“M” IS FOR THE MILLION THINGS SHE GAVE ME: EFFECTS OF PRIMING MOTHER’S SUPPORT ON WOMEN’S MATH MOTIVATION

by

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"If we're going to out-innovate and out-educate the rest of the world, we've got to open doors for everyone. We need all hands on deck, and that means clearing hurdles for women and girls as they navigate careers in science, technology, engineering, and math."

-- First Lady Michelle Obama, September 26, 2011
White House conference held to announce the NSF Career-Life Balance Initiative

Both President Barrack Obama and his wife believe in the importance of increasing women's interest in science, technology, engineering, and mathematics (STEM). The administration has consistently stressed the need to bolster women's participation for STEM fields, and this emphasis has fueled efforts to improve government investments in STEM recruitment and education. Launched in November 2009, the President's Educate to Innovate campaign has attracted more than $700 million in financial support and partnerships to help prepare more than 10,000 new math and science teachers (Obama Launches "Educate to Innovate," 2009*).* The current administration believes strengthening STEM interest and education is important because people, especially women, are not entering STEM fields in numbers sufficient to meet our country's future demand. Occupational opportunities in STEM fields have increased as much as three times compared to non-STEM fields in the past decade, and are projected to experience sustainable growth in the future (US Department of Commerce, 2011a). Despite the wealth of opportunities available in STEM fields, in 2009 the US ranked 27th of 29 developed countries for the total number of STEM degrees awarded (Organization for Economic Cooperation and Development, 2009). Of those that do pursue STEM fields, women represent only 24% of the STEM workforce, despite earning 33% more on average compared to women in non-STEM fields (US Department of Commerce, 2011b).

President Obama believes it is imperative that our country persuades women to enter STEM fields in greater numbers in order for our nation to out-build, out-educate, and out innovate future competitors. The current set of studies aims to tackle this problem by exploring ways to increase women's motivation to pursue mathematics. Specifically, the main goal of the current work is to examine whether women who think about their mother's support subsequently experience heightened math motivation.

Women's Deterrence from Math: Negative Stereotypes and Cultural Norms

If STEM fields have solid job opportunities and offer substantially better pay, why are women not motivated to pursue these fields? In 2005, President of Harvard University Lawerence H. Summers sparked controversy when he suggested the under-representation of female scientists at elite universities may stem in part from "innate" differences between men and women (Hemel, 2005). Another possible explanation, and much easier to accept, is that negative stereotypes about women's mathematics ability may undermine their sense of belongingness and performance. Women in our society are consistently exposed to negative stereotypes about their math ability from the time they are children (Quinn & Spencer, 2001). In elementary school, parents tend to have higher expectations for their sons than daughters when it comes to math and science (Furnham, Reeves & Budhani, 2002), and they are more likely to attribute their sons' success in these subjects to innate ability (Yee & Eccles 1988). It has been suggested that as a result of these negative stereotypes and gender socialization, women experience more trait anxiety when it comes to math (e.g., Eccles & Jacobs, 1986). Betz (1978) has estimated that about 50% of college students experience mild anxiety when it comes to math. Additionally, studies have repeatedly shown that women typically report greater trait math anxiety compared to men (e.g., Hembree, 1988, 1990; Hyde, Fennema, Ryan, Frost, & Hopp,

1990; Betz, 1978; Wigfield & Meece, 1988; Ashcraft & Faust, 1994; Ma & Cartwright, 2003; Miller & Bichsel, 2004). The experience of math anxiety may lead women to feel uncomfortable, nervous, uneasy, or confused when it comes to math (Betz, 1978). Compared to men, undergraduate women are less confident in math, enroll in fewer math courses, and report more negative attitudes toward math (Hyde et al., 1990).

