12-15-2019

Consequences of Math Anxiety and Stereotype Threat: An Intersectional Perspective

Jennifer E. John Buck

CONSEQUENCES OF MATH ANXIETY AND STEREOTYPE THREAT: AN INTERSECTIONAL PERSPECTIVE

By

Jennifer E. John Buck

Bachelor of Arts – Psychology
North Central College
2010

Master of Social Work
Boston University
2013

A thesis submitted in partial fulfillment
of the requirements for the

Master of Arts – Psychology

Department of Psychology
College of Liberal Arts
The Graduate College

University of Nevada, Las Vegas
December 2019

UNLV | GRADUATE COLLEGE

Thesis Approval

The Graduate College
The University of Nevada, Las Vegas

October 22, 2019

This thesis prepared by

Jennifer E. John Buck

Entitled

Consequences of Math Anxiety and Stereotype Threat: An Intersectional Perspective

is approved in partial fulfillment of the requirements for the degree of

Master of Arts – Psychology
Department of Psychology

Rachael Robnett, Ph.D.
Examination Committee Chair

Jennifer Rennels, Ph.D.
Examination Committee Member

Mark Ashcraft, Ph.D.
Examination Committee Member

Gwen Marchand, Ph.D.
Graduate College Faculty Representative

Kathryn Hausbeck Korgan, Ph.D.
Graduate College Dean

Abstract

Individuals with science, technology, engineering, and math (STEM) skills are highly valued for their contribution to the U.S. workforce and society. However, women and some people of color enter STEM fields at lesser rates than do White men. Math anxiety and stereotype threat have been found to cause math performance decrements for women and some people of color. Presently, it is not clear how math anxiety and stereotype threat might work together to dually influence math performance and subsequent STEM participation. The current study focuses on a diverse sample of 295 undergraduate students who were randomly assigned to one of two threat conditions prior to taking a math test. Participants also completed measures of implicit gender-math attitudes and math anxiety. Despite a failure to replicate prior research, contributions of the current study include a better understanding of how math anxiety presents in an ethnically diverse sample as well as how math anxiety and math task performance vary by demographic factors such as age, major, and first-generation status. Implications for future research regarding math anxiety and stereotype threat in diverse groups are discussed.

Keywords: math anxiety, stereotype threat, intersectionality, gender, race, STEM education

Table of Contents

Introduction

Science, technology, engineering, and math (STEM) fields have become increasingly important within our technology-focused and interconnected world, and individuals with skills and knowledge in STEM are highly valued for their ability to contribute significantly to the U.S. economy and workforce (NSF, 2016). Recent years have seen the implementation of many initiatives aimed toward increasing participation in STEM fields and bolstering STEM education (Koizumi, 2015). However, there continues to be both gender and racial inequity in STEM (Cook, Mason, Morse, & Neuhauser, 2015; NSF 2016). For example, women who pursue bachelor's degrees in STEM are underrepresented in STEM careers. Indeed, women obtain about 50% of bachelor's degrees in STEM, but account for only about 29% of the total STEM workforce (NSF, 2016). Members of various ethnic groups are also underrepresented in STEM fields. For instance, people who identify as Hispanic, Black, American Indian, or Alaska Native make up nearly 30% of the U.S. population, but hold only 11% of STEM jobs (NSF, 2016).

These statistics are concerning for several reasons. First, gender and racial gaps in STEM persist despite concerted efforts to close them using a variety of interventions, such as improving STEM education, employing goal orientation and values affirmation in STEM classrooms, and improving environmental factors for women in STEM (Hernandez et al., 2013; Koizumi, 2015; Miyake et al., 2010; Ramsey, Betz, & Sekaquaptewa, 2013). Second, an emerging body of literature has found that diversity in the workplace is associated with increased creativity and innovation (Ostergaard, Timmermans, & Kristinsson, 2011), factors that are vital for the United States to maintain its status as a global leader in STEM education and innovation (Committee on STEM Education, 2018). In addition, there is research suggesting no significant differences in math performance based on gender (Hyde et al., 2008), and although there is evidence of racial differences in math performance (AAUW, 2008), research suggests that these differences can be at least partially eradicated when controlling for socioeconomic status (Magnusen & Duncan, 2006).

Why, then, is the STEM gap so persistent for women and certain people of color? One possibility is that members of these groups have uniquely negative experiences with math throughout their education. The current research will focus on two of these negative experiences: math anxiety and stereotype threat. *Math anxiety* is a fearfulness of math that has negative effects on math performance (Ashcraft, 2002). *Stereotype threat* is the fear of confirming a negative stereotype held about one's group, which tends to result in math performance decrements (Steele, 1997). For example, math-specific stereotype threat targets women via the stereotype that they are "bad" at math, whereas the same phenomenon targets underrepresented racial groups via negative stereotypes about their intellectual capabilities.

Although a multitude of factors influence an individual's decision to pursue STEM (see Halpern et al., 2007, for a review), the current research focuses on math anxiety and stereotype threat for two reasons. First, gender and racial inequities tend to be most severe in math-intensive STEM fields (e.g., computer science, engineering, and some physical sciences; NSF, 2016). Second, most STEM fields – even those that are not math-intensive – require math proficiency. Given that stereotype threat and math anxiety are associated with reduced math performance and disengagement from math (Davies, Spencer, Quinn & Gerhardstein, 2002; Hembree, 1990), these negative experiences may contribute to a lower likelihood of pursuing STEM majors in college or STEM careers.

There is ample literature regarding the negative effects of math anxiety and stereotype threat. However, there is a shortage of work examining how they might work together to dually influence math performance. Further, little prior work has tested for variation in the effects of these constructs at the intersection of race and gender. The current study aims to address these gaps in the literature while also replicating prior research findings in the fields of math anxiety and stereotype threat.

Literature Review

Math Anxiety

Math anxiety is a fearfulness that impedes math performance in both academic and everyday situations. It is most often studied as a trait, or habitual, form of anxiety that is thought to be present whenever an individual interacts with math (Goetz et al., 2013; Roos et al., 2015). Math anxiety is negatively correlated with math achievement scores across both age and gender, and is often positively correlated with an aversion to math (Ashcraft, 2002; Hembree, 1990; Richardson & Suinn, 1972). For example, in a study of both college students and adults, higher levels of math anxiety were associated with lower math performance scores (Miller & Bischel, 2004). In addition, higher math anxiety is related to more negative personal views of math. For instance, a meta-analysis on math anxiety found that, in college students, higher math anxiety was related to less enjoyment of math, lower self-confidence in math, lower math self-concept, less motivation in math, and an overall more negative attitude towards math (Hembree, 1990). Math anxiety is also related to a lesser intent to pursue math classes and math-intensive college majors or careers (Hembree, 1990; Ma, 1999). Finally, although math anxiety seems to peak around ninth grade (Hembree, 1990; Wigfield & Meece, 1988), college students and adults also report feelings of math anxiety (Beilock & Willingham, 2014; Jameson & Fusco, 2014).

Gender differences in math anxiety. Girls and women consistently report higher levels math anxiety than do men (Beilock, Gunderson, Ramirez & Levine, 2010; Goetz et al., 2013; Hembree, 1990; Jameson et al., 2014; Ramirez, Gunderson, Levine, & Beilock, 2013; Wigfield et al., 1988). Further, higher math anxiety in women is negatively correlated with their interest in science careers (Chipman, Krantz, & Silver, 1992). This disinterest is particularly problematic because, as noted earlier, women already pursue math courses and math-intensive careers far less than do men (Jacobs, 2005), and they are significantly underrepresented in math-intensive STEM fields (NSF, 2016).

Racial differences in math anxiety. Although there are clear gender differences in math anxiety, the available literature on racial differences in math anxiety is both sparse and somewhat inconsistent. For example, one meta-analysis found that Hispanic/Latino college students cited higher overall math anxiety than White students (Hembree, 1990). However, another meta-analysis found that mean levels of math anxiety were essentially the same in both diverse and non-diverse samples (Ma, 1999). Thus, despite there being some data on racial differences in math anxiety, the findings are ultimately inconclusive.

Academic Stereotypes and Stereotype Threat

Math anxiety may be one reason why women, and potentially people of color, choose not to enter math-intensive careers (Chipman et al., 1992), but it is not the only factor. For some groups, exposure to stereotypes can reduce both performance and interest in academic domains such as math (Davies et al., 2002). For example, there is a prevailing U.S. stereotype that women are "bad at math" (Eccles, Jacobs, & Harold, 1990; Shapiro & Williams, 2012; Shih, Pittinsky, & Ambady, 1999; Spencer, Steele, & Quinn, 1999). There is also a prevalent stereotype that certain racial groups are not as intelligent as others (Steele, 1997; Steele & Aronson, 1995).

Implicit stereotypes. Many individuals are hesitant to openly agree with stereotypes. This is likely due to social desirability pressures (Krumpal, 2013). Thus, stereotypes are often assessed via implicit measures. The most common way to test for implicit attitudes is to use the implicit association test (IAT; Greenwald & Banaji, 1995), which measures associations that are thought to occur outside of conscious awareness (Greenwald et al., 1995). Research using the IAT consistently shows that both men and women associate men with math and science domains and women with other fields, such as liberal arts (Cvencek, Meltzoff, & Greenwald, 2011; Kiefer & Sekaquaptewa, 2006; Nosek et al., 2007; Nosek et al., 2009; Steffens, Jelenec & Noack, 2010). Accordingly, as a preliminary step, I administered the IAT to my participants in the current study to determine whether or not they held common math-gender stereotypes.

Stereotype threat activation. Negative stereotypes contribute to a phenomenon called *stereotype threat*, which is a term used to describe the pressure or anxiety an individual feels when they believe they are at risk of confirming a negative stereotype held about their group (e.g., gender, race; Spencer et al., 1999; Steele, 1997; Wheeler, Jarvis, & Petty, 2001). Stereotype threat can be activated in a variety of ways. Nguyen and Ryan's (2008) meta-analysis noted three key ways of inducing stereotype threat: indirect or subtle, moderately explicit, and blatant. *Indirect* or *subtle* stereotype threat activation involves manipulations that aim to implicitly make group membership salient to the test-taker. For example, inquiring about race or gender prior to having participants take a test would be a form of subtle stereotype threat activation. Stating diagnostic aims of a task is also a form of subtle stereotype threat activation. *Moderately explicit* stereotype threat activation involves directly conveying group differences in performance, but does not include the direction of these group differences; the interpretation of the message is left up to the participant. For example, stating that there are racial or gender differences on a math task would be a form of moderately explicit stereotype threat activation. *Blatant* stereotype threat activation includes explicitly stating a message about a group's inferior abilities. For example, stating that men perform better than women, or that White people perform better than Black people on a math task, are examples of blatant stereotype threat activation.

Different forms of threat-activation produce different results across diverse groups. For instance, Nguyen et al. (2008) found that subtle threat-inducing cues produced the largest stereotype threat effects for women. This finding informed my decision to use a subtle stereotype threat manipulation in the current study. There is also variation in how experimental manipulations are used in stereotype threat research. For instance, researchers will sometimes employ a no-threat condition in which the stereotype threat is neutralized, whereas others will use multiple threat conditions (e.g., subtle and moderately explicit) and may or may not include a control or no-threat condition (Smith & White, 2002; Stone, 2002). However, most research uses threat and control conditions (see Pennington, Heim, Levy, & Larkin, 2016). To align with the majority of the literature, I decided to use threat and control conditions in the current study.

