2012

Reconsidering Math Gender Stereotypes in a Single-Gender College Context: A Study of Female Psychology & Neuroscience Majors

Julia Martin
Wellesley College, jmartin2@wellesley.edu

Reconsidering Math Gender Stereotypes in a Single-Gender College Context:

A Study of Female Psychology & Neuroscience Majors

Julia Martin

Submitted in Partial Fulfillment
of the
Prerequisite for Honors
in Wellesley College's Psychology Dept.

April 2012

Acknowledgements

This thesis would not have been possible without the support, guidance, and encouragement of my advisor, Dr. Nancy Genero. I am also thankful to Drs. Margery Lucas and Angela Bahns for their comments on an earlier draft. Lastly, I would like to thank the Wellesley College Psychology Department for their support of this research.

Abstract

Survey data collected from 67 female college students attending a prestigious single-gender institution were examined in order to ascertain to what degree women in a single-gender college environment are aware of math gender stereotypes. The results indicate that the majority of the participants were aware of a math gender stereotype. Furthermore, participants also reported awareness of three different stereotype categories: traditional math gender, competitive, and negative personal characteristics. An association was found between stereotype category and college major, whereby a higher percentage of psychology majors reported awareness of both the traditional math gender and competitive stereotypes compared to neuroscience majors. Additionally, the stereotype category with which one reported an awareness had several implications, the most notable of which being that individuals who reported an awareness of a competitive stereotype also reported a higher mean level of work-related stress. A predictive relationship was also found to exist between the competitive stereotype category and work-related stress. The implications of these results are discussed.

Reconsidering Math Gender Stereotypes

Gender: A Meaningful Construct?

Humans have an innate tendency to categorize people, objects, and ideas and to then compare the subsequent groups across a range of characteristics (Gabora, Rosch, & Aerts, 2008). Thus, it is only natural that one of the first categories to which an individual is introduced, gender, is also one of the most researched areas in psychology (e.g., Anderson & Leaper, 1998; Archer, 2004; Kling, Hyde, Showers, & Buswell, 1999; Konrad, Ritchie, Lieb, & Corrigall, 2000; Su, Rounds, & Armstrong, 2009). Countless studies have been conducted on differences between the genders, and meta-analyses have revealed moderate to strong effect sizes in several domains.[1] A meta-analysis by Su, Rounds, and Armstrong (2009) on gender differences in interests showed that men tend to prefer to work with objects rather than people (d = 0.93) and that men also have interests in more realistic, less imaginative subject matters (d = 0.84). Furthermore, women tend to have a greater interest in social activities (d = -0.68), and on average, women also have more artistic interests (d = -0.35).[2] Moderate to strong effect sizes favoring males were found for interest in science (d = 0.36), mathematics (d = 0.34), and engineering (d = 1.11). In a meta-analysis on gender differences in job attribute preferences, men were found to prefer jobs that allowed them to work alone (d = 0.26) and were leisurely (d = 0.25), whereas women preferred jobs that offered the opportunity to make friends (d = -0.35) and to work with others (d = -0.22; Konrad et al., 2000).

Apart from gender differences in preferences, meta-analyses have also suggested that men and women may differ on several social and personality variables. Men self-report more physical (d = 0.39) and verbal aggression (d = 0.30) than women, and in addition, men are also reported by peers as more physically (d = 0.84) and verbally aggressive (d = 0.51) than women (Archer, 2004). In addition to being more aggressive, males are more likely to use intrusive interruptions during conversation (d = 0.33; Anderson & Leaper, 1998). Men also appear to have slightly higher self-esteem than women (d = 0.21), with the greatest difference emerging between the ages of 15-18 (d = 0.33; Kling et al., 1999).

Some researchers have taken the existence of such gender differences in behavior and personality as evidence for the theory of biological determinism, the view that biological or genetic factors are the primary source of behavioral differences between individuals (Malott, 2007). In the recent book *The Female Brain*, for instance, Dr. Louann Brizendine (2006) theorized that men and women have fundamental neurological differences, particularly in relation to their hormonal makeup and brain structure, and that as a result of these differences men and women will inevitably behave in different manners. Brizendine's (2006) deterministic view of gender, however, is not one that is readily endorsed by all psychologists.

In a review of the book, Else-Quest (2007), for instance, dismissed the work and other similar writings as unsubstantiated and inaccurate, pointing to a meta-analysis by Hyde (2007) that revealed little difference between the genders in as many domains as there are established gender differences. In this meta-analysis by Hyde (2007), 46 meta-analyses were included, and of those 46 meta-analyses, 48% were found to have a small effect size (d < 0.20) and 30% were close to zero. Hyde (2007) and Else-Quest (2007) both interpreted these small effect sizes as evidence for Hyde's (2005) "gender similarities hypothesis," the idea that men and women are similar across the vast majority of psychological variables. Additionally, Hyde (2007) argued that gender should also be regarded as a "social-stimulus variable," whereby an individual's gender influences people's behavior toward them. For instance, research participants in one study evaluated an infant's crying differently based upon whether they were told that the baby was male or female. If told that the infant was male, its crying was interpreted as a sign of anger, but if led to believe that the infant was female, its crying was perceived as an indication of fear (Condry & Condry, 1976).

In spite of what Else-Quest's (2007) review of *The Female Brain* might lead one to believe, Brizendine (2006) is neither the first nor the only person to argue that gender differences in neuroanatomy and neurophysiology exist and that as a consequence men and women are predisposed to behave and think in different ways. Numerous neurological studies have in fact shown that the very structure of the brain differs between males and females. The brain, for example, is approximately 10% larger in men than in women (e.g., Dekaban & Sadowsky, 1978). Gender differences have also been documented with respect to neuron density (Witelson, Glezer, & Kigar, 1995), and certain structures in the female brain are smaller or even completely absent in the male brain (Allen & Roger, 1991). Although the precise behavioral implications of these disparities are unknown, these findings are nonetheless important, because they indicate that there are gender differences in neuroanatomy (Sax, 2001).

More recently, fMRI studies have shown that in addition to men and women differing in certain aspects of neuroanatomy, the two genders also display differences in brain activation during certain tasks (Garn, Allen, & Larsen, 2009; Grön, Wunderlich, Spitzer, Tomczak, & Riepe, 2000; Gur et al. 2000; Hugdahl, Thomsen, & Ersland, 2006; Nowak, Resnick, Elkins, & Moffat, 2011). Garn et al. (2009) found that different regions of the brain are activated in men and women when performing an object-naming task involving plants and tools. Hugdahl et al. (2006) reported that different regions of the brain are activated in men and women when performing a mental rotation task; similarly, Gur et al. (2000) found gender differences in regional activation during verbal and spatial tasks. Furthermore, when completing spatial tasks involving navigation through a computerized maze, gender differences in regional activation of the brain once again appear (Nowak et al., 2011; Grön et al., 2000). As with gender differences in neuroanatomy, the exact implication of gender differences in brain activation during certain tasks is not yet known, but once again, the fact that there are any gender differences is in itself an important finding.

Leonard Sax (2010) argues that there is one gender difference with clear implications: auditory functioning. Research has shown that women are more sensitive to a given range of tones than men (Sagi, D'Alessandro, & Norwich, 2007). Furthermore, the most comfortable listening level for women is 6 decibels lower than that for men, and females' tolerable level of background noise is 7 decibels lower than that for males. Thus, men prefer louder speakers and are able to tolerate more background noise than women (Rogers, Harkrider, Burchfield, & Nabelek, 2003). This difference in noise and background tolerance clearly has relevance outside the laboratory, such as in school or the workplace. Women, presumably, are going to prefer a quieter environment if they have a higher sensitivity to noise.

Gender and the STEM Fields

One area in particular in which these gender differences in neuroanatomy, brain activation, and perception are being debated is the domain of science, technology, engineering, and math – often referred to as the STEM fields. In 2004, female undergraduate students earned 46% of the degrees in math, 25% of the degrees in computer science, 22% of the degrees in physics, and 21% of the degrees in engineering. This trend of female underrepresentation in the STEM fields continues into the postgraduate level, where in 2004 women earned less than 33% of all the doctoral degrees in chemistry, computer science, math, physics, and engineering (Halpern et al. 2007). This gender discrepancy in the STEM fields is further attested to by the fact that only 26% of the science and engineering workforce is comprised of women (Halpern et al., 2007). While these statistics make it clear that women are indeed underrepresented in the areas of math and science, they fail to explain why so few women are pursuing study in math or science-related fields. Is it the case that men are simply better at math and science due to some neurological difference, such as those that have been previously discussed, or is something else at work?

Gender and Mathematics Performance

A meta-analysis of 78 different studies on gender differences in spatial abilities by Voyer, Voyer, and Bryden (1995) revealed that men tend to outperform women in tasks involving mental rotation, a cognitive difference which would seemingly give them the edge over women in mathematics, particularly in such sub-disciplines as geometry, where the ability to visualize and mentally manipulate various shapes and objects is a must. This effect of gender on one's ability to mentally rotate objects was strong across all ages ($d = 0.56$), but it became even stronger among individuals over 18 years of age ($d = 0.66$). This gender gap, however, does not appear to extend to overall math performance. In a recent cross-national meta-analysis, the weighted mean effect size of the gender difference in performance on an international mathematics assessment test was $d = -0.01$, indicating no statistical difference in performance between men and women on the test (Else-Quest, Linn, & Hyde, 2010). Likewise, in a second meta-analysis on differences in math performance between the genders, an overall effect size of $d = 0.05$ was found, suggesting once again that men and women are performing similarly on mathematical tasks (Lindberg, Shibley, Hyde, Petersen, & Linn, 2010).

Although Else-Quest et al. (2010) and Lindberg et al. (2010) might have concluded that there is no significant overall difference between the genders in terms of mathematical performance, there are two points that must be stressed. First, a small or negligible effect size does not necessarily equate to an absence of real-world significance; under certain contexts, a small effect size might be considered important (Coe, 2002). For instance, if in a clinical trial, a drug was shown to improve symptoms even by an effect size of only 0.1, that improvement could still be seen as meaningful enough to justify the use of the drug. Regardless of the strength of the effect size, a person taking the drug would have a better chance of alleviating their symptoms than someone who is not taking it, especially if clinical improvement due to the drug is difficult to detect. Furthermore, as Coe (2002) points out, small effect sizes can especially bring about change when they are cumulative over time. Thus, although Lindberg et al. (2010) found that men were only outperforming women in math by an effect size of 0.05, if women continue to underperform relative to men, that "small" effect size could be indicative of a consistent gender difference over time.

Furthermore, even if one believes that small effect sizes render differences unimportant, one cannot ignore the fact that the individual studies included in the meta-analyses by Lindberg et al. (2010) and Else-Quest et al. (2010) varied considerably in their reported effect sizes. In the meta-analysis by Else-Quest et al. (2010), for instance, the effect sizes of the included studies ranged from d = -0.42 to d = 0.40. This range in reported effect sizes means that while some researchers have concluded that men outperform women on mathematical assessments, others have found either no difference between the genders or a difference that favors women. If one considers this range in effect sizes for gender differences in math performance, as well as the idea that small effect sizes may have important behavioral implications, then what these meta-analyses really demonstrate is that there is actually no consensus on whether or not women underperform in math relative to men. In samples of women that do underperform relative to men, it is possible that the source of underperformance may be a combination of individual differences and sociocultural factors, including math gender stereotypes.