Despite the social hurdles and potential anxiety women have to overcome when it comes to the pursuit of mathematics, some women manage to become identified with mathematics and pursue a STEM related major. The problem is these women still tend to show a stereotypical association of math with men and display a stronger association of math with men on implicit attitude measures (Nosek, Banaji, & Greenwald, 2002). Once immersed in their respective fields, these women may continue to experience stereotype threat. Stereotype threat is the immediate situational threat that arises when people are aware of negative stereotypes that exist about groups they belong to, and they fear confirming the negative stereotype or being treated stereotypically (Steele & Aronson, 1995). In the current context, stereotype threat may lead women to experience high state anxiety and underperform in mathematics, leading them to disengage from the domain. Women who choose STEM degrees, for example, typically diverge in their choice of career path compared to their men counterparts. About 40% (2.7 million) of men with STEM college degrees work in STEM jobs, whereas only 26 percent (0.6 million) of women with STEM degrees work in STEM fields (US Department of Commerce, 2011b).

In addition to stereotypes about women's math ability, women must also contend with stereotypes that math is unfeminine. In a meta-analysis examining math performance in over 3 million participants, Hyde, Fennema, and Lamon (1990), for example, found that through elementary and middle school, there are virtually no differences between boys and girls in

performance on standardized math tests but that a trend toward men doing better steadily increases from high school through college, and into adulthood. Middle school brings pressure for girls to conform to feminine norms (e.g., Sengupta, 2006), and girls begin perceiving subjects like physics as uncool (Kessels, 2005). More recent research suggests in high schools across the United States, girls now take as many STEM courses as boys and even receive higher grades than boys, but are still much less likely than boys to major or pursue a career in STEM (Ceci, Williams, & Barnett, 2009). One possible reason for the discrepancy is that women who excel in stereotypically masculine domains may be subtyped into a less feminine gender category (e.g., Heilman & Okimoto, 2007). In one example, participants used fewer feminine traits to describe a female engineering student than a female nursing student, a more stereotypically feminine profession (Yoder & Schleicher, 1996). When women enter college, subtle situational cues in STEM environments, like the presence of stereotypically masculine objects (Cheryan, Plaut, Davies, & Steele, 2009), can decrease women's sense of belonging in these fields, and as a result deter women's interest from pursuing STEM majors.

The lack of successful female role models (and the lack of women in general) in STEM is another reason women may be reluctant to pursue STEM fields. Steele (1997) has argued a lack of role models is one of the key factors in why women do not pursue subjects related to math because it makes it difficult for women to identify with those domains. By the time women reach high school, for example, there is little reference to female scientists in textbooks (Sadker & Sadker, 1994), further strengthening the association between men and STEM fields. Additionally, only 18% of full professors in STEM departments at research universities are women (National Science Foundation, 2009). In one example, high math identified women were shown a video promoting a STEM conference at Stanford. In one of the videos, men and women

were equally represented, whereas the other video portrayed significantly more men at the conference than women (Murphy, Steele, & Gross, 2007). Women who were highly identified with math and watched the video with a greater representation of men subsequently reported lower sense of belonging and less desire to participate in the STEM conference, than did women who viewed the gender-balanced video (Murphy, Steele, & Gross, 2007). Situational cues, like being outnumbered in an environment, may signal to women that they may experience a psychological threat if they were to enter that environment, such as isolation or ostracism.

Women may perceive there are valuable job opportunities in STEM, but the combination of negative stereotypes and a lack of role models leads them to disengage from the domain. In order to increase women's desire to pursue and excel in STEM, perhaps increasing the presence of role models can lead women to approach mathematics. Female role model exposure could communicate positive information about women's competence and success in math, women's representation, and weaken the implicit stereotypes about math being unfeminine.