Stereotype threat and women. There are several key studies related to stereotype threat effects on women's math performance. For example, Spencer et al. (1999), using a moderately explicit form of activation, induced stereotype threat in women by stating that the math test they were about to take had produced gender differences in the past. The authors found that women in the stereotype threat condition performed worse on the math task than men in general, and worse than women in either the no-threat (stating that no gender differences had been found on the test) or control (stating no information about the test) conditions. Further, Good, Aronson, and Harder (2008) found evidence for subtle stereotype threat activation in women. The authors had men and women in a high-level college math course take a math exam. Half of the sample was told only about the diagnostic nature of the exam; the other half of the sample was also told that no gender differences had been found on the exam. Men's scores across conditions did not differ. However, women who were told only about the diagnostic nature of the exam performed worse than women who were also told that no gender differences had been found. These results provide further evidence for the subtle activation of stereotype threat in women, such that simply taking an exam in a math course may be enough to elicit threat effects on their performance.

It is important to note that stereotype threat has consequences outside of causing math performance decrements for women. Specifically, stereotype threat – much like math anxiety – can lead to a disidentification with the threat domain (Crocker & Major, 1989; Steele, 1997). In other words, repeated exposure to stereotype threat can lead individuals to psychologically disconnect from domains that they once valued. For example, women who experience stereotype threat have less interest in quantitative domains and less motivation to improve within these domains (Davies et al. 2002; Fogliati & Bussey, 2013). These findings suggest that stereotype threat may play a role in why women pursue math-intensive STEM careers at a lesser rate than White men.

Stereotype threat and race. Only a few studies have tested for racial differences in stereotype threat effects on math performance. Steele and Aronson (1995), using a subtle form of stereotype threat activation, found significantly lower test scores among African American men when they were told a test would be diagnostic of their academic abilities than when they were not told about the diagnostic aims of the test. Similar results were found among Latino college students when they were told that a test would be diagnostic of their abilities as opposed to when no references were made to the diagnostic aims of the test (Gonzales, Blanton, & Williams, 2002). In addition, Armenta (2010), using a moderately explicit form of stereotype threat activation, found that Latino participants performed worse on a math task when they were told that the test had previously found racial differences in performance than when they were not told about racial differences in performance. These results suggest that a variety of stereotype threat activation techniques can also elicit threat effects in people of color.

Exposure to stereotype threat can also foster disidentification with math and science domains for people of color. For example, comparable to findings in samples of women, research has found that exposure to stereotype threat is related to scientific disidentification and a lesser likelihood of pursuing a scientific career for Black and Hispanic/Latino college students (Woodcock Hernandez, Estrada, & Schultz, 2012). Thus, stereotype threat may also play a role in why people of color are underrepresented in STEM.

Working Memory

The most commonly accepted mechanism by which both math anxiety and stereotype threat function in relation to math performance is *working memory* (Ashcraft & Kirk, 2001; Beilock & Maloney, 2015; Beilock, Rydell, & McConnell, 2007). Working memory is a mechanism of short-term memory that is involved with regulating and maintaining a limited amount of information related to the task being completed (Miyake & Shah, 1999). The anxiety felt by either the prospect of completing a math task (math anxiety) or the prospect of confirming a negative stereotype about one's group (stereotype threat) takes up cognitive resources, disrupts thinking and reasoning ability, and ultimately takes away from the working memory capabilities necessary to complete the task at hand (Ashcraft & Kirk, 2001; Beilock & Maloney, 2015). Ashcraft and Kirk (2001) tested this theory through a working memory task during which participants were asked to remember increasingly large sequences of words or numbers. Results revealed that math anxiety had a significant effect on participants' performance only during the numeric working memory task. In other words, higher math-anxious individuals saw a larger decrement in their numeric task performance, but this effect did not occur for word task performance. These results suggest that math anxiety does indeed negatively impact numeric working memory.

Processing efficiency theory. The explanation for how anxiety or worry can cause a decrease in performance is called *processing efficiency theory* (Eysenck & Calvo, 1992). This theory posits that anxiety reduces both the storage and processing capacity of the working memory system. The result is a decrease in an individual's capability to efficiently process the information necessary to complete a task. Importantly, this theory suggests that the reduction in working memory capacity is associated with detriments to performance regardless of an individual's actual ability (Ashcraft & Kirk, 2001; Ashcraft, Krause, & Hopko, 2007; Faust, Ashcraft, & Fleck, 1996). Indeed, Faust et al. (1996) found that on an untimed, pencil and paper math task, participants of all math anxiety levels performed equally well, whereas the same tasks elicited math anxiety effects in timed laboratory settings, such that those with higher math anxiety performed worse on the math task. In other words, anxiety inducing situations are not necessarily a proxy for low ability. Rather, these situations likely cause a reduction in working memory efficiency, which inevitably leads to lowered performance on the given task.

Intersectionality as Related to Math Anxiety and Stereotype Threat

Theorists and researchers are beginning to explore how various forms of identity can intersect to create complex systems of privilege and oppression. At its core, the *intersectionality* movement aims to understand how multiple forms of identity intersect to create different forms of oppression (e.g., structural, social, political, economic; Crenshaw, 1991). The concept of intersectionality originated in the early political movements of lesbian women of color (Carastathis, 2014). However, the term was first used by Kimberlé Crenshaw in an academic publication that aimed to expand U.S. anti-discrimination laws from addressing the experiences of only White women and Black men (Carastathis, 2014). Today in the field of psychology, intersectionality is used to define scientific approaches that simultaneously consider multiple categories of identity (i.e., gender and race; Else-Quest & Hyde, 2016). Importantly, simply considering multiple categories of identity is not enough; a key tenet of intersectionality is that it must also aim to understand and explain the impact of status and power relations on the well-being of diverse groups (Warner, 2008).

Research conducted from an intersectional standpoint typically takes a qualitative approach to understanding how gender and racial identities interact to influence women of color in STEM fields. For instance, Johnson, Brown, Carlone, and Cuevas (2011) conducted narrative interviews with four women of color in science. All women reported unique conflicts between constructing their identities as scientists and honoring their identities as women of color. For instance, one woman reported hiding her good science grades to maintain her social status as a "hip Black woman." Another woman recounted that she was required to dissect an animal for a science class when it directly conflicted with her beliefs as a Native Indian. In addition, Carlone and Johnson (2007) found that some women of color in science reported feeling overlooked and neglected. In other words, these women felt that both gender and racial factors prevented them from being viewed as good scientists by peers and professors throughout their education.

To my knowledge, only one quantitative study has used intersectional methods to investigate the effects of stereotype threat on math performance. Gonzales et al. (2002) found that, in a sample of White and Latino/a men and women, only Latina women experienced performance decrements when they were told that a math task would be diagnostic of their abilities. In other words, Latina women experienced the most negative consequences of stereotype threat. This result is likely due to their dual minority status as women of color. These findings are an illustrative example of how intersectional approaches can help illuminate the interplay between gender and race. Should only one of these variables be examined, important nuances are lost.

The Current Study

The first objective of the current study was to replicate existing work from the math anxiety and stereotype threat literatures. Replicability is a crucial component of scientific discovery, and the ability to replicate findings within diverse samples provides critical insight into the generalizability of key theories and findings (Simmons, Nelson, & Simonsohn, 2011). Accordingly, my first set of hypotheses was as follows:

H1a: Women in the gender-salient threat condition will perform worse on a math task than women in the non-gender salient condition;

H1b: Women in the gender-salient threat condition will perform worse on a math task than men across conditions;

H2: Women will report higher overall levels of math anxiety than men.

In addition to replicating prior research, the current study also aimed to address two major gaps within the existing literature. The first gap can be characterized by the following question: Do math anxiety and stereotype threat work together to dually influence math performance? Although math anxiety and stereotype threat lead to similar outcomes (i.e., math performance decrements) and are theorized to work via the same cognitive mechanism (i.e., working memory), they are often discussed and studied separately. Thus, existing work may be missing an important theoretical distinction between math anxiety and stereotype threat in relation to their individual effects or potential dual influence on math performance. For example, previous research indicates that negative stereotypes can be implicitly activated in math-testing situations (Shih, Pittinsky, & Ambady, 1999), which suggests that stereotype threat may be a confound in math anxiety studies. Similarly, studies looking to manipulate stereotype threat do not control for pre-existing math anxiety. Thus, it is possible that math anxiety and stereotype threat may confound or interact with each other. Therefore, my third hypothesis was as follows:

H3: For women, there will be a two-way interaction between math anxiety and condition, such that women with the highest levels of math anxiety will have the lowest performance levels on a math task when stereotype threat is induced. Further, women in the gender-salient threat condition who have the highest levels of math anxiety will also have the lowest performance on the math task when compared to all men, regardless of the men's condition or level of math anxiety.

The second gap I address pertained to the need for a more thorough intersectional examination of the effects of math anxiety and stereotype threat. Prior literature has demonstrated that there are some racial differences in math anxiety and stereotype threat effects (Hembree, 1990; Gonzales et al., 2002), but the research is far from comprehensive. Most often, research aims to address either gender *or* racial differences in these constructs rather than examining gender by race effects. Therefore, I propose two research questions:

RQ1: Do average levels of math anxiety vary significantly by race for women?

RQ2: Does the gender-salient threat manipulation affect certain racial groups of women more than others?

Methods

Participants and Setting

The current study focused on the effects of math anxiety and stereotype threat in women. A power analysis conducted in the G*Power program (Faul, Erdfelder, Lang, & Buchner, 2007) suggested that 210 *female* participants would result in a power of .95 to detect a moderate effect size of .25. Therefore, although I needed male participants as a comparison group for the study, a total of 210 female participants was my minimum target sample size. The effect size of .25 was generated based on the aforementioned meta-analysis by Nguyen et al. (2008), which suggested an overall mean effect size of .26 for subtle stereotype threat manipulations among women.

Undergraduate participants ($N = 313$) were recruited from the University of Nevada, Las Vegas (UNLV) psychology participant pool and participated for course credit. UNLV has been consistently ranked as one of the most diverse campuses in the U.S. (UNLV Media Relations, 2017), with nearly 60% of students identifying as members of ethnic minority groups, and 57% of students identifying as women (UNLV, 2016). Thus, the diversity of the UNLV student body provided a unique opportunity to test our intersectional research questions.

The mean age of the full sample was 20.58 years, with participants ranging from 18 to 41 years of age. However, outlier analyses - as detailed later - illustrated that there were 18 significant outliers in the sample, based on age. Accordingly, the current study focuses on 295 participants aged 18-28 ($M = 19.90$), essentially limiting the sample to participants in the developmental period of emerging adulthood (ages 18-30; Arnett, 2000). Sixty-nine percent of the sample identified as female ($n = 205$), 29% of the sample identified as male ($n = 85$), and two percent of the sample elected not to disclose their gender identity ($n = 5$). Twenty-nine percent of the sample identified as Asian/Pacific Islander ($n = 85$), 27% identified as Hispanic/Latino ($n =$

79), 26% identified as White (*n* = 78), 11% identified as African American (*n* = 31), four percent identified as multiracial (*n* = 12), and 1% identified as Native American (*n* = 4). Six participants (2%) did not disclose their ethnic identity. The sample was nearly an even split between STEM majors (48%, *n* = 142) and non-STEM majors (50%, *n* = 147). Six participants (2%) elected not to disclose their major.

Design

Each participant completed two online research sessions. During session one (S1), all participants completed the IAT and the Abbreviated Math Anxiety Scale (AMAS). The IAT was used as a preliminary check to ensure that participants held the expected math-gender stereotypes found in prior research. The order of these two measures was counterbalanced, and no order effects were found during preliminary analyses. The purpose of S1 was to obtain a baseline measure of both implicitly held math-gender stereotypes and math anxiety.