Gender Differences in Attitudes toward Math

One such individual difference variable contributing to the underperformance of women on mathematical tasks could be a given woman's attitudes toward math. Starting in as early as third grade, girls may become less confident in their math skills (Herbert & Stipek, 2005), and lack of confidence in math has been found to be negatively correlated with interest in scientific careers (Chipman, Krantz, & Silver, 1992). In a longitudinal study by Herbert and Stipek (2005), 234 students in kindergarten and 144 students in first grade were asked to rate their own abilities in math, and in third and fifth grade, they were asked to rate themselves again. In kindergarten and first grade, the boys and girls rated themselves similarly, but in third grade, the girls rated their math skills significantly lower than the boys, even though there was no gender difference in mathematical achievement or in teachers' ratings of the math abilities of their students. Then in fifth grade, girls began to actually perform worse than boys on mathematical assessments. Attitudinal changes, therefore, preceded the actual decrease in math achievement among girls.

This lack of confidence in mathematical ability is not only apparent in elementary-aged girls but also in young women, as Hyde, Fennema, Ryan, Frost, and Hopp (1990) illustrated in their meta-analysis of 70 studies (63,229 research participants) on mathematics attitudes and affect. Among all ages of research participants, women were more likely to view math as a male domain (d = -0.90), and this difference was even more pronounced within the 15-18 age group (d = -1.27). Women in the 15-18 age group also displayed less confidence in their math skills than men (d = -0.25). Men in both the 15-18 and 19-25 age groups had greater math self-concepts than women (d = 0.27, d = 0.28, respectively), and 19-to-25-year-old men were also less anxious about math than women (d = 0.20). The effect sizes for these same variables were much weaker among younger participants; therefore, not only do a lack of confidence and overall negative attitude toward math among women continue into early adulthood but the effect sizes for these effects are strongest among women in early adulthood.

In addition to revealing moderate to strong effect sizes in several variables regarding mathematics attitudes, the meta-analysis by Hyde et al. (1990) also showed that women of all ages are less likely than men to attribute success in math to ability (d = 0.35) but are more likely to attribute failure in math to a lack of ability (d = -0.23). The latter was especially true among women between the ages of 15 and 18 (d = -0.39). The idea that women attribute failure in math to a lack of ability ties in with research on the perception of intellectual ability as a fixed entity (e.g., Dweck 2007). An individual who views intellectual abilities, such as the capacity to comprehend math, as fixed entities believes that intellectual abilities are innate and incapable of being cultivated. According to this view, if one were not to understand math, it would be because one lacks the innate ability to understand it. Dweck (2007) found that by the end of the eighth grade, those girls who believed that intellectual abilities were fixed had significantly lower math grades than boys. Those girls, however, who viewed intellectual abilities as skills that could be developed through practice and dedication, performed significantly better than their fixed ability counterparts and practically eliminated the gender gap in math grades.

A girl's teacher or parent may unintentionally reinforce the idea of intellectual abilities as a "gift" through the manner in which they choose to praise her. It is customary when praising an individual to emphasize his or her talent or ability at the task, but research suggests that this ability-centered praise may be detrimental by instilling the view that one achieves success through ability rather than through effort and determination (Corpus & Lepper 2007; Kaminis & Dweck, 1999). In a recent study by Corpus and Lepper (2007) the effects of various types of praise on girls' motivation were investigated. In their study, 93 fourth- and fifth-grade children (44 girls and 49 boys) completed mathematical tasks in the form of two tangram puzzle sets, one that was moderately easy and one that was extremely difficult. The set of difficult tangrams was designed to be too hard for the children to complete so that the children would experience failure. Following completion of the easy tangram, children received ability praise (e.g., "You must be really good at puzzles!"), product praise (e.g., "Nice job on that one."), process praise (e.g., "You're really thinking!"), or neutral feedback (e.g., "OK"); in the difficult tangram task, the children received only the neutral feedback. After both the easy (i.e., success experience) and difficult (i.e., failure experience) tangram had been completed, children were given five minutes to play with an array of objects, including a set of tangrams. The amount of time children spent playing with the tangrams was taken to be an indicator of free-choice motivation, and short- and long-term motivation were measured by offering the children the opportunity to take home a personal tangram set. Although there were no main effects or interactions for free-choice motivation, girls were more likely to take home a personal tangram set when offered if they had received product or process praise rather than neutral or person praise ($p < .05$, partial $\eta^2 = .22$, $r = 0.47$). Furthermore, this interaction between type of feedback and type of take-home gift was maintained several weeks later when the children were asked to make a final selection of which item they wanted as a gift: once again, girls showed greatest preference for tangrams when they had received product or process praise ($p < .05$, partial $\eta^2 = .22$, $r = 0.47$).

As Corpus and Lepper (2007) argue, if one accepts the premise that tangrams are a mathematical task, then the results of their experiment suggest that ability-oriented praise may be especially detrimental to girls' motivation when completing mathematical tasks. In particular, ability-oriented praise reinforces the idea that intellectual abilities are fixed. Thus, in a mathematical context, ability-oriented praise may support the cultural stereotype that girls simply lack the intellect to perform well in mathematics. When this stereotype becomes activated, girls become more vulnerable to low-ability inferences and might become less motivated to complete the mathematical task at hand. This idea proposed by Corpus and Lepper (2007) derives from research on stereotype threat.

Stereotype Threat & Its Implications for Women in Relation to Mathematics

Stereotype threat refers to a situational phenomenon wherein an individual feels threatened and fears that their behavior or performance on a certain task will confirm to both themselves and others a negative stereotype about a group with which they identify (Huguet & Régner, 2009; Inzlicht & Ben-Zeev, 2000; Steele & Carr, 2009). In the case of women, a commonly held stereotype in Western society is that women are inferior to men in mathematical comprehension and performance. The theory of stereotype threat predicts that women would become more anxious about their performance and consequently perform more poorly on a given mathematics assessment in situations where the gender stereotype is made salient (Spencer, Steele, & Quinn, 1999). Spencer et al. (1999) showed that this was the case; women do in fact perform significantly worse than men on a math assessment when the stereotype about their gender's inferior math ability is made salient.

In the study by Spencer et al. (1999), 24 high-achieving men and 30 high-achieving women, where high achievement was classified as a score above the 85th percentile on the math subsection of the SAT, completed two difficult 15-minute math tests in a mixed-gender context. In addition, salience of the gender stereotype about math performance was manipulated by informing half of the participants that the first test had previously elicited gender differences and that the second test had revealed no gender differences. The other half of participants was told the opposite (i.e., the first test had shown no gender differences, while the second test had). Since the two tests proved to not be equally difficult, Spencer et al. (1999) focused on data from the first test. When participants were told that the test had revealed gender differences, women performed significantly worse than men. Women, however, performed as well as men when told that the test had previously yielded no gender differences. These results indicate that when in a context where the gender stereotype concerning math is made salient, women will greatly underperform on a mathematics assessment relative to men.

Similarly, Rivardo, Rhodes, Camaione, and Legg (2011) found that when stereotype threat was activated by informing participants prior to completing a math test that men typically outperformed women, women not only performed more poorly than men but also attempted fewer problems. In addition to affecting performance, stereotype threat has also been found to influence women's adopted performance goals in a math-related context (Smith

2006). The primary aim of Smith's (2006) study was to determine whether women would be more likely to adopt performance-avoidance goals or performance-approach goals in a context in which the math gender stereotype was made salient. Performance-avoidance goals reflect the desire to avoid demonstrating incompetence at a given subject (e.g., not wanting to receive a low score on a math test), whereas performance-approach goals reflect the wish to prove competence at a given subject (e.g., wanting to receive a high score on a math test). Previous research has shown that performance-avoidance (PAV) goals are less advantageous than performance-approach (PAP) goals, as they have been found to lead to poor performance and low levels of task motivation (e.g., Elliot & McGregor, 2001). When women are in a context in which the math gender stereotype is made salient, they are more likely to adopt PAV goals, which in turn, contribute to women's poor performance on math tasks under stereotype threat (Smith 2006).

Research by Inzlicht and Ben-Zeev (2000) further expands this understanding of stereotype threat in relation to women's math performance by showing that simply placing females in a context in which they are outnumbered by males is enough to induce stereotype threat and to worsen their math performance. In the study by Inzlicht and Ben-Zeev (2000), participants were placed in one of three conditions: female minority, female majority, and all-female. Participants were then asked to complete a math assessment, and unlike in Rivardo et al. (2011) and Spencer et al. (1999), the experimenters did not inform the participants that the test had previously revealed gender differences. In other words, the only inducer of stereotype threat was the relative number of men present in the room during the math test. As predicted, women performed best in an all-female context, followed by a mixed-gender context in which women were the majority; women scored the worst in the minority condition. These findings show that math stereotype threat can be induced in women merely by being outnumbered by men, and furthermore, these results indicate that women's performance on a mathematical assessment decreases as the relative number of men present increases.

The activation of math stereotype threat in women is not limited to experimental contexts. In a study by Huguet and Régner (2007), 454 middle-school students (223 girls and 231 boys) attending French coed public schools were met in their regular classroom by two experimenters (one man and one woman), who then informed the students that they would complete a geometry test in which they would be shown a complex figure and then asked to reconstruct the figure from memory. Prior to completing the test, each class of children was divided into either two mixed-gender or two same-gender subgroups of 10 to 14 students, which resulted in a quasi-ordinary classroom context (i.e., "as close as possible to normal classroom conditions"). Girls performed the best (i.e., were better able to reconstruct the geometrical shape) in the same-gender context than when in the mixed-gender context. Additionally, both boys and girls perceived the task as more difficult in the mixed-gender condition compared to the same-gender condition. Perhaps the most interesting results, however, were acquired through a nomination task in which students were asked to give the name of a student who was "low ability" and another who was "high ability." Girls in the same-gender condition were more likely to nominate female rather than male students as high ability compared to girls in the mixed-gender condition. The results from this nomination task as well as those from the geometry task indicate that the math stereotype threat is capable of being activated in women outside the laboratory.

In addition, research has also indicated that even those women who hold counter-stereotypic beliefs in math can be affected by stereotype threat (Huguet & Régner, 2009). In Huguet and Régner's (2009) study, 199 middle school students (92 girls and 107 boys) were shown a geometric shape and subsequently asked to reconstruct it from memory. Half of the participants were told that the task would measure their ability in drawing; the other half was told that the task would measure their ability in geometry. Following completion of the task, the students were asked to rate the geometry ability of each gender in their age group and to self-evaluate their own geometry skills. Although girls on average reported counter-stereotypic beliefs, they self-evaluated more negatively than boys in geometry, and they performed more poorly on the recall task when told that it was assessing their geometry ability. Thus, in spite of holding counter-stereotypic beliefs, both the girls' performance and self-evaluations were being detrimentally affected by stereotype threat: once they were told the task was math-related, their performance and confidence in their own skills decreased.

Even among high-achieving female college students, stereotype threat can still affect math performance and achievement (Good, Aronson, & Harder, 2008). Good et al. (2008) induced stereotype threat in female college students who were currently enrolled in an advanced-level calculus course and planning on pursuing careers in the STEM fields. Just as in previous research on women who were not necessarily high-achieving in mathematics had shown (Huguet & Régner, 2009; Huguet & Régner, 2007; Inzlicht and Ben-Zeev, 2000; Rivardo, Rhodes, Camaione, and Legg, 2011), the high-achieving women underperformed relative to men and relative to women who were in a non-stereotype threat condition. Specifically, the female students attempted fewer problems than the male students in the stereotype threat condition. The results of Good et al. (2008) when considered in conjunction with those of Huguet and Régner (2009), indicate that even women who not only claim to disbelieve the math gender stereotype but are also in the upper tier of math performance for their gender are still vulnerable to the effects of negative stereotypes.