Role Models and Attitudes

Role model exposure has been a popular strategy used for attitude change, motivation, and performance (e.g. Stout, Dasgupta, Hunsinger, McManus, 2011; Lockwood & Kunda, 1997; Taylor, Lord, McIntyre & Paulson, 2011). Interestingly, identifying characteristics in a role model that will result in inspiration can be tricky. In one instance, accounting majors who were exposed to outstanding accountants or superstars in their field were more likely to report greater self-enhancement and inspiration, but only if the role model's success seemed attainable (Lockwood & Kunda, 1997). If the role model's success seemed unattainable, students were instead left feeling demoralized and unmotivated. In another example, students reported greater academic motivation after reading about a positive role model if they were promotion-focused

individuals (e.g., favor pursuing desirable outcomes), whereas prevention-focused individuals (e.g., favor avoiding negative outcomes) were more academically motivated by exposure to negative role models (Lockwood, Jordan, & Kunda, 2002).

Others have also used role models to try and increase women's math performance while under stereotype threat. In one example, exposure to female experimenters who were portrayed as competent in math buffered stereotype threat in women and led to comparable math performance to men (Marx & Roman, 2002). In another example, women who read about four fictitious role models who excelled in various domains (e.g., architecture, law, medicine, invention) performed better on a math test compared to women who read about four successful corporations (McIntyre, Paulson, & Lord, 2003). Additional research has shown that women who read about Hillary Clinton while under threat subsequently performed just as well as a no-threat control on a math test, but only if the women believed Hillary Clinton was deserving of her success (Taylor et al., 2011).

The previous examples outline how role model exposure can be effective for buffering mathematics stereotype threat in women, but do the same types of manipulations apply to increasing women's interest and motivation to pursue math? In one example examining role models on women's math motivation, women students in a calculus class were recruited to participate in a study (Stout, Dasgupta, Hunsinger, & McManus, 2011). Some of the calculus sections had female professors paired with female teaching assistants, whereas other sections had male professors paired with male teaching assistants. Students did not know who their professors would be when they signed up for the course. At the end of the semester, women who were instructed by female faculty reported greater self-efficacy in mathematics, more positive implicit math (vs. English) attitudes, and stronger implicit identification with math (vs. English)

relative to women who had male professors (Stout et al., 2011; Study 3). In a similar example, when women in college science classes had female professors they perceived as role models, they were more likely to identify themselves with science on an implicit association task and implicitly associated science as more feminine than masculine compared to women students who had male faculty (Young, Rudman, Buettner, McLean, 2013). Laboratory experiments have also shown that simply reading about same-sex role models can have an effect on women's gender stereotypes and attitudes toward math. Women who read 16 short biographies about famous female leaders in various professions subsequently displayed weakened implicit ''male-leader'' stereotypes (Dasgupta & Asgari, 2004). Similarly, women undergraduates who read about same-sex STEM experts showed more positive implicit attitudes toward math (relative to English) and stronger implicit identification with STEM (Stout et al., 2011; Study 2).

Others have had less luck with using female STEM role models to increase women's math interest. When female STEM role models are perceived as being stereotypically unfeminine or geeky, for example, women subsequently show less interest in pursuing STEM fields (Cheryan, Siy, Vichayapai, Drury, & Kim, 2011). One might think the answer would be to present feminine STEM role models who counter prevalent stereotypes, but this approach can also backfire. In one instance, middle school girls who were exposed to feminine STEM role models experienced reduced math interest, self-rated ability, and success expectations relative to gender-neutral STEM role models (Betz & Sekaquaptewa, 2012). The authors suggest a role model who is both feminine and good at math may seem unrealistic, or unattainable for girls. Others argue against the commonly held assumption that role models must be female to inspire women to pursue STEM, and instead argue male role models can be just as effective for women's recruitment to STEM (Drury, 2011). Although Young and colleagues (2013) found

women's implicit attitudes toward science were positively affected by having female professors, women's explicit attitudes and career aspirations were most influenced by perceiving one's professor as a role model, regardless of the professor's gender. Additionally, many of the previous studies have focused on retention of women in STEM by targeting women who are already enrolled in advanced math and science courses, and not the recruitment of women to enroll in STEM courses.