Approximately one week after participants completed S1, they completed session two (S2). The purpose of separating S1 and S2 by one week was to avoid priming participants with the IAT or math anxiety questionnaire before the experimental manipulation. At the beginning of S2, participants were randomly assigned to one of two threat conditions (gender salient or non-gender salient) prior to receiving a math task (Appendix A). The experimental design was a modification of subtle stereotype threat procedures used in prior work on stereotype threat with college women (Shih et al., 1999), in addition to procedures used by both Steele and Aronson (1995) and Gonzales et al. (2002). In the gender salient condition, participants responded to questions such as, "Are most of your friends women or men?" In the non-gender salient condition, participants responded to questions that were not related to gender, such as, "Do you have any pets?" All manipulation questions were likely things that individuals have thought about before and are therefore minimally invasive with minimal risk.

Prior to beginning the math task, participants in the gender-salient condition received threat enhancement phrasing, which stated that the math task they were about to complete was very difficult, measured personal factors involved in their performance, and assessed their true mathematical abilities and limitations (Appendix B). Unintentionally, participants in the non-gender salient condition received this phrasing as well. As such, the current study has no control condition, but instead two slightly different threat conditions: (1) gender-salient + threat enhancement and (2) non-gender salient + threat enhancement. I will return to the implications of this error in the discussion.

Procedure

Both research sessions occurred via the Qualtrics online survey software. At both S1 and S2, participants completed the online survey remotely in a location of their choice. All participants completed a consent process at both S1 and S2 and had the opportunity to ask questions at any time. All students received an electronic debrief after study procedures were complete.

Measures

Implicit Association Test (IAT). Participants completed a math-gender IAT during S1. Participants followed standard IAT procedures (Greenwald, McGhee, & Schwartz, 1998), which require that they quickly sort words associated with either math (e.g., algebra, equation, numbers) or language (e.g., reading, poetry, writing) into different categories (i.e., male and female) (Appendix C). The IAT has generally shown good internal reliability in prior work (Lane, Banaji, Nosek, & Greenwald, 2007). The IAT is interpreted by computing an overall difference score (D) for each participant. The D score is a measure of effect size and indicates preference for one of the two target groups over the other; a D score of 0 indicates no preference (Greenwald, Nosek, & Banaji, 2003). In this case, a positive D score would indicate a stronger association of men with math, whereas a negative D score would indicate a stronger association of women with math.

Math Anxiety. Participants also completed the Abbreviated Math Anxiety Scale (AMAS; Appendix D; Hopko, Mahadevan, Bare & Hunt, 2003) at S1. The AMAS is a 9-item measure that has shown excellent internal reliability in prior work. This measure is used to assess individual math anxiety. Participants were asked to rate statements in terms of how much anxiety they believe different situations would cause. Sample items include, "Thinking about an upcoming math test the day before" and "Starting a new chapter in a math book." Items are rated on a scale of 1 (*low anxiety*) to 5 (*high anxiety*). Higher scores indicate higher math anxiety. Reliability was good in the current sample (α = .87).

Math Task. After receiving the manipulation at the beginning of S2, participants completed a math task (Appendix E). The math task was timed and composed of 15 SAT-type questions that ranged in difficulty. Math problems from available online practice tests were used to create the math tasks. Participants had 15 minutes to complete as many problems as possible.

Demographics. Participants provided demographic information as their last task during S2 (Appendix F). Specifically, they responded to questions about racial identification, gender identification, age, and college major. The demographics measure was completed last to prevent the possibility of priming or activating stereotypes outside of the experimental manipulation.

Results

Findings from the current study are presented in three sections. First, I begin by describing my preliminary analyses, which included an examination of implicit stereotype endorsement as well as tests for significant covariates and outliers. Next, I present the results of my hypothesis tests regarding gender. Finally, I report the results pertaining to my research questions on intersectionality.

Preliminary Analyses

Correlations between all continuous variables of interest are presented in Table 1. Preliminary analyses included an examination of IAT scores to determine whether participants in the sample held math-gender stereotypes favoring men. The average D score for the sample was .258 (SD = .438). A t-test indicated that the sample average D score was significantly different from zero ($t(291) = 10.070$, $p < .001$). These results indicate that participants in the current sample held expected stereotypical associations between men and math. Further, a follow-up t-test indicated that although both men (M = .338) and women (M = .224) reported math-gender stereotypes that favor men, men reported significantly stronger associations between men and math than did women ($t(285) = 2.023$, $p = .044$). A one-way ANOVA revealed no significant differences in D scores by ethnicity ($F(3, 266) = 1.400$, $p = .243$).

I also investigated whether math task performance and math anxiety differed based on the following demographic variables: age, major, and first-generation status. Because the sample included several students who were nontraditional in terms of their age, I conducted a test for possible multivariate outliers with respect to age and math anxiety. Inspection of Mahalanobis Distance statistics for each participant revealed significant multivariate outliers, $d^2_{max}(2) = 33.969$, $p < .05$. Ultimately, 18 outliers were removed from the sample and all subsequent analyses. These outliers included all participants aged 30 years and older, as well as any participants aged 25 or older whose Mahalanobis Distance statistic exceeded the critical X^2 criterion (5.99). After the removal of outliers, a regression analysis indicated that age was a significant predictor of math anxiety ($F(1, 304) = 5.917$, $p = .003$, $R^2 = .031$), such that for each unit increase in age, math anxiety was expected to decrease by .070 units ($b = -.070$, $SE = .023$, $p = .003$). Age was not a significant predictor of math performance ($F(1, 286) = 1.211$, $p = .272$).

Next, a two group MANOVA indicated significant differences in the linear combination of math anxiety and math task performance, by both major (STEM/Non-STEM), $\lambda = .964$, $F(2, 284) = 5.385$, $p = .005$, and first-generation status, $\lambda = .973$, $F(2, 284) = 3.868$, $p = .022$. Follow up univariate tests indicated that STEM majors ($M = .444$) performed significantly better on the math task than did non-STEM majors ($M = .393$), $F(1, 285) = 6.153$, $p = .014$, $\eta_p{}^2 = .021$. STEM majors ($M = 2.585$) also reported significantly lower math anxiety than did non-STEM majors ($M = 2.783$), $F(1, 285) = 5.974$, $p = .015$, $\eta_p{}^2 = .021$. Further, first-generation students ($M = 2.846$) reported significantly higher math anxiety than did non first-generation students ($M = 2.592$), $F(1, 285) = 6.850$, $p = .009$, $\eta_p{}^2 = .023$. First-generation status was not a significant predictor of math task performance, $F(1, 285) = 1.634$, $p = .202$. Finally, the interaction between major and first-generation status was not significant, $\lambda = .992$, $F(2, 284) = 1.186$, $p = .307$. The following analyses were conducted after controlling for age, major, and first-generation status, where appropriate.

Finally, chi-squares explored whether or not first-generation and continuing-generation students differed by gender, major, or race. Chi-square analyses found no differences in generational status by gender ($X^2\,(1) = 2.055$, $p = .152$, $V = .084$), or major ($X^2\,(1) = .011$, $p = .917$, $V = .006$). However, with regard to the four largest racial groups, first-generation students were significantly more likely to identify as Hispanic/Latinx than they were to identify as White, Asian, or Black (X^2 (3) = 25.990, p <.001, V = .309).

Hypothesis Testing

Hypothesis H1a predicted that women in the gender salient condition would perform worse than women in the non-gender salient condition. Hypothesis H1b predicted that women in the gender-salient threat condition would perform worse than men across conditions. I tested both predictions with a 2 x 2 ANCOVA, using condition (gender-salient vs. non-gender salient) and gender (women vs. men) as IVs, math task performance as the DV, and major as a covariate. Results from the ANCOVA indicated that major was a significant covariate (F(1, 284) = 7.320, p = .007, η_p^2 = .025), but otherwise found no significant differences in math task performance by gender (F(1, 284) = .304, p = .582), condition (F(1, 284) = 1.396, p = .238), or the interaction between the two (F(1, 284) = .186, p = .667).

Hypothesis H2 predicted that women would report higher levels of math anxiety than men. I tested this using a one-way ANCOVA using gender as the IV, math anxiety as the DV, and both age and first-generation status as covariates. Age (F(1, 284) = 8.710, p = .003, η_p^2 = .030) and first-generation status (F(1, 284) = 5.327, p = .022, η_p^2 = .018) were significant covariates, but gender was not a significant predictor of math anxiety (F(1, 284) = 2.126, p = .146).

Hypothesis H3 predicted that, for women specifically, there would be a 2-way interaction between math anxiety and condition, such that performance on the math task would be worst for women with high math anxiety who were also in the gender-salient threat condition. This hypothesis was analyzed using multiple regression to determine whether math anxiety and condition interacted to negatively affect women's math task performance. Specifically, predictors in the model included major as a covariate, math anxiety, experimental condition, and the two-way interaction between math anxiety and experimental condition. To improve interpretability, math anxiety scores were centered at zero prior to computing the interaction term. The overall regression was non-significant ($F(4, 200) = 1.685$, $p = .155$, $R^2 = .033$), indicating that there was no main effect of math anxiety or condition, and no interaction between math anxiety and condition, on math task performance for women. Major was not a significant covariate.

Research Question Analyses

My first research question (RQ1) explored whether average levels of math anxiety among women varied significantly by race. This research question was investigated using a one-way ANCOVA. Specifically, the IV was race (White, Hispanic/Latina, Asian/Pacific Islander, and African American), the DV was math anxiety, and both age and first-generation status were added as covariates. Age ($F(1, 188) = 7.912$, $p = .005$, $\eta_p^2 = .040$), but not first-generation status ($F(1, 188) = 1.903$, $p = .169$), was a significant covariate. In addition, no significant racial differences in math anxiety were found for women, $F(3, 188) = .523$, $p = .667$.

Research question two (RQ2) aimed to explore whether the gender-salient threat manipulation would affect certain racial groups of women more than others. This research question was analyzed using a 2 x 4 ANCOVA. Specifically, the IVs were condition (gender-salient vs. non-gender salient) and race (White, Hispanic/Latina, Asian/Pacific Islander, and African American). The DV for this analysis was math task performance, and major was added as a covariate. Major was not a significant covariate, $F(1, 186) = 1.422$, $p = .235$. Further, math task performance did not vary significantly by race ($F(3, 186) = 1.861$, $p = .138$), condition ($F(1, 186) = 2.132$, $p = .146$), or the interaction between the two ($F(3, 186) = 1.901$, $p = .131$).

Finally, I tested for a three-way interaction between race, condition, and math anxiety for women. Specifically, predictors in the model included major as a covariate, math anxiety, experimental condition, ethnicity, the two-way interaction between ethnicity and math anxiety, the two-way interaction between ethnicity and condition, the two-way interaction between math anxiety and condition, and the three-way interactions between ethnicity, math anxiety, and condition. The DV for this analysis was math task performance. To improve interpretability, math anxiety scores were centered at zero prior to computing the interaction terms. The overall regression was non-significant, $F(16, 178) = 1.536$, $p = .092$, $R^2 = .121$. As such, no further analyses were conducted to test for two-way interactions between math anxiety and experimental condition on math task performance for women of color.