In opposition to stereotype threat is the concept of social facilitation. While stereotype threat is about differences between groups and how awareness of those differences influences behavior, social facilitation is about similarity between individuals and how that similarity affects behavior. Social facilitation asserts that when similar individuals work together under evaluative conditions, their performance improves (Arterberry, Cain, & Chopko, 2007). Early research on social facilitation focused on the mere presence of others and concluded that an individual's performance on a task will improve when among others, provided that the task is well-learned (Zajonc, 1965; Matlin & Zajonc, 1968). Subsequent research has investigated the role of context on social facilitation and has found that people perform best when in the presence of similar others, including when similarity is defined by gender (Corston & Colman, 1996). In Corston and Colman's (1996) study, male and female participants completed a computer task in one of six conditions: females alone, males alone, females with a female audience, females with a male audience, males with a female audience, and males with a male audience. Both male and female participants scored slightly higher when in the presence of a male audience than when alone, but when female participants were in the presence of a female audience, they scored significantly higher than when they were alone or in the presence of a male audience. The fact that being in a single-gender environment improved the participants' performance, especially for female participants, provides evidence of social facilitation.

Competence Perception: The Link between Attitude, Motivation, Stereotypes, & Performance in Math

As described in previous sections of this paper, the variation in mathematical performance and achievement among women can be partially explained by women's attitudes which are reinforced by cultural contexts (Chipman et al., 1992; Herbert & Stipek, 2005; Hyde et al., 1990), motivation (Corpus & Lepper, 2007; Dweck, 2007; Kaminis and Dweck, 1999), and through the gendered math stereotype threat (Inzlicht & Ben-Zeev, 2000; Good et al., 2008; Huguet and Régner 2007; Rivardo et al., 2011; Smith, 2006; Spencer et al., 1999;). What remains to be discussed is how the interplay among attitudes, motivation, and stereotype threat influences performance and achievement; the answer may be found in the construct of competence beliefs (Elliott & Dweck, 2005). At its core, the construct of competence perception involves an individual's perceived ability to learn or perform behaviors at designated levels (Bandura, 1997). According to Bandura (1986), an individual's motivation and accomplishment are based not on their actual competence but rather on their perceived self-efficacy. The idea that an individual's beliefs about themselves might have more influence on their behavior than their actual competence would explain why a person's performance on a task is not always consistent with their actual ability (Schunk & Pajares, 2005). For instance, a gifted woman may score poorly on a math assessment when led to believe that the exam has previously shown gender differences in achievement (Good et al., 2008). In this example, when a woman is told that men and women have performed differently on a math assessment, stereotype threat will be activated, which subsequently lowers her confidence in her own math abilities and will ultimately lead to poor performance on the math test. Thus, stereotypes do not directly affect performance; rather, they decrease one's perception of their competence at a particular task, which in turn, can weaken their performance at that task (Aronson & Steele, 2005).

Research by Pietsch, Walker, and Chapman (2003) provides supporting evidence for the role of perceived self-efficacy as a predictor of mathematical performance. Four hundred and sixteen high school students completed a questionnaire designed to measure self-efficacy for mathematics. The questionnaire contained items that assessed their ability to perceive both general results (e.g., "I am able to achieve high grades in mathematics") and specific results ("I am able to achieve at least a 90% in my mathematics course this year") in math. A student's level of perceived self-efficacy was indeed found to be predictive of their performance in mathematics: those students who had higher levels of perceived self-efficacy performed better on the final exam than those with lower perceived self-efficacies.

The key to increasing or maintaining a higher level of math performance and achievement among women, therefore, is to help female students achieve high perceived self-efficacy for mathematic abilities. In order to boost women's perceived confidence in math, all the contributing factors to self-efficacy (e.g., attitude, motivation, and stereotypes) must be considered. Aronson and Steele (2005) suggest that one way to increase performance of stereotype-vulnerable individuals, such as women, is to establish a cooperative learning environment. Aronson's research on the "Jigsaw Classroom," a classroom approach in which students must work with and depend upon one another to learn the classroom material, showed the benefits of a cooperative environment within a mixed-group setting: increased self-esteem, grades, and overall satisfaction with the class among minority students (Aronson & Steele, 2005). Thus, if one wishes to increase women's perceived self-efficacy in mathematics, one would have to establish a sense of cooperation within the math class.

The Single-Gender Classroom

The single-gender classroom is an environment that may provide individuals with a sense of community and cooperation that may effectively reduce feelings of threat and anxiety and improve learning and achievement (Sax, Arms, Woodruff, Riggers, & Eagan, 2009; Streitmatter, 1997; U.S. Department of Education, 2008). Lee and Bryk (1986), in a survey of 1087 students from 45 single-gender schools and 30 coeducational schools, found that students attending single-gender institutions held more positive attitudes toward academics and expressed greater interest in the subjects of math and English than their coeducational counterparts. Furthermore, students from the single-gender high schools tended to have higher achievement, particularly during the sophomore year, than students from the coeducational high school, and they held fewer stereotypic attitudes concerning gender roles than their coed peers. A longitudinal follow-up study of Lee and Bryk (1986) by Lee and Marks (1990) concluded that many of the effects of attending a single-gender high school are long-lasting. The women who had attended single-gender high schools held higher educational aspirations than those who had attended a coed high school, and they were more likely to be satisfied with both the academic and nonacademic aspects of their college experiences. Furthermore, female graduates of single-gender high schools held significantly less stereotypic attitudes about the role of women in the workplace compared to their coed counterparts. Other research has since suggested that men who have attended single-gender high schools also adhere less to gender roles than their coed counterparts (James & Richards, 2003). Lastly, both male and female college students who went to a single-gender high school were also more likely to be attending selective four-year schools and to be considering application to graduate or law school.

In a more recent survey study by Sax, Arms, Woodruff, Riggers, and Eagan (2009), data collected from the Freshman Survey, an annual nationwide survey completed by students entering their first year of college, was analyzed to determine how female graduates of single-gender and coeducational high schools differ in their personal characteristics and transition to college. The survey was completed by 6,552 female graduates of 225 private single-gender high schools and 14,684 female graduates of 1,169 coeducational high schools. Sax and colleagues found that women who had attended a single-gender high school exhibited higher academic engagement than their coed counterparts, and on average, they also outscored their coed counterparts on the SAT by 43 points. Additionally, female graduates of single-gender high schools were more likely to display a greater interest in graduate school and to exhibit higher levels of academic self-confidence than graduates of coed high schools. Graduates of single-gender high schools also entered college with greater confidence in their mathematical and computer abilities, and they were more likely to express an interest in pursuing a career in engineering.

Similarly, other studies have concluded that single-gender education fosters positive attitudes toward and achievement in mathematics (Shapka & Keating, 2003; Shapka, 2009; Streitmatter, 1997). Shapka and Keating (2003) conducted a longitudinal study on female students from two public coed high schools (one of which offered single-gender math and science courses) to study the effect of a single-gender environment on girls' achievement in and attitudes toward math and science. The girls answered questions about a number of constructs, including their math achievement and expended effort in math at two points in time: first during 9th or 10th grade when they were enrolled in a single-gender math or science class and then again after 10th grade when they had returned to a coed class for math or science. The results of the study indicate that girls in the single-gender classes achieved at a higher rate in math in science and took more math and science courses than girls in the coed classes. Furthermore, girls in the single-gender classrooms put forth more effort in their math work than girls in the coed classrooms. Shapka (2009) suggested that all-girls instruction in math even helps to prevent the temporary decline in math achievement that is experienced by both boys and girls in a coeducational context.

Further evidence of the benefits of teaching math to girls in a single-gender classroom can be found in another longitudinal study conducted on all-girl math classes (Streitmatter, 1997). Streitmatter (1997) observed all-girl pre-algebra and algebra classes, as well as the corresponding coed classes of 7^{th} and 8^{th} grade students over a period of two years. Her observations indicated that the girls ($N = 24$) were more comfortable volunteering their thoughts and asking or answering questions in the all-girl math class than in the coed math class. Interviews conducted with the girls in the single-gender math classes revealed that the girls felt more confident in their math abilities than they had in their previous coed math classes, and they also felt a greater sense of personal freedom being in a single-gender classroom. Taken together, Sax et al. (2009), Shapka (2009), Shapka and Keating (2003), and Streitmatter (1997) indicate that a single-gender math class for girls not only increases math achievement and improves attitudes toward math but also makes girls feel less vulnerable and more confident in their mathematic abilities. Based on these studies, it would appear that a single-gender classroom is indeed an environment that is capable of increasing girls' perceived self-efficacy beliefs for math and subsequently improving their performance and achievement in math.

In spite of the abundance of research in favor of a single-gender environment for teaching math to girls, there are still many who criticize single-gender education (e.g., Halpern et al. 2011; Hilliard & Liben, 2010). The critique is based upon experimental studies in which the accessibility of gender as a social category is manipulated. For example, Hilliard and Liben (2010) observed and interviewed children from four coeducational preschool classrooms, and in two of those classrooms, gender salience was manipulated by the teachers. Teachers increased gender salience by frequently separating the children by gender, using gender-specific language (e.g., "Good morning boys and girls."), and organizing the classroom in terms of gender (e.g., having separate bulletin boards for the boys and girls). Following the gender-salience manipulation, the preschoolers were less likely to indicate that culturally stereotyped activities and occupations should be performed equally by both genders. They also reported that children in the gender salient condition were less likely to play with opposite-gender peers. One might attempt to generalize these results to single-gender education and argue that single-gender environments lead to a rise in gender stereotypes and in-group bias for one's own gender among children; however, it is important to remember that Hilliard and Liben (2010) conducted their study in a coeducational rather than single-gender classroom. As the study's environment did not duplicate that of a single-gender classroom, the study's findings should be applied to single-gender education with caution. Furthermore, since Hilliard and Liben (2010) did not conduct a follow-up study, it is not known whether the preschoolers' change in attitude toward gender is long-lasting.

In a recently published article in *Science*, Halpern et al. (2011) dismiss single-gender education as a "pseudoscience" and potentially harmful. Furthermore, although they claim that research has shown little to no advantage to single-gender education, there are numerous studies that have indicated that single-gender education can be beneficial (James & Richards, 2003;Lee and Bryk, 1986; Lee and Marks, 1990; Sax, 2009; Shapka, 2009; Shapka & Keating, 2003; Streitmatter, 1997; U.S. Department of Education, 2008).

Goals and Hypotheses of Present Study

The present study has two primary goals: 1) to determine to what extent women in a single-gender college environment are aware of math gender stereotypes and 2) to investigate how an awareness of math gender stereotypes affects women in a single-gender college environment. To ascertain its effect on women, awareness of math gender stereotypes will be examined in relation to a number of variables including stress (subdivided into overall stress, stress related to classroom relations, & stress related to work), social support within the class, engagement in the course, math competence (subdivided into math confidence and math satisfaction), and actual performance in an introductory statistics course.

Unlike the majority of previous research on math gender stereotypes, the data for the present study were collected via a survey and were gathered from women attending a single-gender college. Prior studies of the presence and effect of math gender stereotypes within all-female institutions have primarily collected data in elementary and high schools. In my review of the literature, I came across no articles on math gender stereotypes among students in all-female colleges. Thus, the present study will be investigating math gender stereotypes as they relate to a relatively unexamined subset of the female population: women currently attending a single-gender college.