Together the findings support that women role models in STEM can positively influence women's implicit attitudes, stereotypes, and identification with STEM domains, but in other situations these STEM role models that are supposed to produce emulation can backfire. Most of the role models used in previous studies focused on STEM retention, but these role models may seem too out of reach, or their success unattainable, for women who are not already taking math and science coursework. The qualities or characteristics that role models must exhibit in order to promote recruitment of women to math and science are unclear. In much of the research examining the effects of role models on attitudes and stereotype threat, the role models tend to be chosen or crafted by the experimenters. It is possible that role models who are personally close and meaningful to women may exert a more consistent effect on their attitudes and motivation.

Attachment Figures as a Source of Influence and Motivation

One category of role models that has been relatively unexplored in this respect is attachment figures, such as one's mother. In order to understand how attachment figures may influence women's math motivation, it is first necessary to understand how our attachment system operates. Attachment theory (Bowlby, 1982; Ainsworth & Bowlby, 1991) posits that because a helpless infant's survival is dependent on the care and protection of others, infants are predisposed to form attachment relationships with others (initially the parents) who offer care

and protection against external threats (e.g., starvation). Attachment is grounded in a motivational-behavioral control system that is preferentially responsive to a small number of familiar caregiving figures. Infants are motivated to maintain close proximity to their attachment figures and experience distress upon separation from these attachment figures. Parents serve as both a physical and emotional "secure base" for their growing children, and attachment behavior is most observable when the attached person is frightened, fatigued, or sick and is calmed when the attachment figure provides protection, help, or comfort (e.g., Ainsworth 1973, 1991). This attachment system is designed so that feelings of security and actual conditions of safety are highly correlated, although the relationship is not always perfect (Bretherton, 1985). Bowlby (1973) also described major individual differences in the regulatory functioning of the attachment system. Interactions with attachment figures who are available in times of need and responsive to their children's needs/bids for proximity promote a secure attachment style in their children (e.g., sense that the world is a safe place, others will be responsive and helpful when needed, and that it is possible to explore one's environment confidently). When attachment figures are unavailable or inconsistent in their responsiveness, felt security is destabilized, and normal attachment strategies are replaced with secondary attachment strategies, conceptualized in terms of anxiety and avoidance (for review see Mikulincer & Shaver, 2003, 2007a). Although attachment behavior is most noticeable in childhood, it can be observed throughout one's lifetime, especially when one is faced with stress or anxiety (Bretherton, 1985).

Attachment figures serve as a secure base from which children can explore and learn about their world (see also Hazan & Shaver, 1994; Mikulincer, Shaver, & Pereg, 2003). Children's confidence in their mother's physical and psychological responsiveness allows for autonomous exploration and problem solving, coupled with the expectation that the mother's

help will be available when needed. In one example, 12 and 18-month children were presented with easy and difficult tool-using tasks (Matas, Arend, & Sroufe, 1978). When securely attached children were presented with easy tool-using tasks they confidently attempted solutions on their own. When presented with challenging tool-using tasks, securely attached children enlisted their mothers' support in order to achieve a solution. This was not the case for insecure 2-year-olds, who reacted negatively to both the difficult and easy tool using tasks with frustration and whininess.

Although much of the attachment research focuses on the mother-child relationship, Bowlby envisioned attachment relationships within a hierarchy in which people have a consistent order of preference for whom they seek out when their attachment system is activated (Bowlby, 1982). In Western cultures one's mother tends to become the preferred attachment figure whereas father tends to become the preferred playmate (e.g., Lamb, 1978; Lytton, 1980; Bretherton, 1985). As children transition to adulthood they may also form strong attachment bonds with peers or romantic partners, but parents typically remain a stable base that provide individuals with emotional support and guidance throughout their lifetimes (e.g., Bretherton, 1985). Fraley and Davis (1997), for example, found that a majority of their college-aged participants (60%) still used their parents as primary attachment figures. Additionally, undergraduates who were primed with threat displayed heightened cognitive accessibility to their mother's names, but not other primary attachment figures (Carr & Landau, 2012). It is likely that many women share a close relationship with their mother and view their mothers as role models. In fact, when undergraduate women were asked to list five women who they viewed as very successful in life and were deserving of their success, "mother" appeared in the top five

names most frequently listed (Taylor et al., 2011). In short, mothers continue to play a unique and important role in people's lives throughout adulthood.