Discussion

Math anxiety and stereotype threat have repeatedly been found to produce negative math-related outcomes for both women and people of color (e.g., Hembree 1990; Nguyen & Ryan, 2008), and are theorized to work via the same cognitive mechanism (i.e., a reduction in working memory; Maloney & Beilock, 2012; Miller & Bischel, 2004). However - despite their similarities - these literatures remain largely separate. As such, existing research may be missing important theoretical distinctions or interactions between how math anxiety and stereotype threat affect math performance. The current study aimed to fill this gap in the literature by both replicating prior research and exploring the dual effects of math anxiety and stereotype threat on math task performance, while also using an intersectional perspective. Although preliminary analyses revealed several patterns that are consistent with prior research, the core analyses failed to reveal significant gender or racial differences in both math anxiety and math task performance.

Expected Findings: Covariates and IAT Scores

Findings revealed several significant patterns that are supported by existing literature. For instance, math anxiety scores differed significantly as a function major and first-generation status, whereas math task performance differed significantly as a function of major only. More specifically, first-generation students reported significantly higher math anxiety than continuing-generation students. In addition, STEM majors reported less math anxiety and also performed significantly better on the math task than did non-STEM majors. These covariates are meaningful because they provide relevant information about the unique experiences of college students from different backgrounds. In particular, they align with literature that suggests distinct barriers to STEM persistence for first-generation college students, including lower overall academic achievement, lower math confidence, and weaker self-reported math skills than their continuing generation counterparts (Katrevich & Aruguete, 2017). These covariates also support existing research suggesting that students with lower math anxiety are more likely to pursue STEM fields than students with high math anxiety (Ahmed, 2018). This finding aligns with literature suggesting a negative correlation between math anxiety and both math confidence and achievement (Wigfield & Meece, 1988). It also aligns with more recent literature suggesting that individuals with high confidence in their math abilities are more likely to choose STEM majors (Moakler Jr. & Kim, 2014); high math confidence is also associated with greater math performance (Wigfield & Eccles, 2000).

In addition, preliminary analyses indicated that the students in our sample held traditional math-gender stereotypes that favor men. This finding is congruent with extant literature on gendered ability stereotypes (Kiefer & Sekaquaptewa, 2007; Nosek, Banaji, & Greenwald, 2002). This suggests that math-gender stereotypes are alive and well, and that the null results from my hypothesis tests are not due to a decline in the prevalence of these stereotypes. Further, implicit math-gender stereotypes were held more strongly by men than women. This finding is consistent with some of the current literature on the topic. For instance, research with children, adolescents, and college students have found that men and boys hold significantly stronger math-male implicit stereotypes than do women and girls (Cvencek, Meltzoff, & Greenwald, 2011; Steffens & Jelenec, 2011).

Unexpected Findings: Covariates and Hypothesis Tests

Unexpected Covariates. Preliminary analyses revealed that levels of math anxiety differed as a function of age. More specifically, older students reported significantly lower math anxiety than did younger students. This was an unexpected covariate, as the literature suggests that math anxiety tends to level off during high school and remain relatively consistent throughout college and beyond (Hart & Ganley, 2019; Hembree, 1990). Indeed, older college students report similar levels of math anxiety to younger college students, and sometimes even report higher math anxiety than do younger college students (Jameson & Fusco, 2014). As such, this covariate raises an interesting question about why older college students might report less math anxiety than younger college students. One potential explanation comes from research showing that older college students (e.g., 24 years of age and older) are more likely to employ mastery goals, whereas younger college students are more likely to employ performance goals (see Johnson, Taasoobshirazi, Clark, Howell, & Breen, 2016). Mastery goals are used when striving to gain competence in an area; performance goals are used when striving to appear competent in an area (Elliot & Dweck, 2005). Extant research has found that mastery goals are associated with lower math anxiety (Federici, Skaalvik, & Tangen, 2015; Furner & Gonzalez-DeHass, 2011), suggesting that motivation and learning strategies likely differ between older and younger college students, and may have downstream implications for math anxiety and math performance. Future research should more thoroughly explore how age moderates the relationship between goal-orientation and math anxiety.

Unsupported Hypotheses. Results indicated that the stereotype threat manipulations failed to produce significant differences in math task performance by gender. This may be due in part to the methodological error described earlier, which invalidates the analyses that compared women in the gender-salient threat condition to women in the non-gender salient threat condition. More precisely, all women in the study were under some level of threat when they completed the math task. Hence, it is unsurprising that women's math performance did not vary as a function of condition.

However, analyses comparing women to men were still valid in comparing women under threat to men under threat, which is common in the stereotype threat literature. Indeed, this literature concludes that men are generally unaffected by stereotype threat manipulations in the math domain and, when under threat, perform significantly better than do women under threat (e.g., Good et al., 2008; Spencer, Steele, & Quinn, 1999; Steele, 1997). As such, I expected that men would outperform women on the math task. Counter to expectations, however, I found no such effect. Interestingly, a pilot experiment conducted at the same institution – using a moderate threat manipulation as well as a control group for comparison - also failed to produce gender differences in math task performance (see Appendix G for a summary of results). Taken together, these results suggest that fairly commonplace stereotype threat findings are not replicating in the UNLV student body.

In addition, there were no significant gender differences in average math anxiety, which is also in direct opposition to the literature and the aforementioned pilot results. This indicates another failure to replicate a fairly robust effect. Of note, when age and first-generation status were not considered as covariates, the expected gender difference in math anxiety approached significance. Given these covariates, it is possible that an increased proportion of both older and first-generation students in the current sample make it unique relative to samples obtained in prior work on math anxiety.

A small assembly of literature has found racial differences in the effects of math anxiety and stereotype threat (e.g., Gonzales et al., 2002; Hembree, 1990; Steel & Aronson, 1995), but an exploration of these differences across multiple racial groups has yet to be accomplished in a single study. As such, a key goal of the current study was to explore how math anxiety and stereotype threat might differ as a function of race. I explored this by comparing math anxiety and stereotype threat effects for the four largest ethnic groups in my sample (White, Asian, Hispanic/Latino, Black). However, these analyses did not yield significant differences. Intersectional analyses related to my research questions were also unfruitful, such that I did not find specific gender by race effects of stereotype threat or math anxiety on math task performance for women. More specifically, there was not a significant three-way interaction between race, math anxiety, and experimental condition for the women in my sample. The lack of stereotype threat effects among diverse sub-groups of women in my sample is likely a function of the manipulation error. However, the null math anxiety findings are potentially informative, as much of the core research on math anxiety does not examine differences by race. The current results suggest that levels of math anxiety are likely relatively consistent across these four racial groups.

Possible Explanations for Null Findings

Campus Climate. In addition to overlooking racial and ethnic differences, socio-cultural factors (e.g., diversity at the classroom or college level) are often ignored when examining math anxiety and stereotype threat. Indeed, the ethnic diversity of the current sample is much greater than what is found in the extant literature. As one of the most diverse campuses in the nation, UNLV both promotes and overtly values diversity in its student body. As such, it is possible that a more welcoming campus climate lessened math anxiety and the effects of stereotype threat in the current sample. Campus climate – or the feeling that one "belongs" on their campus or in their discipline – has been theorized to play a role in STEM performance and engagement (Eddy & Brownell, 2016). More specifically, research has found that "chilly" campus climates – as opposed to welcoming campus climates – are related to emotional exhaustion, cynicism, and greater feelings of identity interference for women in STEM (Jensen & Deemer, 2019). In contrast, feelings of social belonging on college campuses have been associated with higher academic achievement and improved physical and mental health in underrepresented racial groups (see Walton & Cohen, 2011). Future research on the effects of math anxiety and stereotype threat should aim to simultaneously consider socio-cultural factors such as campus climate, classroom diversity, and feelings of social belonging, as these may be theoretically and practically relevant moderators that present unique avenues for future intervention.

Identity. Further, some research has found that the strength of one's identity moderates the effects of stereotype threat. More specifically, individuals who strongly identify with the group being stereotyped are more likely to see a reduction in performance than individuals who do not strongly identify with the group being stereotyped (Schmader, 2002). Thus, it is possible that women who more strongly identify with their gender might have seen reduced performance on the math task when compared with women who do not strongly identify with their gender. Stereotype endorsement has also been found to moderate the effects of stereotype threat on women's math performance. More precisely, women who endorse gender stereotypes are more likely to suffer from the negative effects of stereotype threat on their math performance than are women who do not endorse gender stereotypes (Schmader, Johns, & Barquissau, 2004). The current study did not measure the strength of participants' gender identity, nor their endorsement of gender stereotypes. As such, it is possible that these factors may have also played a role in my failure to replicate stereotype threat effects.

Methodological Considerations

Manipulation Error. The manipulation error may explain why my hypotheses comparing women in the sample were not supported (H1a, H3, & RQ2). More specifically, this error assigned all participants to some threat condition, which may have suppressed women's performance across conditions. As such, it is possible that women in a control group might have performed better on the math task than the women in either of the threat conditions. In addition, a variety of methods have been used for inducing stereotype threat in previous literature (see Nguyen & Ryan, 2008 for a review). In fact, certain manipulations seem to work better for women, while other manipulations seem to work better for people of color. As the current study involved both gender and racial comparisons, it is possible that the subtle threat manipulations were not appropriate for eliciting racial differences in the effects of stereotype threat.

Publication Bias and Replication. Although stereotype threat is a well-documented phenomenon in the literature, there has been recent criticism of the core research, mostly in regard to confounded pre-test covariates, such as statistically adjusting for pre-existing math achievement scores (see Stoet & Geary, 2012). There is also quite a bit of heterogeneity in the existing stereotype threat literature. For example, Nguyen & Ryan's (2008) meta-analysis found stereotype threat effect sizes ranging from .17 to .64. A more recent meta-analysis by Flore and Wicherts (2015) noted a mean effect size of -.22 after accounting for all moderators. They also found a high probability for publication bias, which likely distorts the literature on stereotype threat. Further, there have been challenges in replicating the effects of stereotype threat. For instance, Ganley and colleagues (2013) found no evidence of stereotype threat effects for girls in elementary, middle, or high school, even after using a variety of manipulation methods. Further, Gibson, Losee, and Vitello (2014) aimed to replicate the iconic stereotype threat study conducted by Shih et al. (1999). However, stereotype threat effects were only significant after they removed participants who were unaware of the specific ethnic or gender stereotypes being targeted. Finally, Stoet and Geary (2012) found that, of the studies that did not use confounded pretest covariates, only 30% successfully replicated prior work. These studies suggest that future research on stereotype threat should prioritize large replication efforts, be wary of using pretest covariates, and consider a variety of simultaneous moderators.

Limitations and Future Directions

Several limitations should be considered when interpreting the results of the current study. First, the lack of a control group did not allow for comparison of math task performance for women. As such, it is possible that the two threat conditions did yield negative effects on math task performance, but these effects simply did not differ between threat conditions. Additionally, although the sample had adequate power and was quite diverse, I was still only able to perform intersectional analyses on the four largest racial groups (i.e., White, Asian, Hispanic/Latino, Black). This limits the more complex understanding of how math anxiety and stereotype threat work in other diverse groups, such as Native American and Middle Eastern students. Finally, UNLV is unique in its size and diversity, and the obtained sample was one of convenience. As such, results from the current sample are unlikely to generalize outside of UNLV.

Considering the paucity of research on math anxiety in diverse ethnic groups in conjunction with the diversity of UNLVs campus, it is not necessarily surprising that ethnic differences in math anxiety did not emerge. However, it is surprising that there were no gender effects for math anxiety, as this is a well-established phenomenon. Future research on math anxiety and stereotype threat should continue to pursue diverse college student samples in an effort to understand whether these constructs have differential effects on groups from varying backgrounds. In particular, given that the majority of the literature on math anxiety and stereotype threat is conducted with predominantly White samples and at predominantly White institutions, it would be interesting to compare the effects of math anxiety and stereotype threat on math performance in student samples from both diverse and predominantly White college campuses.