I propose the following questions:

1. Are the majority of participants from the all-women's college aware of math gender stereotypes?

   a. H_1: The majority of participants (i.e., more than 50%) from an all-women's college are aware of math gender stereotypes.
2. What is the association between awareness of math gender stereotypes and math competence beliefs?
   a. H_1: Math competence is negatively associated with awareness of math gender stereotypes.
3. What is the association between awareness of math gender stereotypes and math confidence?
   a. H_1: Math confidence is negatively associated with awareness of math gender stereotypes.
4. What is the association between awareness of math gender stereotypes and math satisfaction?
   a. H_1: Math satisfaction is negatively associated with awareness of math gender stereotypes.
5. What is the association between awareness of math gender stereotypes and perceived level of social support within a math course?
   a. H_1: Perceived level of social support within a math course is negatively associated with awareness of math gender stereotypes.
6. What is the association between awareness of math gender stereotypes and engagement in a math course?
   a. H_1: Engagement in a math course is negatively associated with awareness of math gender stereotypes.

7. What is the association between awareness of math gender stereotypes and reported levels of overall stress associated with a math course?
    a. H_1: Reported levels of general stress within a math course are positively associated with awareness of math gender stereotypes.
8. What is the association between awareness of math gender stereotypes and reported levels of stress related to work?
    a. H_1: Reported levels of stress related to work are positively associated with awareness of math gender stereotypes.
9. What is the association between awareness of math gender stereotypes and reported levels of stress related to classroom relations?
    a. H_1: Reported levels of stress related to work are positively associated with awareness of math gender stereotypes.

Method

Participants

Survey data were collected from 67 students (N = 67) attending a prestigious all-women's college located in New England. Of those 67 students, 27 were majoring in psychology (n = 27), 30 in neuroscience (n = 30), and 10 in other disciplines (n = 10). Student majors in the "other" category included sociology, chemistry, mathematics, linguistics, undecided, music, and economics. Thirty students self-identified as Caucasian (n = 30), 20 as Asian (n = 20), 9 as African American (n = 9), and 4 as Hispanic (n = 4). Four of the participants (n = 4) chose not to identify their race or ethnicity. Each of the four class years was represented in the subject pool: freshmen (n = 7), sophomores (n = 17), juniors (n =

24), and seniors (n = 19). Twenty-one (n = 21) of the participants were enrolled in an introductory statistics class at the time of the survey.

Measures

A survey created especially for the present study was used to collect data (Appendix I). The survey was composed of basic demographic questions (e.g., "Year in college?" and "Please indicate your racial/ethnic background."), as well as a series of Likert-scale (e.g., "To what extent do you agree or disagree with the following statements") and open-ended questions. The Likert-scale questions asked the participants to think of either their previous experiences that they have had with math or a math course that they have taken at Wellesley, and with the experiences or course in mind, they were then asked to respond to a series of statements using an appropriate Likert scale (e.g., "strongly disagree" to "strongly agree"). These questions can be grouped into three different categories based upon the variable that they are intended to measure:

a. Math Competence: confidence in and enjoyment of math (Appendix I items 10 a-f, l); Cronbach's alpha = 0.803. A Cronbach's alpha of 0.70 or greater "suggests that the items in an index are measuring the same thing" (Vogt & Johnson 2011); thus, this scale has strong reliability.

    i. Math confidence: how confident an individual is in their mathematical or statistical skills (Appendix I items 10f, l: "I am confident that I would do well in a math or statistics course;" "Learning math has always been challenging for me"); Cronbach's alpha = 0.584. This reliability coefficient is not particularly strong, because the variable math confidence is only comprised of two items.

    ii. Math satisfaction: how much an individual enjoys or is interested in math or statistics (Appendix I items 10a, b, c, g, j: "I've always enjoyed math;" "I would only take a math or statistics course to fulfill a requirement;" "Solving a difficult math problem is a satisfying experience;" "I would rather work on a math problem than write a paper;" "What I learn in my math courses is applicable to other areas that interest me"); Cronbach's alpha = 0.783.

b. Perceived social support within math course: how supportive was the environment created within a given math or statistics course (Appendix I items 11d, e, h, i [3]: "It seemed like students really liked me;" "It felt I could relate to students in this class;" "I made new friends from taking this class;" "If I needed help, I could always count on students in this class"); Cronbach's alpha = 0.802

c. Engagement in course: how engaging was the math or statistics course and to what extent did the course shape their goals and mathematical understanding (Appendix I items 11a, b, c, g, j: "I felt engaged by this class;" "I felt my quantitative understanding improved as a result of this class;" "I didn't feel comfortable participating in class;" "I became more confident as a result of this class;" "This class helped shape my academic goals"); Cronbach's alpha = 0.837

d. Overall Stress associated with math course: overall stress associated with the course (Appendix I items 12a – o: "How often did you anticipate the following activities would be stressful for you: knowing how to study for exams, taking tests, finishing problem sets, etc."); Cronbach's alpha = 0.927

    i. Stress related to work: level of stress associated with completing assignments and tasks for the math or statistics course (Appendix I items 12a, b, c, e, f: "Knowing how to study for exams;" " Taking tests;" "Finishing problem sets on time;" "Finishing lab reports on time;" "Getting a really good grade"); Cronbach's alpha = 0.862

ii. Stress related to classroom relations: level of stress associated with peer and teacher-interactions (Appendix I items 12d, g, h, i, j, k, l, m, n, o: "Being praised for my ability to do math in front of other students;" "Asking my teaching assistant for help outside of class;" "Being corrected for a wrong answer in front of other students;" "Going to office hours to meet with the professor;" "Being praised for the quality of my work in front of other students;" "Asking for help from the professor outside of class;" "Answering questions in class in front of other students;" "Asking questions in class;" "Going to office hours to meet with my teaching assistant;" "Letting other students know how I'm doing in this class"); Cronbach's alpha = 0.927

The five open-ended questions were intended to assess participants' awareness and perception of math gender stereotypes. The first and fourth open-ended questions (Appendix I items 13, 16) were meant to assess whether the participants were aware of the traditional math gender stereotype (i.e., men are better at mathematics than women). The second open-ended question (Appendix I item 14) was supposed to determine whether participants believed that they could be negatively affected by math gender stereotypes via stereotype threat. The third open-ended question (Appendix I item 15) was meant to see whether participants' conceptualizations of successful mathematicians or statisticians showed evidence of being influenced by math gender stereotypes (i.e., do participants use stereotypically masculine terms in describing the successful mathematician/statistician?). The final open-ended question (Appendix I item 17) was simply intended to provide participants with the opportunity to describe any miscellaneous pieces of personal information that might impact their performance in a math or statistics course.

Procedure

All participants completed the survey online. Those students who were enrolled in the introductory statistics course were required to complete the survey for their class. All other participants who were not enrolled in the introductory statistics course completed the survey voluntarily with no incentive.

Participants' open-ended responses were coded in the following manner:

- Item 13 ("Stereotypes are described as generalizations about an individual's or group's characteristics, e.g., all little girls like dolls. However, there is some kernel of truth to be found in stereotypes, e.g., many but not all little girls like dolls. In the space provided below, please describe a specific stereotype about female college students that you think may interfere with your progress in a math or statistics class.")

  Answers were coded as yes or no. A participant answer naming a stereotype was coded as yes. If a participant was unable to name a stereotype that she thought might interfere with her progress, her answer was coded as no.
- Item 14 ("Do you think the presence of a male would inhibit you from participating in a math or statistics course? If yes, please explain below.")

  Answers were coded as yes, no, or unsure. An unsure response includes such answers as maybe, perhaps, possibly, or don't know.
- Item 15 ("Professor 'so-and-so' is considered to be a top-notch statistician/data analyst. In the space below, please list in rank order – with the first being the most important – five important personal traits or characteristic you would use to describe this professor.")

The participants' responses were examined in order to determine whether any overall tendency to describe the successful statistician in stereotypically masculine terms existed. Examples of masculine terms include stern, strict, commanding, powerful, intimidating, and male.

- Item 16 ("At most colleges and universities, would this professor more likely be female or male? Please explain your answer.")

  Answers were coded as male, female, or indecisive. An indecisive answer includes such responses as either gender, both genders, unsure, or don't know.

- Item 17 ("Is there anything else you would like to let use know about your learning style, interests, or preferences that may affect your performance in a math or statistics course?")

  Responses from this question primarily provided qualitative data; no coding system was applied.

Results

Preliminary Comparisons by Student Major

To assess the comparability of the groups defined by college major across the dependent variables, a series of one-way ANOVAs were performed. The results suggest that the data from psychology, neuroscience, and "other" majors are comparable (Table 1).

Table 1

Results of one-way ANOVAs assessing comparability of college majors across dependent variables

	n	Mean	SD
Math Competence			
$F(2, 64) = 1.935$, $p = 0.15$			
Psychology	27	3.18	0.71
Neuroscience	30	3.54	0.68
Other	10	3.43	0.72
Math Confidence			
$F(2, 64) = 0.295$, $p = 0.75$			
Psychology	27	3.15	0.97
Neuroscience	30	3.30	0.85
Other	10	3.35	0.67
Math Satisfaction			
$F(2, 64) = 2.514$, $p = 0.089$			
Psychology	27	3.19	0.77
Neuroscience	30	3.64	0.73
Other	10	3.64	0.77
Social Support			
$F(2, 61) = 0.701$, p = 0.50			
Psychology	26	3.25	0.57
Neuroscience	28	3.06	0.76
Other	10	3.03	0.55
Engagement			
$F(2, 61) = 0.111$, $p = 0.90$			
Psychology	26	3.22	0.94
Neuroscience	28	3.30	0.79
Other	10	3.18	0.61
Overall Stress			
$F(2, 64) = 0.125$, $p = 0.88$			
Psychology	27	2.96	0.86
Neuroscience	30	3.09	1.16
Other	10	2.97	1.11
Work-Related Stress			
$F(2, 64) = 0.276$, $p = 0.76$			
Psychology	27	3.51	1.00
Neuroscience	30	3.52	1.25
Other	10	3.47	1.34
Relations-Related Stress			
$F(2, 64) = 0.169$, $p = 0.85$			
Psychology	27	2.63	0.97
Neuroscience	30	2.78	1.21
Other	10	2.81	1.06

Relationships among the Criterion Variables

As there was no significant difference between the majors, bivariate correlations were run using the total sample for all of the criterion variables (i.e., math competence beliefs, math confidence, math satisfaction, overall stress, stress related to work, stress related to classroom relations, engagement, and social support). The results are summarized below, as well as in Table 2. Strong, positive correlations were found to exist between the following variables: math competence & math confidence ($r = 0.74$, $p < 0.01$); math competence & math satisfaction ($r = 0.95$, $p < 0.01$); math confidence & math satisfaction ($r = 0.51$, $p < 0.01$); overall stress & work-related stress ($r = 0.89$, $p < 0.01$); overall stress & relations-related stress ($r = 0.95$, $p < 0.01$); work-related stress & relations-related stress ($r = 0.73$, $p < 0.01$). Strong, negative correlations were found to exist between math confidence & work-related stress ($r = -0.51$, $p < 0.01$). In addition, moderate, positive correlations were found between the following variables: engagement & social support ($r = 0.32$, $p < 0.01$); engagement & math competence ($r = 0.39$, $p < 0.01$). Moderate, negative correlations were found between the following variables: math competence & work-related stress ($r = -0.44$, $p < 0.01$); math confidence & overall stress ($r = -0.42$); math confidence & relations-related stress ($r = -0.32$, $p < 0.01$); overall stress & work-related stress ($r = -0.33$; $p < 0.01$). The significant associations among these criterion variables suggest that the criterion variables have reasonably high construct validity (Vogt & Johnson, 2011).