Attachment Figures in Adulthood: Priming Effects

As individuals grow into adulthood, attachment figures continue to influence behavior, even if they are not physically present. When making evaluations, individuals often consider how close others (e.g., parents, spouse, best friend) would want them to act in a given situation, and measuring these subjective norms typically increases the predictive power of attitudes (for reviews see Ajzen & Fishbein, 2010; Manning, 2009). Individuals care about the opinions of those close to them, and as a result the presence of close others can influence behavior. Even the *psychological presence* of close others can nonconsciously influence people's self-evaluations and goal directed behavior (Baldwin, Carrell, & Lopez, 1990; Fitzsimons & Bargh, 2003).

One reason attachment figures continue to be important in adulthood, regardless of their physical presence, is because individuals construct complementary internal working models of their attachment figures and of the self. Over time, the history of different attachment relationships becomes integrated into one's personality structure (Bowlby, 1973). Repeated positive interactions with an attachment figure during times of stress reinforce the association in long-term memory between bids for support and stress reduction (e.g., Mikulincer & Shaver, 2007a). As a result, mental representations of attachment figures may become capable of activating feelings of safety and calmness. Previous research has shown that individuals rely on attachment figures when faced with threat and external stressors (see, e.g., Mikulincer & Shaver, 2003, for a review). Activating thoughts of one's parent following a mortality salience prime, for example, reduced death-thought accessibility and increased feelings of self-worth (Cox et al., 2008). In another example, Secluk et al. (2012) found that writing about a positive experience

with one's mother was effective at relieving distress in students following the recall of an upsetting memory. Similarly, students who were given negative feedback, or primed with negative words, experienced increased positive affect after subliminally viewing a sketch of a mother holding a baby (secure base prime) or subliminally viewing the name of one of their attachment figures. Students who were exposed to positive nonattachment stimuli (e.g., pictures of treasure, smiling face), in contrast, did not experience increases in positive affect (Mikulincer, Hirschberger, Nachmias, & Goliath, 2001). These findings suggest that simply calling to mind thoughts of an attachment figure, such as one's mother, may provide emotional regulatory benefits even in adulthood. Women experience more trait anxiety when it comes to math compared to men, which may inhibit them from enrolling in math-related courses. If calling to mind one's mother has emotion regulation benefits, like alleviating negative affect, women may be more likely to try out a math course after thinking about their mother.

In addition to emotion regulation, thinking of one's mother may also lead women to feel more secure and comfortable with exploring tasks they perceive as challenging. Dispositional attachment security has been associated with greater curiosity, increased openness to new and unusual ideas, and increased exploratory interest (e.g., Feeney, 2007; Mikulincer, 1997; Green & Campbell, 2000). Additionally, when confidence and support is available (in both infancy and adulthood), people feel more comfortable taking risks and engage in more autonomy-promoting activities (e.g., Bretherton 1985; Mikulincer, Shaver, & Rom, 2011). Individuals with secure attachment are also more likely to realize that feeling bewildered when trying novel tasks, while uncomfortable, is only temporary and can lead to a greater mastery of skills and broadened perspectives (e.g., Mikulincer & Shaver, 2007; Mikulincer et al., 2011). Whereas in infancy the physical presence of attachment figures is necessary to elicit felt security, as people grow older a

"secure base" can be contextually activated (Bowlby, 1982; Mikulincer & Shaver, 2007a). In one study, for example, students who were subliminally exposed to names of security enhancing attachment figures performed better on a creativity problem solving task, regardless of attachment style (Mikulincer et al., 2011; Study 1). Despite the importance of the topic, there has been little theoretical elaboration of the interplay between attachment and exploration in adulthood, and empirical research on the topic is only in its infancy (for review, see Feeney & Van Vleet, 2010).