Future research should also attempt to test different types of stereotype threat manipulations within diverse samples. It is possible that certain threat manipulations might heighten math anxiety or elicit stereotype threat effects for some groups more than others. For instance, researchers might test a variety of subtle threat manipulations in an experiment related to women and math performance, whereas a separate study might test a variety of moderate threat manipulations in an experiment related to race/ethnicity and academic performance. Researchers may also consider comparing the effects of subtle, moderate, blatant, and no-threat conditions on academic performance in different sub-groups (e.g., gender, race) of a single sample.

In addition, future research on math anxiety and stereotype threat should consider a greater variety of moderators, including but not limited to the strength of one's gender or ethnic identity, stereotype awareness, stereotype endorsement, campus climate, classroom diversity, and feelings of social belonging, when examining stereotype threat and math performance. Some of these moderators may also be considered simultaneously, as it is likely that these socio-contextual factors influence each other, as well as academic outcomes. To examine these factors, researchers might consider a multi-institution study that considers how both university-level (e.g., classroom diversity, campus diversity) and student-level factors (e.g., stereotype awareness, stereotype endorsement, feelings of social belonging) moderate the effects of math anxiety and stereotype threat on academic performance.

Conclusion

The current research aimed to better understand how the effects of math anxiety and stereotype threat contribute to the gender and racial gap in STEM fields. A more nuanced goal of this research was to gain insight into how these constructs affect individuals based on multiple, intersecting forms of identity. Results suggest sample trends in line with some of the extant literature on implicit gender-math stereotypes, math anxiety, and math performance. However, there were no gender differences in math anxiety and no stereotype threat effects on the sample as a whole. Though results are in opposition to much of the extant literature, the current study has several strengths, including the diversity of the sample. Many of the central findings related to math anxiety and stereotype threat have been found with majority White samples or conducted at majority White institutions. The null results of the current study underscore the need for future research to consider not only the diversity of the sample, but the diversity of the sample institution as a whole, as these factors and their associated socio-cultural effects may moderate the effects of well-established phenomena such as math anxiety and stereotype threat.

Table 1. Bivariate Correlations.

Measure	1	2	3	4	M	SD
1. D-Score	-				.26	.44
2. AMAS	-.054	-			2.69	.81
3. Math %	.015	-.137*	-		.41	.17
4. Age	-.100	-.177*	.065	-	19.90	2.06

Note. M and SD are used to denote Mean and Standard Deviation, respectively.
* indicates $p < .05$.

Appendix A

Experimental Manipulation Questions

1. **Gender Salient**
    a. Do you have siblings? If yes, how many brothers and sisters do you have?
    b. Are most of your friends men or women?
    c. Do you live in a co-ed or single-sex dorm?
    d. List three reasons why you might prefer to live in a co-ed dorm.
    e. List three reasons why you might prefer to live in a single-sex dorm.
    f. Do you have a roommate / roommates? If so, are they the same or opposite gender as you?

2. **Control**
    a. Do you have any pets? If yes, what kind?
    b. Do you prefer dogs or cats?
    c. Do you have cable TV or an online TV/Movie subscription service (i.e., Netflix, Hulu, etc.)?
    d. List three reasons why you might prefer to have cable TV over a TV/Movie subscription service.
    e. List three reasons why you might prefer a TV/Movie subscription service over cable TV.
    f. Do you live on or off campus?

Appendix B

Math Task Text

“Next you will complete a timed math task. You will have 15 minutes to complete as many of the following problems as possible. You may choose only one answer for each problem.

This math task is very difficult, and is meant to be a genuine assessment of your mathematical abilities and limitations. Please do your best on this test, as it will help us better understand the personal factors involved in your performance.”

Appendix C

Math-Gender IAT

Male: man, father, son, boy, uncle, grandpa, husband, male
Female: mother, wife, aunt, woman, girl, female, grandma, daughter
Math: algebra, equation, math, calculus, numbers, geometry, statistics, computation
Language: reading, literature, poetry, writing, vocabulary, books, spelling, grammar

Appendix D

Abbreviated Math Anxiety Scale

Response Scale: Low Anxiety = 1; Some Anxiety = 2; Moderate Anxiety = 3; Quite a bit of Anxiety = 4; High anxiety = 5

Prompt: Please rate each item below in terms of how anxious it would make you feel:

1. Having to use the tables in the back of a mathematics book.
2. Thinking about an upcoming mathematics test one day before.
3. Watching a teacher work an algebraic equation on the blackboard.
4. Taking an examination in a mathematics course.
5. Being given a homework assignment of many difficult problems which is due the next class meeting.
6. Listening to a lecture in mathematics class.
7. Listening to another student explain a mathematics formula.
8. Being given a pop-quiz in a mathematics class.
9. Starting a new chapter in a mathematics book.

Appendix E

Math Task

1. In a sports club with 30 members, 17 play badminton and 19 play tennis and 2 do not play either. How many members play both badminton and tennis?
   a) 7
   b) 8
   c) 9
   d) 10
   e) 11

2. 3x + y = 19 , and x + 3y = 1.
   Find the value of 2x + 2y
   a) 20
   b) 18
   c) 11
   d) 10
   e) 5

3. A cubical block of metal weighs 6 pounds. How much will another cube of the same metal weigh if its sides are twice as long?
   a) 48
   b) 32
   c) 24
   d) 18
   e) 12

4. If x and y are integers, and 3x + 2y = 13, which of the following could be the value of y ?
   a) 0
   b) 1
   c) 2
   d) 3
   e) 4

5. How many numbers between 200 and 400 meet **one or both** of the conditions given in the two statements below?
   Statement 1: The number begins with 3
   Statement 2: The number ends with 3

   a) 20

b) 60
c) 100
d) 110
e) 120

6. What are supplementary angles?
   a) 2 angles whose measures total 180 degrees
   b) 2 angles with equal measures
   c) 2 angles whose measures total 90 degrees
   d) 2 angles whose measures total 360 degrees

7. A piece of ribbon 4 yards long is used to make bows requiring 15 inches of ribbon for each. What is the maximum number of bows that can be made?
   a) 8
   b) 9
   c) 10
   d) 11
   e) 12

8. Jo's collection contains US, Indian and British stamps. If the ratio of US to Indian stamps is 5 to 2 and the ratio of Indian to British stamps is 5 to 1, what is the ratio of US to British stamps?
   a) 5 : 1
   b) 10 : 5
   c) 15 : 2
   d) 20 : 2
   e) 25 : 2

9.

Which of the following best describes the points in this scatter plot?
   a) Increasing Linear
   b) Decreasing Linear
   c) Constant Linear

d) None of these

10. The distance from town A to town B is five miles. C is six miles from B. Which of the following could be the distance from A to C?
    I. 11
    II. 1
    III. 7

    a) I only
    b) II only
    c) I and II only
    d) II and III only
    e) 1, II, or III

11. What is the greatest of 3 consecutive integers whose sum is 24?
    a) 6
    b) 7
    c) 8
    d) 9
    e) 10

12. Find the unit rate if 12 tablets cost $1,440
    a) $100
    b) $150
    c) $120
    d) $50
    e) $40

13. Sheila works 8 hours per day on Monday, Wednesday and Friday, and 6 hours per day on Tuesday and Thursday. She does not work on Saturday and Sunday. She earns $324 per week. How much does she earn in dollars per hour?
    a) 11
    b) 10
    c) 9
    d) 8
    e) 7

14. A set of instructions says to subtract 5 from a number n and then double that result, calling the final result p. Which function rule represents this set of instructions?
    a) P = 2(n-5)
    b) P = 2n-5

c) N = 2(p-5)
d) N = 2p-5

15. Jorge and Jillian have cell phones with different service providers. Jorge pays $50 a month and $1 per text message sent. Jillian pays $72 a month and $0.12 per text message sent. How many texts would each of them have to send in order for their bill to be the same amount at the end of the month?
a) 2 texts
b) 22 texts
c) 25 texts
d) 47 texts

Appendix F

Demographics

Prompt: Please respond to the following questions about *yourself*:

1. Education Level-
   Response: a. (1st year college student) b. (2nd year college student) c. (3rd year college student) d. (4th year college student) e. (5th year college student or beyond) f. (bachelor's degree) g. (other)

2. Enrollment Status-
   Response: a. (full-time) b. (half-time) c. (less than half-time) d. (other)

3. Are you a first-generation college student? This means that you are the first person in your family to attend college.
   Response: a. (yes) b. (no)

4. College Major Field –
   Response: a. (STEM – Majors include life/biological sciences, chemistry, physics, geoscience, agricultural/environmental science, engineering, computer science, and mathematics) b. (Non-STEM - All other majors)

5. Employment status-
   Response: a. (employed) b. (unemployed)

6. Number of hours spent on paid labor outside of schoolwork-
   Response: a. (less than 10) b. (10-20) c. (20-30) d. (30-40) e. (40+)

7. Annual Income (please choose your *individual* annual income) -
   Response: a. (less than $10,000) b. ($10,000 - $20k) c. ($21k - $30k) d. ($31k - $40k) e. ($41k - $50k) f. ($51k - $60k) g. ($61k - $70k) h. (More than $70k)

8. Age-
   Response: open-ended

9. Race-
   Response: a. (White/European American) b. (Hispanic/Latino/Chicano) c. (African American) d. (Native American) e. (Asian/Pacific Islander) f. (other)

10. Gender Identity-
    Response: a. (male) b. (female) c. (trans male) d. (trans female) e. (non-binary) f. (gender neutral) g. (gender fluid) h. (other)

Appendix G

Pilot Study Summary of Results

The pilot study was conducted with 327 undergraduate students at UNLV, who participated for course credit. The mean age of the full sample was 20.22 years, with participants ranging from 18 to 28 years of age. Fifty-seven percent of the sample identified as female (n = 187), 40% of the sample identified as male (n = 131), and 3% of the sample elected not to disclose their gender identity (n = 12). Thirty-two percent of participants identified as White (n = 106), 25% identified as Hispanic/Latino (n = 83), 21% identified as Asian/Pacific Islander (n = 69), 13% identified as African American (n = 42), 5% identified as multiracial (n = 16), and 1% identified as Native American (n = 2). Three percent of participants (n = 12) did not disclose their ethnic identity. Twenty-six percent of participants identified as STEM majors (n = 87), whereas 41% identified as non-STEM majors (n = 134). A third of participants (33%, n = 109) were undecided or elected not to disclose their major. Finally, 45% of the sample (n = 147) identified as first-generation college students.

Participants completed an online survey in which they were asked to complete the Abbreviated Math Anxiety Scale (AMAS). Next, they were randomly assigned to one of three conditions prior to completing a math task: threat, no-threat, or control. Participants in the moderate threat condition saw the following text: "*Next, you will be asked to complete a set of 20 math problems. You have been selected to take a test that has produced gender differences in the past*." Participants in the no-threat condition saw the same beginning text but were told that they had been selected to take a test "*that has not produced gender differences in the past*." Participants in the control condition simply saw the text, "*Next, you will be asked to complete a set of 20 math problems*." Demographics were asked at the end of the survey to avoid priming.

Preliminary analyses revealed that major was a significant covariate, F (1, 207) = 7.125, $p = .008$, $\eta_p{}^2 = .033$, indicating that STEM majors performed significantly better on the math task than did non-STEM majors. No other significant covariates were found. The following statistical analyses were conducted after controlling for major, where appropriate. In addition, analyses were conducted so that they aligned with the hypotheses in my thesis. As such, I compared only the participants assigned to the threat and control conditions. Finally, power was inadequate to run the intersectional analyses associated with the research questions from my thesis.