Table 2

Correlations between criterion variables ($n_{social\ support\ \&\ engagement} = 64$; $n_{all\ others} = 67$)

	1	2	3	4	5	6	7	8
1. Math Competence	-	0.74**	0.95**	-0.32**	-0.44**	-0.22	0.27*	0.39**
2. Math Confidence		-	0.51**	-0.42**	-0.51**	-0.32**	0.28*	0.19
3. Math Satisfaction			-	-0.22	-0.33**	-0.14	0.23	0.42**
4. Overall Stress				-	0.89**	0.95**	-0.23	-0.23
5. Work-related Stress					-	0.73**	-0.18	-0.18
6. Relations-related Stress						-	-0.23	-0.23
7. Social Support							-	0.32**
8. Engagement								-

* $p < 0.05$; ** $p < 0.01$

Awareness of Math Gender Stereotypes

In assessing the percent frequency of math gender stereotypes, 83.6% of the 67 participants identified a stereotype in response to the first open-ended question (Appendix I, item 13). Six (N = 6) of the participants claimed either that they were unaware of any stereotypes that could impede their performance in a math or statistics course or that the math gender stereotypes were not applicable to them. Five (N = 5) of the participants did not answer the question. Furthermore, a chi square test of independence revealed a significant association between stereotype awareness and college major, χ^2 (2) = 7.514, $p = 0.02$, Cramer's V = 0.34, moderate effect size (Table 3). Of the three major categories, students majoring in neuroscience reported being the least aware of math gender stereotypes.

Table 3

Valid % of stereotype awareness by college major

	Unaware	Aware	Total
Psychology (n = 27)	3.7%	96.3%	100%
Neuroscience (n = 30)	30%	70%	100%
Other (n =10)	10%	90%	100%

Participants' responses to the fourth open-ended question, which asked them to indicate whether a "top-notch statistician" would more likely be a man or woman (Appendix I item 17), also suggested an overall awareness of math gender stereotypes. Thirty-five (N = 35; i.e., 58.3%) participants wrote that the statistician would more likely be a male, compared to the six (N = 6; i.e., 10%) participants who said that the statistician would more likely be a female (Table 3). Nineteen (N = 19; i.e., 31.7%) participants were unsure or believed that the statistician could be either male or female (Table 4). A goodness of fit chi-square test revealed that this observed distribution for the statistician's gender was significantly different from the expected distribution, χ^2 (2) = 2.11, $p < 0.001$. No significant association was found between indicated gender of statistician and college major, χ^2 (4) = 3.188, $p = 0.53$.

Table 4

Gender of top-notch statistician

	N	Valid %
Male	35	58.3%
Female	6	10%
Either/Unsure	19	31.7%

No definitive pattern, however, emerged when the participants were asked to describe the top-notch statistician in the third open-ended question ("'Professor so-and-so' is considered to be a top-notch statistician/data analyst. In the space below, please list in rank order – with the first being the most important – five important personal traits or characteristics you would use to describe this professor.”). The participants did not use any particularly sex-typed traits to describe the professor. Of the 62 participants who answered the question, the five most frequent terms used to describe the professor were: intelligent/smart (25.8%), organized (24.2%), approachable (17.7%), analytical (14.5%), and clear (12.9%).

Although the majority of participants were aware of math gender stereotypes, 85.2% of the participants believed that they would not fall victim to stereotype threat. In response to the second open-ended question (“Do you think that the presence of a male student would inhibit you from participating in a math or statistics class? If yes, please explain below.”), only four (N = 4; i.e., 6%) participants believed that they would participate less if a male were present in a math course (Table 5). Fifty-two (N = 52; i.e., 85.2%) participants claimed that they would be unaffected by the presence of a male, and five (N = 5; i.e., 7.5%) participants indicated that the presence of a male might inhibit their participation (Table 5). A goodness of fit chi-square test revealed that this distribution of observed responses was significantly different from the expected distribution, with “no” being the most prevalent category, χ^2 (2) = 74, $p < 0.001$. No significant association was found between perceived vulnerability to stereotype threat and college major, χ^2 (4) = 4.058, $p = 0.40$.

Table 5

Participants’ responses to whether the presence of a male student would inhibit their participation in a math or statistics course

	N	Valid %
Yes	4	6.6%
No	52	85.2%
Maybe	5	8.2%

Perceptions of Math Gender Stereotypes

Upon further inspection of the qualitative data, it was found that students mentioned three different stereotype categories: “negative personal,” “traditional math gender,” and “competitive” (Table 6).

Table 6

Number of mentions per stereotype category

	N	Valid Percent
Traditional Math Gender	34	54.8%
Competitive	12	19.4%
Negative Personal	10	16%
Unaware/Not applicable	6	9.7%
Total	62	100%
Missing	5	

Traditional math gender stereotypes emphasize male superiority in the fields of math and science. Overall, 54.8% of students mentioned the traditional math gender stereotype (Table 6). Examples of participant responses falling into the traditional math gender category included:

- “One stereotype is that women are not good at math. It is said our brains are not made for math, unlike men. This is hindering to me, because I do not always succeed in math, which I feel may be written off because I am a female. I want to hold myself to a higher standard but feel that there may be some truth to the stereotype when I am not succeeding.”
- “’Women are not good at math and science, or shouldn’t be taken seriously in these fields.’ I think that this is something that I’ve subconsciously inferred from our society, and it has definitely influenced my academic career. In college, I have leaned towards the humanities. Only in the last year have I really embraced my science and math side. Although it is challenging for me and sometimes discouraging, I am determined to do well and learn the material, because I think that it is important to succeed in this world.”

The competitive stereotype states that female students tend to be more competitive and uptight about their academic work, especially when in a single-gender environment. Overall, 19.40% of participants reported a competitive stereotype (Table 6). Examples of participant responses falling into the competitive category included:

- "There is a stereotype that many female college students, especially those at women's colleges, tend to be more confident and therefore more competitive. I think this would interfere with my progress in the class, because I am simply just trying to learn the material and not turn it into a competition of who had the right answer and how often."
- "I believe that female college students, especially at Wellesley, are extremely competitive with one another. In this class, students may interfere with my progress by refusing to offer help if I ask for an explanation (although I will likely ask a TA for help rather than a student), and may create an inferiority complex for me, in which I feel incompetent in class, compared to the other women taking it, as my peers may falsely portray their competence, in accordance with their competitiveness to be the best in the class, even if they are not."

Negative personal stereotypes focus on personal characteristics and behaviors. Overall, 16% of participants reported a negative personal stereotype (Table 6). Examples of participant responses falling into the negative personal category include:

- "One stereotype about female college students is that they are self-conscious, and because of that, are often nervous to speak up in class and ask questions and contribute to the discussions. If students don't ask questions they have, or don't contribute ideas to class discussions, this could affect my progress in the class."
- "Because this class solely consists of female college students, I don't expect this kind of stereotype to cause an issue, as I might in a co-ed classroom setting, however, there is one I can think of. The stereotype that female college students who are always dressed up with their outfits, hair, and makeup are slow and stupid, could be a problem as far as how other students teat them. For instance, other students may avoid working with them as a partner or in groups."

To examine the association between stereotype category and college major, the "other" major category was excluded due to small sample size. Results showed a significant association between stereotype category and major, χ^2 (3) = 11.915, *p* = 0.008, Cramer's V = 0.474, moderate effect size (Table 7; Figure 1). Of the psychology majors (n = 27), 66.7% reported awareness of the traditional math gender stereotype, compared to the 25.9% for the competitive stereotype and 3.7% for the negative personal stereotype. Of the neuroscience majors (n =26), 34.6% reported awareness of the traditional math gender stereotype, 15.4% the competitive stereotype, and 30.8% the negative personal stereotype. Compared to the neuroscience majors, a higher percentage of psychology majors mentioned both the traditional math gender (66.7% vs.

34.6%) and competitive stereotypes (25.9% vs. 15.4%). A higher percentage of neuroscience majors, however, mentioned the negative personal characteristics stereotype (30.8% vs. 3.7%). In addition, neuroscience majors more frequently reported being unaware of a stereotype or did not perceive stereotypes as being applicable to them (19.2% vs. 3.7%).

Table 7

Stereotype category by College major

	Stereotype Category				
	Traditional Math Gender	Competitive	Negative Personal	Unaware/Not applicable	Total
Psychology (n =27)	66.7%	25.9%	3.7%	3.7%	100%
Neuroscience (n = 26)	34.6%	15.4%	30.8%	19.2%	100%

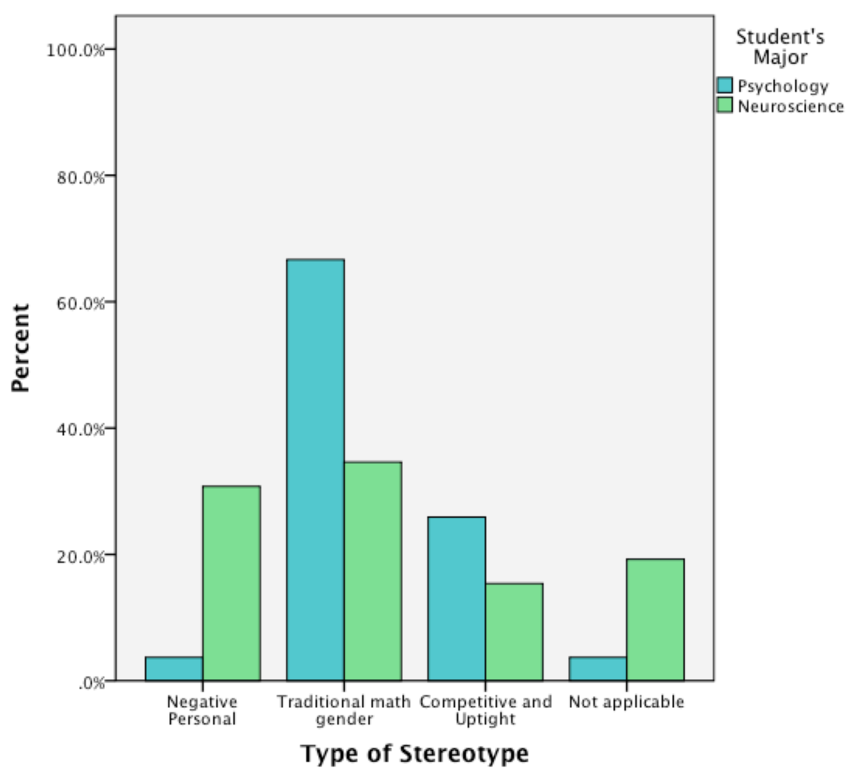

Figure 1

Bar graph of percent of responses per stereotype category by major (psychology vs. neuroscience), $p < 0.01$

Impact of Stereotype Perception

To test hypotheses 2 - 9, a series of two-way ANOVAs were run to assess the main effects by stereotype category and interactions between stereotype category and college major on the criterion variables. [In running the ANOVA tests, the "other" college major category and participants who reported being unaware of a stereotype were excluded.] The two-way ANOVAs revealed no significant interactions between factors for each of the variables; however, there were significant main effects by stereotype category for math confidence, overall stress, and work-related stress. Mean levels of math confidence were found to differ significantly across the stereotype categories, $F(2, 41) = 4.338$, $p = 0.02$, $\eta_p^2 = 0.175$, $r = 0.42$ (moderate effect). Compared to the competitive and negative personal stereotype groups, the traditional math gender stereotype group reported having the highest levels of math confidence. However, a Bonferroni post-hoc multiple comparisons test with an adjusted alpha level of 0.0167 only revealed a significant trend between students who reported a traditional math gender stereotype and level of math confidence. Students who reported an awareness of a competitive stereotype reported a lower mean level of math confidence ($M = 2.73$, $SE = 0.26$, $n = 11$) compared to those who reported an awareness of a traditional math gender stereotype ($M = 3.56$, $SE = 0.17$, $n = 27$), $p = 0.038$ (Figure 2).