The current set of studies examined whether positive reminders of one's mother might lead women to be more motivated to pursue and excel in mathematics. Because this was a relatively novel approach toward changing women's attitudes toward math, we recognized there may be multiple mechanisms through which reminders of mom may affect women's attitudes toward math. One's mother is likely perceived as a role model, which has been applied to retaining women in STEM. The current set of studies focuses on the recruitment of women to STEM, and hypothesizes that attachment functions associated with mothers will positively influence women's attitudes toward math. Thinking about one's mother may increase positive affect and decrease the perceived threat surrounding mathematics, but we also believe that the mother's role as a secure base will contribute to women feeling like it is safe to step outside their comfort zone and approach math.

The Present Studies

The overall purpose of the current set of studies was to examine whether directing women to think about a time when their mother was supportive increases their desire to pursue and excel in mathematics. We predicted that activating thoughts of maternal support in women would prime women to feel secure, and in turn make women more likely to step outside their

comfort zone and approach mathematics. Women might perceive math as a beneficial skill, but avoid math classes because of stereotypes associating women with poor mathematical aptitude, and the possibility that they might fail. Recent thoughts of their moms would provide a safe haven from which to launch at least tentative first steps toward approaching math. Three studies were designed to test this central hypothesis. Experiment 1 tested whether women who visualize and write about their mother being non-evaluative and supportive would report greater math motivation compared to women who completed an unrelated filler task, and explored whether attachment style moderates the results. Experiment 2 incorporated a more behavioral measure of math motivation (e.g., time spent solving math problems), and examined whether individual differences between mothers (e.g., enjoyment of math, gender roles, empathy) influences the effectiveness of the mom manipulation. Additionally, Experiment 2 examined whether other attachment figures (e.g., dad or same-sex best friend) have the same effect as mom on women's math motivation. Experiment 3 also examined whether a different subtle prime (e.g., sketch of a mother and child) is enough to increase women's math motivation, or whether a more explicit writing prime is necessary to produce the predicted effects.

Experiment 1

Method

Participants. The sample consisted of 115 women undergraduates[1]. Women who had an extremely positive attitude toward math were excluded from participating, since their attitudes could not be made more positive. Seniors were excluded from participating because one of the

[1] Men and women undergraduates at the same university reported their general anxiety when it came to math on a 0 (*not at all anxious*) to 10 (*extremely anxious*) scale (n = 950). Women (n = 711) reported moderate anxiety when it came to math (M = 5.10, SD = 2.64), and this was significantly greater than men's (n = 239) reported anxiety, (M = 4.32, SD = 2.33), F (1, 948) = 15.90, $p < .001$.

dependent measures assessed likelihood of taking math courses in the future. Three women were excluded from the analyses for not completing the writing prime, leaving a total of 112 participants.

Materials and Procedure. The procedure was composed of five parts. All measures were completed on a computer via Qualtrics. Women first completed a measure of general attachment style and four items assessing their math identity. This was followed by the primary manipulation, where women wrote about a time when their mother was supportive (n = 55) or completed an unrelated filler task (n = 57). Women then completed questions about their willingness to step outside their comfort zone, which we thought might be influenced by thinking of one's mother. This was followed by questions assessing women's desire to pursue and excel in mathematics (dependent variable).

Potential Moderators and Covariates. Women first completed demographic information and a 4-item measure of math identity (Pronin, Steele & Ross, 2003). Previous studies examining math performance and math interest typically control for math identity, since students are likely to vary in their baseline math interest (Steele, 1997; Pronin, Steele & Ross, 2003). Items on the scale range from 0 (*not at all important/skilled)* to 10 *(very important/skilled*), with questions assessing perceived mathematical aptitude, importance of math to the person and their sense of self, and importance of performing well on standardized mathematical tests. A composite of these four questions was used as a covariate when analyzing the results (α = .81). Following the measure of math identity, women completed the Experience in Close Relationships Scale to control for differences in attachment style (Brennan, Clark, & Shaver, 1998). Two subscales can be calculated from this 36-tem measure to examine the degree to which people endorse an avoidant or anxious attachment style. Questions are on a 1 (*disagree strongly)* to 7 (*agree*

strongly) scale. Examples of statements on this scale include "I prefer not to show a partner how I feel deep down" and "I worry about being abandoned" (Appendix A).