Hypothesis H1a predicted that women in the threat condition would perform worse than women in the control condition. Hypothesis H1b predicted that women in the threat condition will perform worse than men across conditions. I tested both predictions with a 2 x 2 ANOVA, using condition (threat vs. control) and gender (women vs. men) as IVs and math performance as the DV. Results from the 2x2 ANOVA indicated no significant differences in math performance by gender, condition, or the interaction between the two.

Hypothesis H2 predicted that women would report higher levels of math anxiety than men. The one-way ANOVA using gender as the IV and math anxiety as the DV indicated that women ($M = 2.879$) reported significantly higher math anxiety than did men ($M = 2.510$), F(1, 312) = 13.845, $p < .001$, $\eta_p{}^2 = .042$.

Hypothesis H3 predicted that, for women specifically, there would be a 2-way interaction between math anxiety and condition, such that performance on the math task would be worst for women with high math anxiety who were also in the threat condition. This hypothesis was analyzed using multiple regression to determine whether math anxiety and condition interact to negatively affect women's math performance. Specifically, predictors in the model included major as a covariate, math anxiety, experimental condition, and the two-way interaction between math anxiety and experimental condition. To improve interpretability, math anxiety scores were centered at zero prior to computing the interaction term. The overall regression was significant, $F(4, 65) = 2.849$, $p = .031$, $R^2 = .149$. However, outside of major as a significant covariate (B = -.091), the regression indicated no main effects of math anxiety or condition on math performance, nor an interaction between math anxiety and condition, for women.

References

Ahmed, W. (2018). Developmental trajectories of math anxiety during adolescence: Associations with STEM career choice. *Journal of Adolescence*, *67*, 158–166. https://doi.org/10.1016/j.adolescence.2018.06.010

American Association of University Women (2008). *Where the girls are: The facts about gender equity in education*. Retrieved from: https://www.aauw.org/files/2013/02/Where-the-Girls-Are-The-Facts-About-Gender-Equity-in-Education.pdf.

American Association of University Women (2015). *Solving the equation: The variables for women's success in engineering and computing*. https://www.aauw.org/research/solving-the-equation/.

Armenta, B. E. (2010). Stereotype boost and stereotype threat effects: The moderating role of ethnic identification. *Cultural Diversity and Ethnic Minority Psychology*, *16*(1), 94–98. https://doi.org/10.1037/a0017564

Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist*, *55*(5), 469–480. https://doi.org/10.1037//0003-066X.55.5.469

Aronson, J., Fried, C.B. & Good, C. (2002). Reducing the effects of stereotype threat on african american college students by shaping theories of intelligence. *Journal of Experimental Social Psychology, 38*, 113-125. DOI: 10.1006/jesp.2001.1491.

Ashcraft, M.H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science, 11*(5), 181-185. DOI: 10.1111/1467-8721.00196

Ashcraft, M.H. & Kirk, E.P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology, 130*(2), 224-237. DOI: 10.1037/0096-3445.130.2.224

Ashcraft, M.H., Krause, J.A., & Hopko, D.R. (2007). Is math anxiety a mathematical learning disability? In D. Berch & M. Mazzocco (Eds.), *Why is math so hard for some children? The nature and origins of mathematical learning difficulties and disabilities* (pp. 329-248). Baltimore: Paul H. Brookes Publishing Co.

Beasley, M. A., & Fischer, M. J. (2012). Why they leave: the impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors. *Social Psychology of Education*, *15*(4), 427–448. https://doi.org/10.1007/s11218-012-9185-3

Beilock, S.L., Gunderson, E.A., Ramirez, G., & Levine, S.C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences 107*(5), 1860-1863. DOI: 10.1073/pnas.0910967107

Beilock, S.L. & Maloney, E.A. (2015). Math anxiety: A factor in math achievement not to be ignored. *Policy Insights from the Behavioral and Brain Sciences, 2*(1), 4-12. DOI: 10.1177/2372732215601438

Beilock, S.L., Rydell, R.J., & McConnell, A.R. (2007). Stereotype threat and working memory: mechanisms, alleviation, and spillover. *Journal of Experimental Psychology, 136*(2), 256-276. DOI: 10.1037/0096-3445.136.2.256. 256

Beilock, S.L. & Willingham, D.T. (2014). Math anxiety: Can teachers help students reduce it? *American Educator,* 28-32. Retrieved from: https://files.eric.ed.gov/fulltext/EJ1043398.pdf.

Brunye, T.T., Mahoney, C.R., Giles, G.E., Rapp, D.N., Taylor, H.A., & Kanarek, R.B. (2013). Learning to relax: Evaluating four brief interventions for overcoming the negative emotions accompanying math anxiety. *Learning and Individual Differences, 27,* 1-7. DOI: 10.1016/j.lindif.2013.06.008

Carastathis, A. (2014). The Concept of Intersectionality in Feminist Theory: The Concept of Intersectionality in Feminist Theory. *Philosophy Compass*, *9*(5), 304–314. https://doi.org/10.1111/phc3.12129

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187–1218. https://doi.org/10.1002/tea.20237

Chipman, S.F., Krantz, D.H., & Silver, R. (1992). Mathematics anxiety and science careers among able college women. *Psychological Science, 3*(5), 292-295. DOI: 10.1111/j.1467-9280.1992.tb00675.x

Committee on STEM Education (2018). *Charting a course for success: America's strategy for STEM education.* Retrieved from: https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

Cook, L., Mason, M., Morse, R. & Neuhauser, A. (2015, June 29). The 2015 U.S. News/Raytheon STEM Index. *U.S. News.* Retrieved from: http://www.usnews.com/news/stem-index/articles/2015/06/29/the-2015-us-news-raytheon-stem-index.

Crenshaw, K. (1991). Mapping the margins: Intersectionality, identity politics, and violence against women of color. *Stanford Law Review, 43*(6), 1241-1299. DOI: 10.2307/1229039

Crocker, J., & Major, B. (1989). Social stigma and self-esteem: The self-protective properties of stigma. *Psychological Review*, *96*(4), 608–630. https://doi.org/10.1037/0033-295x.96.4.608

Cvencek, D., Meltzoff, A. N., & Greenwald, A. G. (2011). Math-gender stereotypes in elementary school children: Gender stereotypes. *Child Development*, *82*(3), 766–779. https://doi.org/10.1111/j.1467-8624.2010.01529.x

Davies, P. G., Spencer, S. J., Quinn, D. M., & Gerhardstein, R. (2002). Consuming Images: How Television Commercials that Elicit Stereotype Threat Can Restrain Women Academically and Professionally. *Personality and Social Psychology Bulletin*, *28*(12), 1615–1628. https://doi.org/10.1177/014616702237644

Eccles, J.S., Jacobs, J.E., & Harold, R.D. (1990). Gender role stereotypes, expectancy effects, and parents' socialization of gender differences. *Journal of Social Issues, 46*(2), 183-201. DOI: 10.1111/j.1540-4560.1990.tb01929.x

Eddy, S. L., & Brownell, S. E. (2016). Beneath the numbers: A review of gender disparities in undergraduate education across science, technology, engineering, and math disciplines. *Physical Review Physics Education Research*, *12*(2). https://doi.org/10.1103/PhysRevPhysEducRes.12.020106

Else-Quest, N.M. & Hyde, J.S. (2016). Intersectionality in quantitative psychological research: I. theoretical and epistemological issues. *Psychology of Women Quarterly 40*(2), 155-170. DOI: 10.1177/0361684316629797

Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and Performance: The Processing Efficiency Theory. *Cognition & Emotion*, *6*(6), 409–434. https://doi.org/10.1080/02699939208409696

Faul, F., Erdfelder, E., Lang, A., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175-191. doi:10.3758/bf03193146

Faust, M.W., Ashcraft, M.H., & Fleck, D.E. (1996). Mathematics anxiety effects in simple and complex addition. *Mathematical Cognition, 2*(1), 25-62. DOI: 10.1080/135467996387534

Federici, R.A., Skaalvik, E.M., & Tangen, T.N. (2015). Students perceptions of the goal structure in mathematics classrooms: Relations with goal orientations, mathematics anxiety, and help-seeking behavior. *International Education Studies, 8,* (3), 146-158.

Flore, P. C., & Wicherts, J. M. (2015). Does stereotype threat influence performance of girls in stereotyped domains? A meta-analysis. *Journal of School Psychology*, *53*(1), 25–44. https://doi.org/10.1016/j.jsp.2014.10.002

Fogliati, V., & Bussey, K. (2013). Stereotype threat reduces motivation to improve: Effects of stereotype threat and feedback on women's intentions to improve mathematical ability. *Psychology of Women Quarterly, 37*(3), 310-324. https://doi.org/10.1177/0361684313480045

Furner, J. & Gonzalez-DeHass, A. (2011). How do students' mastery and performance goals relate to math anxiety? *Eurasia Journal of Mathematics, Science, & Technology Education, 7*(4), 227-242.

Ganley, C. M., Mingle, L. A., Ryan, A. M., Ryan, K., Vasilyeva, M., & Perry, M. (2013). An examination of stereotype threat effects on girls' mathematics performance. *Developmental Psychology*, *49*(10), 1886–1897. https://doi.org/10.1037/a0031412

Gibson, C. E., Losee, J., & Vitiello, C. (2014). A replication attempt of stereotype susceptibility: Identity salience and shifts in quantitative performance. *Social Psychology*, *45*(3), 194–198. https://doi.org/10.1027/1864-9335/a000184

Goetz, T., Bieg, M., Ludtke, O., Pekrun, R., & Hall, N.C. (2013). Do girls really experience more anxiety in mathematics? *Psychological Science 24*(10), 2079-2087. DOI: 10.1177/0956797613486989

Gonzales, P. M., Blanton, H., & Williams, K. J. (2002). The effects of stereotype threat and double-minority status on the test performance of Latino women. *Personality and Social Psychology Bulletin*, *28*(5), 659–670. https://doi.org/10.1177/0146167202288010

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*(1), 17–28. https://doi.org/10.1016/j.appdev.2007.10.004

Good, C., Aronson, J. & Inzlicht, M. (2003). Improving adolescents' standardized test performance: An intervention to reduce the effects of stereotype threat. *Applied Developmental Psychology, 24*, 645-662. DOI: 10.1016/j.appdev.2003.09.002.

Greenwald, A.G. & Banaji, M.R. (1995). Implicit social cognition: Attitudes, self-esteem, and stereotypes. *Psychological Review, 102*(1), 4-27. DOI: 10.1037//0033-295X.102.1.4

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: the implicit association test. *Journal of Personality and Social Psychology*, *74*(6), 1464–1480. https://doi.org/10.1037/0022-3514.74.6.1464

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the Implicit Association Test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology*, *85*(2), 197–216. https://doi.org/10.1037/0022-3514.85.2.197

Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbacher, M. A. (2007). The Science of Sex Differences in Science and Mathematics. *Psychological Science in the Public Interest:A Journal of the American Psychological Society*, *8*(1), 1–51. https://doi.org/10.1111/j.1529-1006.2007.00032.x

Hart, S. A., & Ganley, C. M. (2019). The nature of math anxiety in adults: Prevalence and correlates. *Journal of Numerical Cognition*, *5*(2), 122–139. https://doi.org/10.5964/jnc.v5i2.195

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*(1), 33-46. DOI: 10.12691/education-2-7-7.