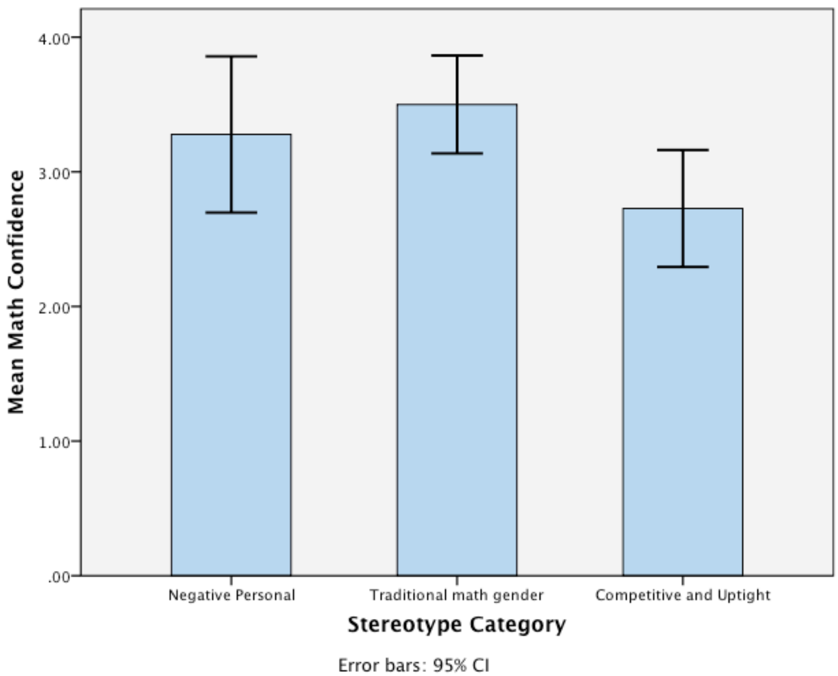

Figure 2

Bar graph of mean level of math confidence by stereotype category. Error bars represent 95% confidence intervals.

Mean levels of overall stress were also found to differ significantly across the stereotype categories, F (2, 41) = 5.149, p = 0.01, $\eta_p^2 = 0.201$, $r_p = 0.45$ (moderate effect). The Bonferroni post-hoc tests (adjusted alpha = 0.0167) showed that students who reported an awareness of a competitive stereotype reported a higher but not statistically significant mean level of overall stress (M = 3.96, SE = 0.30, n = 11) compared to those who reported an awareness of a traditional math gender stereotype (M = 2.83, SE = 0.20, n = 27), p = 0.04. A significant difference emerged between the competitive stereotype and negative personal stereotype group (M = 2.91, SE = 0.51, n = 9), p = 0.009 (Figure 3). The 95% confidence interval of the mean differences indicated that the mean overall stress level for students who reported awareness of a competitive stereotype could be as much as 2.19 points higher than that for students who reported an awareness of a negative personal stereotype (95% CI = 0.04, 2.19).

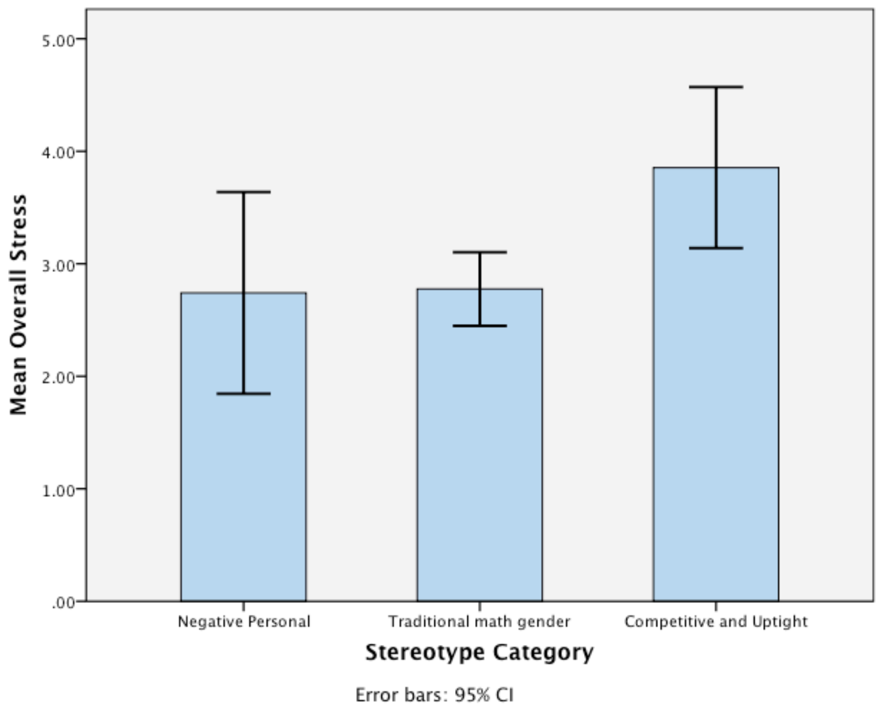

Figure 3

Bar graph of mean level of overall stress by stereotype category. Error bars represent 95% confidence intervals.

A significant difference was found among the stereotype categories for the mean values of work-related stress, $F\ (2, 41) = 8.65$, $p = 0.001$, $\eta_p^2 = 0.297$, $r = 0.54$ (strong effect). The Bonferroni post-hoc tests (adjusted alpha = 0.0167) revealed that the mean level of work-related stress was significantly higher among students aware of a competitive stereotype (M = 4.70, SE = 0.30, n = 11) than students aware of both traditional math gender stereotypes (M = 3.20, SE = 0.20, n = 27), $p < 0.001$ and negative personal stereotypes (M = 3.59, SE = 0.51, n = 9) $p = 0.004$ (Figure 4). The 95% confidence intervals of the mean differences indicate that the mean work-related stress level for students aware of a competitive stereotype could be as much as 2.34 points higher than that for students aware of a traditional math gender stereotype (95% CI = 0.62, 2.34) and 2.19 points higher than that for students aware of the negative personal stereotype (95% CI = 0.41, 2.57).

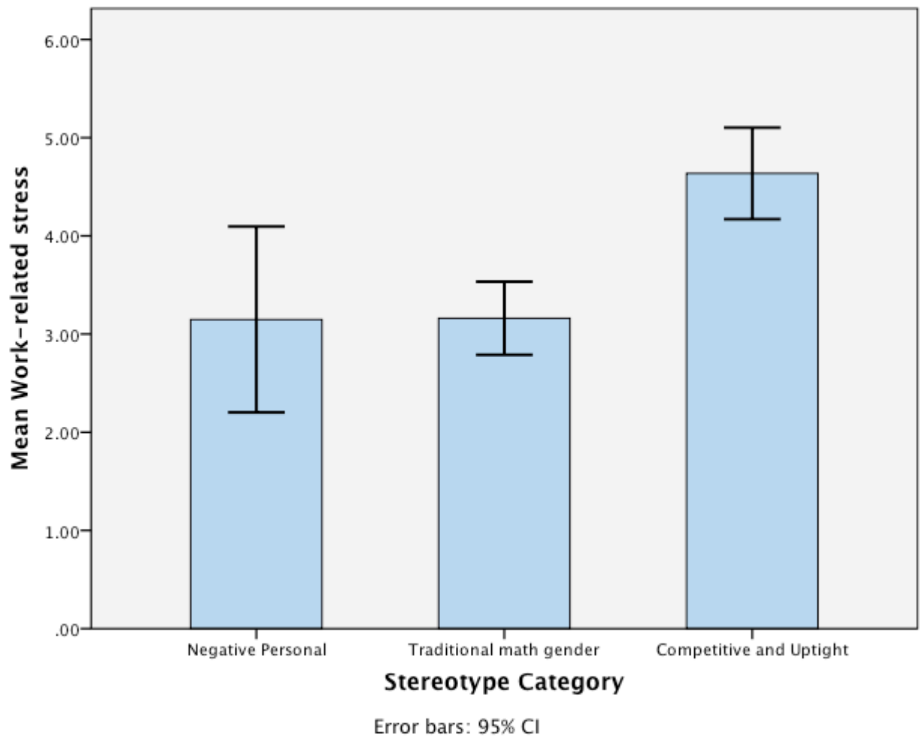

Figure 4

Bar graph of mean level of work-related stress by stereotype category. Error bars represent 95% confidence intervals.

Predictive Power of Stereotype Categories

Three stepwise regression analyses were performed to assess how well the stereotype categories and math confidence predicted work-related stress levels. To perform these analyses, we first created three separate stereotype category variables containing two levels each: traditional math gender vs. competitive; negative personal vs. traditional math gender; and competitive vs. negative personal. The strongest model that emerged included the traditional math gender vs. competitive and math confidence variables. The stepwise algorithm entered the math gender vs. competitive stereotype variable first into the model, and this variable accounted for 40.2% of the variance in work-related stress, $R^2 = 0.402$, $F(1, 44) = 29.58$, $p < 0.001$. This is a strong effect, $r = 0.67$. The math confidence variable was entered second, and it accounted for 6.1% of the variance in work-related stress, $\Delta R^2 = 0.047$, $F(1, 43) = 4.899$, $p = 0.032$. This is a weak effect, $r = 0.11$. Overall, stereotype category (traditional math gender vs. competitive) and math confidence accounted for 46.3% of the variation in work-related stress among those students who reported awareness of a traditional math gender or competitive stereotype. Approximately 54% of the variation remained unexplained.

Table 8

Unstandardized beta, standard error for beta, & standardized beta for multiple regression with the outcome variable of work-related stress & 2 predictors (traditional math gender vs. competitive stereotype and math confidence)

	B	**SE B**	**β**
Step 1			
Constant	1.43	0.39	
Traditional math vs. Competitive	1.60	0.29	0.63**
Step 2			
Constant	2.93	0.77	
Traditional math vs. Competitive	1.33	0.31	0.53**
Math Confidence	-0.35	0.16	-0.27*

Note: $R^2 = 0.402$ for Step 1, $\Delta R^2 = 0.047$ for Step 2 ($p = 0.032$). ** $p < 0.001$, * $p < 0.05$

Discussion

The results of this study demonstrate that the majority of participants were aware of a math gender stereotype. Of the 67 participants, 83.6% were able to identify a stereotype that might interfere with their performance in a math or statistics course, and when asked whether a successful statistician would more likely be male or female, 58.3% of participants responded with male, the stereotype-consistent response. A significant association was also found between college major and reported awareness of stereotypes, whereby neuroscience majors reported being aware math gender stereotypes to a lesser degree than psychology majors. That psychology majors should be more aware of math gender stereotypes makes sense, given the fact that psychology courses tend to devote more time to discussing the topic of stereotypes.

