was _____ human use.

- A) universality...refined by
- B) importance...relegated to
- C) rationale...emphasized by
- D) primacy...determined by**
- E) variability...reflected in

3. The demise of the rigorous academic curriculum in high school resulted, in part, from the progressive rhetoric that _____ the study of subjects previously thought _____ as part of school learning.
- A) advocated...necessary
 - B) enhanced...indispensable
 - C) restricted...impractical
 - D) undermined...popular
 - E) **sanctioned...inappropriate**
4. Business forecasts usually prove reasonably accurate when the assumption that the future will be much like the past is _____; in times of major _____ in the business environment, however, forecasts can be dangerously wrong.
- A) specified...discontinuities
 - B) questioned...surges
 - C) contradicted...improvements
 - D) entertained...risks
 - E) **satisfied...shifts**
5. Histocompatibility antigens that attack foreign tissue in the body cannot have been _____ through evolution expressly to _____ organ transplantation; on the contrary, they have been found to facilitate many essential biological functions.
- A) **conserved...foil**
 - B) produced...aid
 - C) developed...enhance
 - D) selected...promote
 - E) designed...retain
6. In the absence of any _____ caused by danger, hardship, or even cultural difference, most utopian communities deteriorate into _____ but enervating backwaters.
- A) turmoil...frantic
 - B) **stimulation...placid**
 - C) amelioration...ignorant
 - D) decimation...intrusive
 - E) mistrust...naïve
7. Although in eighteenth-century England an active cultural life accompanied by the beginnings of middle-class consumerism, the _____ of literacy was _____ with the rise of such consumerism in the different areas of the country.
- A) repudiation...reconciled
 - B) renewal...inconsistent
 - C) promotion...combined
 - D) spread...compatible
 - E) **degree...uncorrelated**

8. The painting was larger than it appeared to be, for, hanging in a darkened recess of the chapel, it was _____ by the perspective.
- A) improved
 - B) aggrandized
 - C) embellished
 - D) jeopardized
 - E) diminished**
9. Even though they tended to be _____ strangers, fifteenth-century Europeans did not automatically associate _____ and danger.
- A) trusting of...diversity
 - B) haughty with...nonconformity
 - C) hostile to...foreignness**
 - D) antagonistic to...rudeness
 - E) interested in...enmity
10. The characterization of historical analysis as a form of fiction is not likely to be received _____ by either historians or literary critics, who agree that history and fiction deal with _____ orders of experience.
- A) quietly...significant
 - B) enthusiastically...shifting
 - C) passively...unusual
 - D) sympathetically...distinct**
 - E) contentiously...realistic
11. Like many eighteenth-century scholars who lived by cultivating those in power, Winckelmann neglected to neutralize, by some _____ gesture of comradeship, the resentment his peers were bound to feel because of his _____ the high and mighty.
- A) quixotic...intrigue with
 - B) enigmatic...familiarity with
 - C) propitiatory...involvement with**
 - D) salutary...questioning of
 - E) unfeigned...sympathy for
12. In a _____ society that worships efficiency, it is difficult for a sensitive and idealistic person to make the kinds of _____ decisions that alone spell success as it is defined by such a society.
- A) bureaucratic...edifying
 - B) pragmatic...hardheaded**
 - C) rational...well-intentioned
 - D) competitive...evenhanded
 - E) modern...dysfunctional

13. While it is assumed that the mechanization of work has a _____ effect on the lives of workers, there is evidence available to suggest that, on the contrary, mechanization has served to _____ some of the traditional roles of women.

- A) salutary...improve
- B) dramatic...undermine
- C) benign...revise
- D) debilitating...weaken
- E) revolutionary...reinforce**

14. A _____ acceptance of contemporary forms of social behavior has misled a few into believing that values in conflict with the present age are for all practical purposes _____.

- A) casual...reliable
- B) superficial...trenchant
- C) complacent...superseded**
- D) cautious...redemptive
- E) plaintive...redundant

15. Ever prey to vagrant impulses that impelled him to _____ his talents on a host of unworthy projects, his very _____ nonetheless enhanced his reputation, for the sheer energy of his extravagance dazzled observers.

- A) undermine...enthusiasm
- B) isolate...selectiveness
- C) display...affability
- D) squander...dissipation**
- E) implicate...genius

APPENDIX F

IMPLICIT THEORY MANIPULATION CHECKS

1. How would you rate these math questions overall? (1=very easy 7=very difficult)
2. How confident are you in your answers for the math test? (1=not at all confident 7=very confident)
3. How do you think your actual performance on the math test compares to other UMass **women**? (1=a lot worse 4=about the same 7=a lot better)
4. How do you think your actual performance on the math test compares to other UMass **men**? (1=a lot worse 4=about the same 7=a lot better)
5. How much was your test performance due to your motivation, your effort, the difficulty of the test, your mood, your interest in the task, luck, your concentration, your understanding of the task, practice, your intellectual ability, and your skills? (7 point rating scales—not at all-very much so)
6. If you were to take the math test again, how much would you prefer simple and easy problems? (7 point rating scales 1=not at all 7=very much so)
7. If you were to take the math test again, how much would you prefer relatively difficult and challenging problems? (7 point rating scales 1=not at all 7=very much so)

APPENDIX G

WRITING TASK SCENARIO

Jen is a college junior who interns for a large company. Sometimes she feels like she doesn't get the respect she deserves, like when her ideas aren't taken seriously at the weekly staff meeting. On the other hand, people have often commented on how she works really hard and puts in long hours to get the job done. Jen wishes she could have more responsibilities—maybe then she could finally prove herself. The tide may be slowly turning—last week she was asked to read through and edit a project for the company.

The company has not had a good history of retaining its interns, mostly because of the low pay. Because of this, the word around the office is that one of the interns will be fired so that the company can increase the salaries of the remaining interns. Jen's boss emailed all the interns to set up individual meetings with them. Jen's meeting is at 2:00 this afternoon.

What happens next? Please write 3 paragraphs, focusing on what Jen will do, say, think, and feel as the story continues.

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