Hernandez, P. R., Schultz, P. W., Estrada, M., Woodcock, A., & Chance, R. C. (2013). Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. *Journal of Educational Psychology*, *105*(1). https://doi.org/10.1037/a0029691

Hopko, D.R., Mahadevan, R., Bare, R.L. & Hunt, M.K. (2003). The abbreviated math anxiety scale (AMAS): Construction, validity, and reliability. *Assessment, 10*(2), 178-182. DOI: 10.1177/1073191103252351.

Hyde, J.S., Lindberg, S.M., Linn, M.C., Ellis, A.B. & Willians, C.C. (2008). Gender similarities characterize math performance. *Science, 321*, 494-495. doi: 10.1126/science.1160364.

Jacobs, J.S. (2005). Twenty-five years of research on gender and ethnic differences in math and science career choices: What have we learned? In J.E. Jacobs & S.D. Simpkins (Eds.), Leaks in the pipeline to math, science, and technology careers, Special Issue of *New Directions for Child and Adolescent Development, 110,* 85-94.

Jameson, M.M. & Fusco, B.R. (2014). Math anxiety, math self-concept, and math self-efficacy in adult learners compared to traditional undergraduate students. *Adult Education Quarterly, 64*(4), 1-17. DOI: 10.1177/0741713614541461

Jensen, L. E., & Deemer, E. D. (2019). Identity, campus climate, and burnout among undergraduate women in STEM fields. *The Career Development Quarterly*, *67*(2), 96–109. https://doi.org/10.1002/cdq.12174

Johns, M., Schmader, T., & Martens, A. (2005). Knowing is half the battle: Teaching stereotype threat as a means of improving women's math performance. *Psychological Science, 16*(3), 175-179. DOI: 10.1111/j.0956-7976.2005.00799.x

Johnson, A., Brown, J., Carlone, H., & Cuevas, A. K. (2011). Authoring identity amidst the treacherous terrain of science: A multiracial feminist examination of the journeys of three women of color in science. *Journal of Research in Science Teaching*, *48*(4), 339–366. https://doi.org/10.1002/tea.20411

Johnson, M. L., Taasoobshirazi, G., Clark, L., Howell, L., & Breen, M. (2016). Motivations of traditional and nontraditional college students: From self-determination and attributions, to expectancy and values. *The Journal of Continuing Higher Education*, *64*(1), 3–15. https://doi.org/10.1080/07377363.2016.1132880

Federici, R. A., Skaalvik, E. M., & Tangen, T. N. (2015). Students' Perceptions of the Goal Structure in Mathematics Classrooms: Relations with Goal Orientations, Mathematics Anxiety, and Help-Seeking Behavior. *International Education Studies*, *8*(3). https://doi.org/10.5539/ies.v8n3p146

Furner, J. M., & Gonzalez-DeHass, A. (2011). How do students' mastery and performance goals relate to math anxiety? *Eurasia Journal of Mathematics, Science and Technology*

Education, *7*(4), 227–242. https://doi.org/10.12973/ejmste/75209

Katrevich, A. V, & Aruguete, M. S. (2017). Recognizing Challenges and Predicting Success in First-Generation University Students. *Journal of STEM Education*, *18*(2), 40–44. Retrieved from https://0-search.proquest.com.sultan.tnstate.edu/docview/1927819584/fulltextPDF/B102622215D84C9CPQ/2?accountid=14275

Kiefer, A. K., & Sekaquaptewa, D. (2006). Implicit stereotypes and women's math performance: How implicit gender-math stereotypes influence women's susceptibility to stereotype threat. *Journal of Experimental Social Psychology*, *43*(5), 825–832. https://doi.org/10.1016/j.jesp.2006.08.004

Kiefer, A. K., & Sekaquaptewa, D. (2007). Implicit stereotypes, gender identification, and math-related outcomes. *Psychological Science*, *18*(1), 13–18. https://doi.org/10.1111/j.1467-9280.2007.01841.x

Koizumi, K. (2015, February 2). Investing in America's future through R&D, innovation, and STEM education: The President's FY 2016 budget. Retrieved from https://www.whitehouse.gov/blog/2015/02/02/investing-america-s-future-through-rd-innovation-and-stem-education-president-s-fy-2.

Krumpal, I. (2013). Determinants of social desirability bias in sensitive surveys: a literature review. *Quality and Quantity*, *47*(4), 2025–2047. http://dx.doi.org/10.1007/s11135-011-9640-9

Lane, K. A., Banaji, M. R., Nosek, B. A., & Greenwald, A. G. (2007). Understanding and using the implicit association test: IV. In Wittenbrink, B. & Schwarz, N. (Eds). *Implicit Measures of Attitudes*, 59–102. New York, NY: Guilford Press.

Ma, X. (1999). A Meta-Analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education*, *30*(5), 520–540. https://doi.org/10.2307/749772

Magnuson, K. A., & Duncan, G. J. (2006). The role of family socioeconomic resources in the black–white test score gap among young children. *Developmental Review*, *26*(4), 365–399. https://doi.org/10.1016/j.dr.2006.06.004.

Major, B., Spencer, S., Schmader, T., Wolfe, C., & Crocker, J. (1998). Coping with negative stereotypes about intellectual performance: The role of psychological disengagement. *Personality and Social Psychology Bulletin, 24*(1), 34-50. DOI:10.1177/0146167298241003

Miller, H., & Bichsel, J. (2004). Anxiety, working memory, gender, and math performance. *Personality and Individual Differences*, *37*, 591–606. https://doi.org/10.1016/j.paid.2003.09.029

Miyake, A., Kost-Smith, L. E., Finkelstein, N. D., Pollock, S. J., Cohen, G. L., & Ito, T. A. (2010). Reducing the gender achievement gap in college science: A classroom study of values affirmation. *Science*, *330*(6008), 1234–1237. https://doi.org/10.1126/science.1195996

Miyake, A. & Shah, P. (1999). *Models of working memory: Mechanisms of active maintenance and executive control.* New York: Cambridge University Press.

Moakler, M. W., & Kim, M. M. (2014). College major choice in STEM: Revisiting confidence and demographic factors. *The Career Development Quarterly*, *62*(2), 128–142. https://doi.org/10.1002/j.2161-0045.2014.00075.x

National Science Foundation, National Science Board. (2016). *Science and engineering indicators*. Retrieved from: https://www.nsf.gov/statistics/2016/nsb20161/#/report.

Nguyen, H.-H. D., & Ryan, A. M. (2008). Does stereotype threat affect test performance of minorities and women? A meta-analysis of experimental evidence. *Journal of Applied Psychology*, *93*(6), 1314–1334. https://doi.org/10.1037/a0012702

Nosek, B. A., Banaji, M. R., & Greenwald, A. G. (2002). Math = male, me = female, therefore math ≠ me. *Journal of Personality and Social Psychology*, *83*(1), 44–59. https://doi.org/10.1037//0022-3514.83.1.44

Nosek, B. A., Smyth, F. L., Hansen, J. J., Devos, T., Lindner, N. M., Ranganath, K. A., Smith, C.T., Olson, K.R., Chugh, D., Greenwald, A.G., & Banaji, M. R. (2007). Pervasiveness and correlates of implicit attitudes and stereotypes. *European Review of Social Psychology*, *18*(1), 36–88. https://doi.org/10.1080/10463280701489053

Nosek, B. A., Smyth, F. L., Sriram, N., Lindner, N. M., Devos, T., Ayala, A., Bar-Anan, Y., Bergh, R., Cai, H., & Gonsalkorale, K. (2009). National differences in gender–science stereotypes predict national sex differences in science and math achievement. *Proceedings of the National Academy of Sciences*, *106*(26), 10593–10597. https://doi.org/10.1073/pnas.0809921106

Ostergaard, C.R., Timmermans, B., & Kristinsson, K. (2011). Does a different view create something new? The effect of employee diversity on innovation. *Research Policy, 40,* 500-509.

Park, D., Ramirez, G., & Beilock, S.L. (2014). The role of expressive writing in math anxiety. *Journal of Experimental Psychology: Applied, 20*(2), 103-111. DOI: 10.1037/xap0000013

Pennington, C. R., Heim, D., Levy, A. R., & Larkin, D. T. (2016). Twenty years of stereotype threat research: A review of psychological mediators. *PLOS ONE*, *11*(1), 1-25.

Ramirez, G., Gunderson, E.A., Levine, S.C. & Beilock, S.L. (2013). Math anxiety, working memory, and math achievement in early elementary school. *Journal of Cognition and Development, 14*(2), 187-202. DOI: 10.1080/15248372.2012.664593

Ramsey, L. R., Betz, D. E., & Sekaquaptewa, D. (2013). The effects of an academic environment intervention on science identification among women in STEM. *Social Psychology of Education*, *16*(3), 377–397. https://doi.org/10.1007/s11218-013-9218-6

Richardson, F.C. & Suinn, R.M. (1972). The mathematics anxiety rating scale: Psychometric data. *Journal of Counseling Psychology, 19*(6), 551-554. DOI: 10.1037/h0033456

Roos, A.-L., Bieg, M., Goetz, T., Frenzel, A. C., Taxer, J., & Zeidner, M. (2015). Experiencing more mathematics anxiety than expected? Contrasting trait and state anxiety in high achieving students. *High Ability Studies*, *26*(2), 245–258. https://doi.org/10.1080/13598139.2015.1095078.

Schmader, T., Johns, M., & Barquissau, M. (2004). The costs of accepting gender differences: The role of stereotype endorsement in women's experience in the math domain. *Sex Roles*, *50*(11/12), 835–850. https://doi.org/10.1023/B:SERS.0000029101.74557.a0

Schmader, T., Major, B., & Gramzow, R.H. (2001). Coping with ethnic stereotypes in the academic domain: perceived injustice and psychological disengagement. *Journal of Social Issues, 57*(1), 93-111. DOI:10.1111/0022-4537.00203.

Shapiro, J.R. & Williams, A.M. (2012). The role of stereotype threats in undermining girls' and women's performance and interest in STEM fields. *Sex Roles, 66,* 175-183. DOI: 10.1007/s11199-011-0051-0

Shih, M., Pittinsky, T.L., & Ambady, N. (1999). Stereotype susceptibility: Identity salience and shifts in quantitative performance. *Psychological Science, 10*(1), 80-83. DOI: 10.1111/1467–9280.00371

Simmons, J. P., Nelson, L. D., and Simonsohn, U. (2011). False-positive psychology: undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychol. Sci*. 22, 1359–1366. doi: 10.1177/0956797611417632

Smith, J. L., & White, P. H. (2002). An Examination of Implicitly Activated, Explicitly Activated, and Nullified Stereotypes on Mathematical Performance: It's Not Just a Woman's Issue. *Sex Roles*, *47*(3–4), 179–191. https://doi.org/10.1023/A:1021051223441

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. DOI: 10.1006/jesp.1998.1373

Steele, C.M. & Aronson, J. (1995). Stereotype threat and intellectual test performance of African Americans. Journal of Personality and Social Psychology, *69*(5), 797-811. DOI: 10.1037/0022-3514.69.5.797

Steele, C.M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*(6), 613-629. DOI: 10.1037//0003-066x.52.6.613

Steffens, M. C., & Jelenec, P. (2011). Separating implicit gender stereotypes regarding math and language: Implicit ability stereotypes are self-serving for boys and men, but not for girls and women. *Sex Roles*, *64*(5–6), 324–335. https://doi.org/10.1007/s11199-010-9924-x

Steffens, M. C., Jelenec, P., & Noack, P. (2010). On the leaky math pipeline: Comparing implicit math-gender stereotypes and math withdrawal in female and male children and adolescents. *Journal of Educational Psychology*, *102*(4), 947–963. https://doi.org/10.1037/a0019920

Stoet, G., & Geary, D. C. (2012). Can stereotype threat explain the gender gap in mathematics performance and achievement? *Review of General Psychology*, *16*(1), 93–102. https://doi.org/10.1037/a0026617

Stone, J. (2002). Battling doubt by avoiding practice: The effects of stereotype threat on self-handicapping in white athletes. *Personality and Social Psychology Bulletin*, *28*(12), 1667–1678. https://doi.org/10.1177/014616702237648

UNLV Media Relations. (2017, September 7). *US News and World Report: UNLV Most Diverse Campus in the Nation.* Retrieved from: https://www.unlv.edu/news/release/us-news-world-report-unlv-most-diverse-campus-nation.