Although the vast majority of participants reported awareness of math gender stereotypes, only a small percentage of individuals believed that they could fall victim to stereotype threat. This lack of perceived vulnerability to stereotype threat could be a function of being at an all-women's college. Lee and Bryk (1986) found that women who attend single-gender high schools tend to hold fewer stereotypic attitudes; thus, the same might be true among students of an all-women's college. As Huguet and Régner (2009) showed, however, holding counter-stereotypic beliefs does not necessarily shield an individual from stereotype threat. The participants in this study, therefore, could still fall victim to stereotype threat, in spite of them claiming otherwise. Furthermore, Good, Aronson, and Harder (2008) demonstrated that high-achieving female college students in math and science, such as the participants in the present study, are not exempt from stereotype threat. When placed in a stereotype-threat-inducing context, high-achieving female college students will underperform relative to men on mathematical assessments, just as is the case for their lower-achieving female contemporaries.

An interesting, yet unexpected outcome of the present study was the identification of three different categories of stereotypes (negative personal characteristics, traditional math gender, and competitive) by participants. Prior to running the study, it was expected that participants would only mention the traditional math gender stereotype (i.e., men are better at mathematics than women), and although the majority of individuals did mention the traditional math gender stereotype (54.8%), relatively large numbers of participants mentioned the competitive (19.4%) and negative personal characteristics stereotype (16%). As was the case with overall awareness of math gender stereotypes, a significant association was fond between stereotype category and college major. Compared to the neuroscience majors, a higher percentage of psychology majors reported awareness of both the traditional math gender and competitive stereotypes. A higher percentage of neuroscience majors, however, reported awareness of a negative personal characteristic stereotype. A possible explanation for this difference in stereotype category between the majors is that psychology majors might be more familiar with the traditional math gender stereotype and competition through their greater exposure to these topics in their social and personality psychology courses. Thus, when asked to indicate a stereotype that might impact their performance in a math or statistics class, they responded with traditional math gender or competitive stereotypes. Neuroscience majors, on the other hand, might have relied more heavily on observable personality attributes and behaviors of other students when asked to identify factors that might impede their performance in math or statistics course. Consequently, neuroscience majors might have tended to report negative personal characteristic stereotypes, such as “female college students are self-conscious,” “female college students…are nervous to speak up in class,” and “female college students who are always dressed up with their outfits, hair, and makeup are slow and stupid.”

In addition to being associated with college major, stereotype category was also found to have an impact on the dependent variables math confidence, overall stress, and work-related stress. The mean level of work-related stress was found to be significantly higher among students who reported an awareness of a competitive stereotype compared to those who reported an awareness of both traditional and math gender stereotypes. Furthermore, a significant trend was found between stereotype category and overall stress, whereby students who reported an awareness of a competitive stereotype had a higher mean level of overall stress compared to those who reported an awareness of a traditional math gender stereotype. Students aware of a competitive stereotype also reported a lower but not statistically significant mean level of math confidence. These adverse effects of competitive stereotypes are in line with previous research, which has found associations between female-female competition and stress among adolescents (Salmon, Crawford, & Walters, 2008).

These relationships between stereotype category and the variables math confidence, overall stress, and work-related stress also illustrate the power and impact that stereotype category can have on an individual. In fact, the regression performed in the present study sugested that stereotype category might have strong predictive power. In the regression model, 40.2% of the variance in work-related stress was accounted for by whether one was aware of a competitive or traditional math gender stereotype. In fact, the model predicted that individuals who reported awareness of a competitive stereotype would have higher levels of work-related stress than those who reported a traditional math gender stereotype, and this difference was found to be greater than half a standard deviation unit ($\beta = 0.53$).

The present study showed that in addition to simply being aware of math gender stereotypes, female college students at a single-gender institution were cognizant of multiple types of math gender stereotypes, and each of these stereotype categories carried with it different implications. There are, however, several limitations of this study. As the sample of this study consisted entirely of female college students attending a single-gender institution, no comparisons can be made between female college students at a coed vs. single-gender institution. Furthermore, as the reporting of multiple stereotype categories by participants was unexpected, no items assessing each of the stereotype categories were included in the survey completed by participants; all of the information on the stereotype categories was generated by the respondents. Future research, therefore, should include both a coed comparison group and quantitative items to assess the prevalence of these stereotype categories among females in single-gender and coed schools.

This study was designed to look at non-math majors having to take two or more rigorous math courses as part of the college and major degree requirements. In the future, however, it would be interesting to compare gender stereotypes between female math and non-math majors. The fact that the field of mathematics remains dominated by males would suggest that even math majors might not completely be immune to the negative effects of gender stereotypes.

Overall, these data suggest that a significant percentage of high-achieving female college students perceive their female counterparts in various stereotypically negative ways. This raises the question as to whether stereotypes adversely affect their own and others' performance in math and statistics courses. At this point, there are no data regarding the connection between competitive stereotypes and actual performance. One might speculate, for example, a high-achieving female, who is viewed as highly competitive by her classmates, may likely "shut down" in order to get along with her peers. In addition, it is possible that poor performance in a math or statistics course may be the result of a non-traditional source of stereotype threat, such as competitiveness among students of the same gender. How various gender stereotypes are generated, reinforced, and propagated in single gender academic environments clearly merits further research.

References

Allen, L. S. & Roger, A. G. (1991). Sexual dimorphism of the anterior commissure and massa intermedia of the human brain. *Journal of Comparative Neurology*, *312*, 97-104.

Anderson, K. J. & Leaper, C. (1998). Meta-analyses of gender effects on conversational interruption: Who, what, when, where, and how. *Sex Roles*, *39*, 225-252.

Archer, J. (2004). Sex differences in aggression in real-world settings: A meta-analytic review. *Review of General Psychology*, *8*, 291-322.

Aronson, J. & Steele, C. M. (2005). Stereotypes and the fragility of academic competence, motivation, and self-concept. In Elliot, A. J. & Dweck, C. S. *Handbook of competence and motivation* (pp. 85-104). New York: The Guilford Press.

Arterberry, M. E., Cain, K. M., & Chopko, S. A. (2007). Collaborative problem solving in five-year-old children: Evidence of social facilitation and social loafing. *Educational Psychology*, *27*, 577-596.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Carr, P. B. & Steel, C. M. (2009). Stereotype threat and inflexible perseverance in problem solving. *Journal of Experimental and Social Psychology*, *45*, 853-859.

Chipman, S. F., Krantz, D. H., & Silver, R. (1992). Mathematics anxiety and science careers among able college women. *Psychological Science*, *3*, 292-295.

Coe, R. (2002, September). *It's the effect size, stupid: What effect size is and why it is important*. Paper presented at the Annual Conference of the British Educational

Research Association, University of Exeter, England. Retrieved from http://www.leeds.ac.uk/educol/documents/00002182.htm.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*, 155-159.

Condry, J. & Condry, S. (1976). Sex differences: A study of the eye of the beholder. *Child Development*, *47*, 812-819.

Corpus, J. H. & Lepper, M. R. (2007). The effects of person versus performance praise on children's motivation: Gender and age as moderating factors. *Educational Psychology*, *27*, 487-508.

Corston, R. & Colman, A. M. (1996). Gender and social facilitation effects on computer competence and attitudes toward computers. *Journal of Educational Computing Research*, *14*, 171-183.

Dekaban A.S., Sadowsky, D. (1978). Changes in brain weights during the span of human life: relation of brain weights to body heights and body weights. *Annals of Neurology*, *4*, 345-356.

Dweck, C. S. (2007). Is Math a Gift? Beliefs That Put Females at Risk. In S. J. Ceci, W. M. Williams, S. J. Ceci, W. M. Williams (Eds.), Why aren't more women in science: Top researchers debate the evidence (pp. 47-55). Washington, DC US: American Psychological Association. doi:10.1037/11546-004

Elliot, A. J. & Dweck, C. S. (2005). *Handbook of competence and motivation*. New York: The Guilford Press.

Elliot, A. J. & McGregor, H. A. (2001). A 2 x 2 achievement goal framework. *Journal of Personality and Social Psychology*, *80*, 501-519.

Else-Quest, N. M. (2007). Biological determinism and the never-ending quest for gender differences. *Psychology of Women Quarterly*, *31*, 322-330.

Else-Quest, N. M., Hyde, J. S., Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: A meta-analysis. *Psychological Bulletin*, *136*, 103-127.

Enman, M. & Lupart, J. (2000). Talented female students' resistance to science: An exploratory study of post-secondary achievement, motivation, persistence, and epistemological characteristics. *High Ability Studies*, *11*, 161-178.

Gabora, L., Rosch, E., Aerts, D. (2008). Toward an ecological theory of concepts. *Ecological Psychology*, *20*, 84-116.

Garn, C. L., Allen, M. D., & Larsen, J. D. (2009). An fMRI study of sex differences in brain activation during object naming. *Cortex*, *45*, 610-618.

Good, C., Aronson, J., & Harder, J. A. (2008). Problems in the pipeline: Stereotype threat and women's achievement in high-level math courses. *Journal of Applied Developmental Psychology*, *29*, 17-28.

Grön, G., Wunderlich, A. P., Spitzer, M., Tomczak, R., & Riepe, M. W. (2000). Brain activation during human navigation: Gender-different neural networks as substrate of performance. *Neuroscience*, *3*, 404-408.

Gur, R. C., Alsop, D., Gahn, D., Petty, R., Swanson, C. L., Maldjian, J. A., Turetsky, B. I., Detre, J. A., Gee, J., & Gur, R. E. (2000). An fMRI study of sex differences in regional activation to a verbal and a spatial task. *Brain and Language*, *74*, 157-170.

Halpern, D., Aronson, J., Reimer, N., Simpkins, S., Star, J., & Wentzel, K. (2007). Encouraging girls in math and science (NCER 2007-2003). Washington, DC: National Center for Education Research. Retrieved from http://ncer.ed.gov.

Halpern, D. F., Eliot, L., Bigler, R. S., Fabes, R. A., Hanish, L. D., Hyde, J., Liben, L. S., & Martin, C. L. (2011). The pseudoscience of single-sex schooling. *Science*, *333*, 1706-1707.

Herbert, J. & Stipek, D. (2005). The emergence of gender differences in children's perceptions of their academic competence. *Applied Developmental Psychology*, *26*, 276-295.

Hilliard, L. J. & Liben, L. S. (2010). Differing levels of gender salience in preschool classrooms: Effects on children's gender attitudes and intergroup bias. *Child Development*, *81*, 1787-1798.

Hugdahl, K., Thomsen, T., & Ersland, L. (2006). Sex differences in visuo-spatial processing: An fMRI study of mental rotation. *Neuropsychologia*, *44*, 1575-1583.

Huguet, P. & Régner, I. (2007). Stereotype threat among schoolgirls in quasi-ordinary classroom circumstances. *Journal of Educational Psychology*, *99*, 545-560.

Huguet, P. & Régner, I. (2009). Counter-stereotypic beliefs in math do not protect girls from stereotype threat. *Journal of Experimental Social Psychology*, *45*, 1024-1027.

Hyde, S. H. Fennema, E., Ryan, M., Frost, L. A., & Hopp, C. (1990). Gender comparisons of mathematics attitudes and affect. *Psychology of Women Quarterly*, *14*, 299-324.

Hyde, S. H. (2005). The gender similarities hypothesis. *American Psychologist*, *60*, 581-592.

Hyde, S. H. (2007). New directions in the study of gender similarities and differences. *Current Directions in Psychological Science*, *16*, 259-263.

Inzlicht, M. & Ben-Zeev, T. (2000). A threatening intellectual environment: Why females are susceptible to experiencing problem-solving deficits in the presence of males. *Psychological Science*, *11*, 365-371.