University of Nevada, Las Vegas. (2016). *Facts and Stats*. Retrieved from: https://www.unlv.edu/about/facts-stats.

Walton, G. M., & Cohen, G. L. (2011). A brief social-belonging intervention improves academic and health outcomes of minority students. *Science*, *331*(6023), 1447–1451.

Warner, L.R. (2008). A best practices guide to intersectional approaches in psychological research. *Sex Roles, 59*, 454-463. DOI:10.1007/s11199-008-9504-5

Wheeler, S.C., Jarvis. W.B., & Petty, R.E. (2001). Think unto others: The self-destructive impact of negative racial stereotypes. *Journal of Experimental Social Psychology, 37,* 173-180. DOI: 10.1006/jesp.2000.1448

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*, *25*(1), 68–81. https://doi.org/10.1006/ceps.1999.1015

Wigfield, A. & Meece, J.L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80*(2), 210-216. DOI: 10.1037//0022-0663.80.2.210

Woodcock, A., Hernandez, P. R., Estrada, M., & Schultz, P. W. (2012). The Consequences of Chronic Stereotype Threat: Domain Disidentification and Abandonment. *Journal of Personality and Social Psychology*, *103*(4), 635–646. https://doi.org/10.1037/a0029120

Curriculum Vitae
Jennifer John, MSW
jennifer.e.buck@gmail.com

Employment

Graduate Assistant, Graduate College **2019 – Present**
University of Nevada, Las Vegas (UNLV)

Graduate Teaching Assistant, Psychology Department **2018 – 2019**
University of Nevada, Las Vegas (UNLV)

Graduate Research Assistant, Psychology Department **2016 – 2018**
University of Nevada, Las Vegas (UNLV)

Education

Current	**PhD Student in Quantitative/Experimental Psychology,** University of Nevada, Las Vegas (UNLV)
2013	**M.S.W** (Human Services Management Certificate), Boston University School of Social Work, Boston, MA
2010	**B.A. in Psychology** (*Magna Cum Laude* and Full College Scholar) North Central College, Naperville, IL

Research Interests

Sexism • Diversity • Educational Equity • STEM Outcomes • Math Achievement • Expectancy Value Theory • Academic Motivation and Achievement • Stereotypes • Gender Roles

Awards & Honors

2018	GPSA Summer Sponsorship Award, UNLV
2018	Summer Stipend Research Award Recipient, UNLV College of Liberal Arts
2017	Summer Stipend Research Award Recipient, UNLV College of Liberal Arts
2010	Outstanding Major in Psychology, North Central College, Psychology Department

Publications

Peer Reviewed Journal Articles

Robnett, R.D., & **John, J.E.** (2018). "It's wrong to exclude girls from something they love." Adolescents' attitudes about sexism in science, technology, engineering, and math fields. *Child Development.* Published online ahead of print.

Wooten, N.R., Al-Barwani, M.B., Chmielewski, J.A., **Buck, J.E**., Hall, T.L., Moore, L.L., Woods, A.C. (2014). A Case Study of Social Media and Remote Communications in Military Research: Examining Military and Deployment Experiences of Army Women. *SAGE Research Methods Cases.* http://dx.doi.org/10.4135/978144627305014540257

Chapters in Edited Books

Robnett, R. D., **John, J. E.,** Underwood, C. R., & Thoman, S. E. (in press). Sexism and gender stereotyping. To appear in S. Hupp & J. Jewell (Eds.), *The Encyclopedia of Child and Adolescent Development*. West Sussex: Wiley. 4600 words.

Manuscripts Submitted or in Preparation

Perera, H.N., **John, J.E.,** Barber, D., Part, R., & Maghsoudlou, A. (2020). *Math and Science Expectancy-Value Beliefs in Secondary School Students: A Person-Centered Approach.* Manuscript in Preparation.

Perera, H.N. & **John, J.E.** (2019). *An Integrative Model of Teachers' Math Motivational Self-Beliefs: Relations with Teacher and Student Outcomes.* Manuscript under invited review.

John, J.E., Nelson, P., Klenczar, B., & Robnett, R.D. (2019). *Memories of Math: Narrative Predictors of Math Affect, Motivation, and Future Math Plans.* Manuscript under invited review.

Kent, S., **John, J.E**., & Robnett, R.D. (2019). *"Maybe These Fields Just Don't Interest Them." Gender and Ethnic Differences in Attributions about STEM Inequities.* Manuscript under invited review.

Chaired Conference Symposia

John, J.E. & Thoman, S.E. (2018, August). *From the Inside Out: Evidence for Ecological Influences on Girls and Women in STEM.* Symposium conducted at the Gender and STEM Network Conference, Eugene, OR.

Conference Talks

John, J.E. & Robnett, R.D. (2018, August). *One Size does not Fit All: Gender and Ethnic Variation in Math Anxiety and Stereotype Threat.* Presented at the Gender and STEM Network Conference, Eugene, OR.

Robnett, R.D. & **John, J.E.** (2018, August). *Are Adolescents Concerned about Sexism in STEM Fields? A Mixed-Methods Analysis.* Presented at the Gender and STEM Network Conference, Eugene, OR.

Conference Posters

Perera, H.N., **John, J.E.,** Barber, D., Part, R., & Maghsoudlou. *Math and Science Expectancy-Value Beliefs in Secondary School Students: A Person-Centered Approach.* To be presented at the 2020 American Educational Research Association Conference, San Francisco, CA.

John, J.E, Klenczar, B., Nelson, P., & Robnett, R.D. (2019, February). *Memories of Math: Narrative Predictors of Math Outcomes and Future Math Plans.* Presented at the UNLV Graduate & Professional Student Research Forum, Las Vegas, NV.

Lovitt, A., **John, J.E**., & Millar, M. (2019, February). *The Impact of Positive Assessments on Interpersonal Behavior.* Presented at the Society for Personality and Social Psychology Conference, Portland, OR.

John, J.E., Chaidez, H., Tang, G., & Robnett, R.D. (2019, February). *Perspective-Taking Effects on Bias and Support for Social Activism.* Presented at the Society for Personality and Social Psychology Conference, Portland, OR.

John, J.E, Klenczar, B., Nelson, P., & Robnett, R.D. (2018, October). *Math Life Stories Predict Gendered Outcomes and Future Plans.* Presented at the Gender Development Conference, San Francisco, CA.

Robnett, R.D. & **John, J.E**. (2018, October). *"It's wrong to exclude girls from something they love:" Adolescents' attitudes about sexism in STEM.* Presented at the Gender Development Conference, San Francisco, CA.

Kent, S., **John, J.E**., Klenczar, B., Smith, C., & Robnett, R.D. (2018, October). *"These Fields Just Don't Interest Them": Gender Differences in Attributions about STEM Inequities.* Presented at the Gender Development Conference, San Francisco, CA.

Thoman, S.E., Underwood, C.R., Stephens, A.K., **Buck, J.E**. & Robnett, R.D. (2016, October). *Test Tubes or Soccer Practice: Retention and Work-Life Balance among Women in STEM*. Poster presented at the Gender Development Conference, San Francisco, CA.

Underwood, C.R., Thoman, S.E., **Buck, J.E.**, Robnett, R.D. & Barakat, M. (2016, October). *Redefining Tradition: Generational Differences in Same-Sex Couples' Surname Decisions.* Poster presented at the Gender Development Conference, San Francisco, CA.

Sawyer, T., **John, J.E**., & O'Connor, M. (2010, April). *The Effects of Priming on Perceptions of Facial Features.* Poster presented at the Midwestern Psychological Association Annual Meeting, Chicago, IL.

John, J.E. (2010, April). *Perceptions of Parenting Styles and Personality.* Poster presented at the Midwestern Psychological Association Annual Meeting, Chicago, IL.

Teaching

University of Nevada, Las Vegas
PSY 101: General Psychology (Fall 2018 – Spring 2019)
Average Evaluation: 4.64/5

North Central College
Teaching Assistant, PSY 250: Statistics (Spring 2009)

Mentoring

2019-20 **UNLV Undergraduate Research Mentor**: J. Cowley
Project: Understanding Math Anxiety in Middle School Students

2018-19 **UNLV Research and Mentorship Program (RAMP)**: B. Klenczar
Project: Gender Variance in Positive Memories of Math
Presented at the 2019 Society for Personality and Social Psychology Conference

2018-19 **UNLV Undergraduate Research Mentor:** J. Cowley, P. Green & Gorsakul, B.
Project: Objective-Focus and Perspective-Taking Approaches to Evaluating Racial Biases
Presented at the 2019 Western Psychological Association Convention

2018-19 **UNLV Undergraduate Research Mentor**: S. Kent, B. Klenczar, & C. Smith
Project: Themes of STEM Inequity
Presented at the 2018 UNLV Spring Undergraduate Research Forum

2017 **UNLV Undergraduate Research Mentor**: H. Chaidez & G. Tang
Project: Associations between Perspective-Taking, Racial Bias, and Social Activism
1st Place: 2017 UNLV Spring Undergraduate Research Forum

2016-17 Mentor, Outreach for Undergraduate Mentorship Program (OUMP), UNLV

2012-13 Mentor, First Year MSW Student, Boston University

Professional Development

Multilevel Modeling (2018, June), Todd Little's Stats Camp, Albuquerque, NM.

Theory and Practice of Bayesian Inference using JASP (2019, February), SPSP Annual Convention, Portland, OR.

Service

Intramural
President, Experimental Student Committee (ESC), Department of Psychology, University of Nevada, Las Vegas (2017-2019)

Graduate Student Representative, Graduate Enrollment Management Committee, University of Nevada, Las Vegas (2017-2018)

Invited Presenter, Involving Undergraduates in Research Workshop, University of Nevada, Las Vegas (February 2017)

Graduate Student Judge, Office for Undergraduate Research (OUR) Forum, University of Nevada, Las Vegas (November 2016)

Psychology Department Representative, Graduate and Professional Student Association (GPSA), University of Nevada, Las Vegas (2016-17)

GPSA Representative, Graduate Enrollment Management Committee, University of Nevada, Las Vegas (2016-17)

Extramural
Invited Reviewer, American Education Research Association (AERA) Annual Meeting 2020

- Mixed Methods SIG
- Division C: Learning and Instruction, Section 1c: Mathematics

Student Advisory Board Member, Psychology of Women Quarterly (2017- Present)

Graduate Student Panel Member, Nevada State College (October 2016)

Development Committee Member, Think Dignity (2016-18)

Macro Concentration Committee Chair, Boston University School of Social Work (2012-13)

Ad Hoc Reviewer
International Journal of Gender, Science, and Technology

Membership

2016 – Present Graduate Student Affiliate, Association for Psychological Science (APS)

2018 – Present Graduate Student Member, Society for Personality and Social Psychology (SPSP)

2019 – Present Graduate Student Affiliate, American Psychological Association (APA), Division 15

2019 – Present Graduate Student Affiliate, American Educational Research Association (AERA)