James, A. N. & Richards, H. C. (2003). Escaping stereotypes: Educational attitudes of male alumni of single-sex and coed schools. *Psychology of Men and Masculinity*, *4*, 136-148.

Kamins, M. L. & Dweck, C. S. (1999). Person versus process praise and criticism: Implications for contingent self-worth and coping. *Developmental Psychology*, *35*, 835-847.

Kling, K. C., Hyde, J. S., Showers, C. J., Buswell, B. N. (1999). Gender differences in self-esteem: A meta-analysis. *Psychological Bulletin*, *125*, 470-500.

Konrad, A. M., Ritchie, J. E., Lieb, P., Corrigall, E. (2000). Sex differences and similarities in job attribute preferences: A meta-analyis. *Psychological Bulletin*, *126*, 593-641.

Lee, V. E. & Bryk, A. S. (1986). Effects of single-sex secondary schools on student achievement and attitudes. *Journal of Educational Psychology*, *78*, 381-395.

Lee, V. E. & Marks, H. M. (1990). Sustained effects of the single-sex secondary school experience on attitudes, behaviors, and values in college. *Journal of Educational Psychology*, *82*, 572-592.

Lindberg, S. M., Hyde, J.S., Petersen, J. L., & Linn, M. C. (2010). New trends in gender and mathematics performance: A meta-analysis. *Psychological Bulletin*, *136*, 1123-1135.

Brizendine, L. (2006). *The female brain*. New York: Morgan Road Books.

Malott, R. W. (2007). Are women, people of color, Asians, and southern Europeans inherently inferior to north-European males? A history of biological determinism – a cultural, spiritual, and intellectual disgrace – and the implications for understanding "mental illness." *Behavior and Social Issues*, *16*, 134-169.

Matlin, M. W. & Zajonc, R. B. (1968). Social facilitation of word associations. *Journal of Personality and Social Psychology*, *10*, 455-460.

Nowak, N. T., Resnick, S. M., Elkins, W. & Moffat, S. D. (2011). *Sex differences in brain activation during virtual navigation: a functional MRI study*. Paper presented at Annual Meeting of the Cognitive Science Soc., Boston, MA. Retrieved from http://csjarchive.cogsci.rpi.edu/proceedings/2011/papers/0638/paper0638.pdf

Pietsch, J., Walker, R., & Chapman, E. (2003). The relationship among self-concept, self-efficacy, and performance in mathematics during secondary school. *Journal of Educational Psychology*, *95*, 589-603.

Rivardo, M. G., Rhodes, M. E., Camaione, T. C., & Legg, J. M. (2011). Stereotype threat leads to reduction in number of math problems women attempt. *North American Journal of Psychology*, *13*, 5-16.

Rogers, D. S., Harkrider, A. W., Burchfield, S. B., & Nabelek, A. K. (2003). The influence of listener's gender on the acceptance of background noise. *Journal of the American Academy of Audiology*, *14*, 372-382.

Sagi, E., D'Alessandro, L. M., & Norwich, K. H. (2007). Identification of variability as a measure of loudness: An application to gender differences. *Canadian Journal of the Acoustical Society of America*, *68*, 551-566.

Salmon, C., Crawford, C. B., & Walters, S. (2008). Anorexic behavior, female competition and stress: Developing the Female Competition Stress Test. *Evolutionary Psychology*, *6*, 96-112.

Sax, L. (2001). Reclaiming kindergarten: Making kindergarten less harmful to boys. *Psychology of Men and Masculinity*, *2*, 3-12.

Sax, L. (2010). Sex differences in hearing: Implications for best practice in the classroom. *Advances in Gender and Education*, *2*, 13-21.

Sax, L. (2009). *Women graduates of single-sex and coeducational high schools: Differences in their characteristics and the transition to college* (Research Report). Retrieved from The Sudikoff Family Institute for Education and New Media website: http://www.heri.ucla.edu/PDFs/Sax_FINAL%20REPORT_Sing_1F02B4.pdf

Sax, L., Arms, E., Woodruff, M., Riggers, T., & Eagan, K. (2011 September). [Letter to the editors of *Science*].

Schunk, D. H. & Pajares, F. (2005). Competence perceptions and academic functioning. In Elliot, A. J. & Dweck, C. S. *Handbook of competence and motivation* (pp. 85-104). New York: The Guilford Press.

Shapka, J. D. & Keating, D. P. (2003). Effects of a girls-only curriculum during adolescence: Performance, persistence, and engagement in mathematics and science. *American Educational Research Journal*, *40*, 929-960.

Shapk, J. D. (2009). Trajectories of math achievement and perceived math competence over high school and postsecondary education: Effects of an all-girl curriculum in high school. *Educational Research and Evaluation*, *15*, 527-541.

Smith, J. L. (2006). The interplay among stereotypes, performance-avoidance goals, and women's math performance expectations. *Sex Roles*, *54*, 287-296.

Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). Stereotype threat and women's math performance. *Journal of Experimental Social Psychology*, *35*, 4-28.

Streitmatter, J. (1997). An exploratory study of risk-taking and attitudes in a girls-only middle school math class. *The Elementary School Journal*, *98*, 15-26.

Su, R., Rounds, J., & Armstrong, P. I. (2009). Men and things, women and people: A meta-analysis of sex differences in interests. *Psychological Bulletin*, *135*, 859-884.

U.S. Department of Education, Office of Planning, Evaluation, and Policy Development. (2008). *Early implementation of public single-sex schools: Perceptions and characteristics* (No. ED-01-CO-0055/0010). Washington, DC: Government and Printing Office.

Vogt, P. W. & Johnson, R. B. (2011). *Dictionary of statistics & methodology: A nontechnical guide for the social sciences*, 4th edition. Los Angeles: Sage Publications.

Voyer, D. V., Voyer, S., & Bryden, M. P. (1995). Magnitude of sex differences in spatial abilities: A meta-analysis and consideration of critical variables. *Psychological Bulletin*, *117*, 250-270.

Witelson, S. F., Glezer, I. I., & Kigar, D. L. (1995). Women have greater density of neurons in posterior temporal cortex. *Journal of Neuroscience*, *15*, 3418-3428.

Zajonc, R. B. (1965). Social facilitation. *Science*, *149*, 269-274.

Footnotes

1. Effect size refers to the magnitude of the difference between group means expressed in standard deviation units; an effect size score of $\geq$.80 is considered to be large (Cohen, 1992).

2. In this study by Su et al. (2009), as in all subsequent studies in this paper, a negative effect size, *d*, reflects a difference that favors women, and a positive effect size, *d*, reflects a difference that favors men.

3. When item 11f ("There was a lot of competitiveness among students in this class.") was added to the social support index, the Cronbach's alpha dropped to 0.713; thus, item 11f was not included in the final index.

Appendix I

Fall 2011 Student Survey

As you know, all PSYC and NEURO students are required to complete a statistics course as part of their major. And, some of you may opt to take advantage of statistics in the future. This survey is designed to give us a better understanding of your experiences and preferences regarding math, statistics, and computer technology. There are no "right or wrong" answers; we are simply interested in hearing what you have to say. This survey is voluntary and completely confidential. It should take you no more than 30 minutes to complete. If you have any questions, please feel free to contact Professor Nancy Genero or Julia Martin. Thank you!

1. Please enter the last three letters of your last name.
2. Year in college?
    a. First Year
    b. Sophomore
    c. Junior
    d. Senior

    2a. In the space provided below, please indicate your racial/ethnic background (optional).
3. What is your major or double major? If you have not yet declared, please indicate below your intended major or double major.
4. Did you take an advanced placement statistics course in high school?
5. How did you score in the math section of the SAT or ACT?
    a. Below average
    b. Average

   c. Above average
   d. Well above average
   e. Not applicable
6. Have you completed a research methods course in Psychology or Neuroscience?
7. Are you currently doing or would you like to do an independent research project in your department?
   a. Yes
   b. No
   c. Not sure
8. Are you currently enrolled in PSYC or NEURO 360 or 370 (Honors)?
9. Are you planning to attend or do any of the following within the next five years? (Answer yes or no)
   a. Graduate school (e.g., Ph.D., Master's)
   b. Medical school or other health professions program
   c. Law school
   d. Business school (i.e., MBA)
   e. Teach for America
   f. Teach grades K-12 as a career
   g. Work for a non-profit organization
   h. Work in the private business sector
   i. None of the above
10. The following questions pertain to your previous experiences & preferences regarding math, statistics, and/or computer technology. To what extent do you agree or disagree

with the following statements. (Had choice of strongly disagree, disagree, neither agree nor disagree, agree, or strongly agree.)

a. I've always enjoyed math.
b. I would only take a math or statistics course to fulfill a requirement.
c. Solving a difficult math problem is a satisfying experience.
d. I would rather work on a math problem than write a paper.
e. What I learn in my math courses is applicable to other areas that interest me
f. Learning math has always been challenging for me.
g. I do best in math courses when I can work with a tutor.
h. I prefer working on math problems on my own.
i. I enjoy learning new computer software programs.
j. Searching the internet is second nature to me.
k. I like using computer graphics to illustrate solutions to math problems.
l. I am confident that I would do well in a math or statistics course.

11. To answer the next set of questions, you should think of the math, statistics, or quantitative reasoning course that you most recently completed at Wellesley College. Without identifying that course, please answer the following questions using the scale below. (Had choice of strongly disagree, disagree, neither agree nor disagree, agree, or strongly agree.)

    a. I felt engaged by this class.
    b. I felt my quantitative understanding improved as a result of this class.
    c. I didn't feel comfortable participating in class.
    d. I felt I could relate to students in this class.

e. It seemed like students in this class really liked me.
f. There was a lot of competiveness among students in this class.
g. I became more confident as a result of this class.
h. I made new friends from taking this class.
i. If I needed help, I could always count on students in this class.
j. This class helped shape my academic goals.

12. Think again of your last math, statistics, or quantitative reasoning course at Wellesley. Prior to taking this course, how often did you anticipate the following activities would be stressful for you? (Had choice of never, rarely, occasionally, more often than not, most of the time, all of the time.)
    a. Knowing how to study for exams.
    b. Taking tests.
    c. Finishing problem sets on time.
    d. Being praised for my ability to do math in front of other students.
    e. Finishing lab reports on time.
    f. Getting a really good grade.
    g. Asking my teaching assistant for help outside of class.
    h. Being corrected for a wrong answer in front of other students.
    i. Asking questions in class.
    j. Going to office hours to meet with the professor.
    k. Being praised for the quality of my work in front of other students.
    l. Asking for help from the professor outside of class.
    m. Answering questions in class in front of other students.

n. Going to office hours to meet with my teaching assistant.

o. Letting others know how I'm doing in this class.

13. Stereotypes are described as generalizations about an individual's or group's characteristics (e.g., all little girls like dolls). However, there is some kernel of truth to be found in stereotypes (e.g., many but not all little girls like dolls). In the space provided below, please describe a specific stereotype about female college students that you think may interfere with your progress in a math or statistics class.
14. Do you think the presence of a male student would inhibit you from participating in a math or statistics class? If yes, please explain below.
15. Professor "so-and-so" is considered to be a top notch statistician/data analyst. In the space below, please list in rank order (with the first being the most important), five important personal traits or characteristics you would use to describe this professor.
16. At most colleges and universities, would this professor more likely be female or male? Please explain your answer.
17. Is there anything else you would like to let us know about your learning style, interests or preferences that may affect your performance in a math or statistics course?