Mom Manipulation. Following the introductory measures, women were told they were completing a verbal fluency task, which in reality was the attachment manipulation. The manipulation was adapted from previous research on attachment (Cox et al., 2008). In the control condition, women were given different categories (e.g., vegetables or trees) and had to list as many things that they could think of that belonged to each category. In the "mom" condition, participants were given the following instructions: "Please write about a time when your mother (or motherly figure) expressed a *positive* opinion of you. That is, write about a time when your mother was non-evaluative and simply accepted your for who you are. Try to visualize being in the presence of your mother (i.e., imagine her eye color, hair color, sound of her voice) and express the thoughts and feelings associated with your mother by writing for the length of a page" (See Appendix A). Women worked on the task for five minutes.

Potential Mediators. Immediately following the attachment manipulation, women answered four questions that we identified as potential mediators. All questions were on a sliding scale in Qualtrics, ranging from 1 (*not at all likely/often/open*) to 100 (*extremely likely/often/open*) and attempted to tap into how likely women were to try things outside their comfort zone or approach new challenges. The items included "How likely are you to attempt a task if there is a strong possibility you might not perform well?," "How likely are you to attempt things that are outside of your comfort zone, or that you have little previous experience with?," "How likely are you to approach challenges that may be outside your normal skill set?," and "How open are you to new experiences, especially when you're unsure of the outcome?" (Appendix A).

Dependent Variable. As a cover story, women were then told we wanted to assess their interest in different majors. All questions were on a -5 (*not at all important/ likely)* to a +5 (*extremely important/likely*) scale. Of particular interest were the questions "How important is it for you personally to be successful and excel in each of these areas" and "How likely is it that you will take unrequired courses in each of these areas," with responses for "mathematics" serving as the measure of math motivation (Appendix A).

Following the dependent measure, women rated whether they followed instructions and answered truthfully, described what they thought they purpose of the study was, and were debriefed and dismissed.

Results

Measures. The measure of math motivation used for the current analysis was a composite variable of two questions assessing student's willingness to take unrequired math courses and how important it was for the student to succeed and excel in mathematics ($\alpha = .66$). Math identity was used as a covariate in the analysis because women's baseline math motivation likely differed, and previous research recommends controlling for math identity when examining math performance or math interest (Steele, 1997).

The effect of mom's support. The current study was interested in how thinking about one's mother affects math motivation in women. A one-way analysis of covariance (ANCOVA) was performed to see whether writing about one's mother (vs. completing unrelated verbal task), had an influence on women's math motivation scores, with math identity entered into the model as a covariate. The results revealed a significant main effect of condition, $F(1, 109) = 4.61$, $p = .034$, $\eta^2 = .02$. Specifically, women who wrote about their mother subsequently reported

greater math motivation (M = .88, SD = 2.72) compared to women who completed an unrelated verbal task (M = -.56, SD =2.55), d = .55.

Mediators. Women responded to four items concerning their likelihood to approach things that may be difficult or have uncertain outcomes, and the likelihood of attempting things outside their comfort zones. All items loaded on the same factor, and a composite variable was calculated using the average score across items (α = .82). A linear regression analysis was conducted to examine whether writing about one's mother (vs. completing a filler task) predicted how women responded to approaching things outside their comfort zone. The analysis revealed a significant effect, t = 2.13, p = .035, β = .20, R^2= .04, such that writing about one's mother predicted increases in women reporting they were likely to approach things that were difficult and step outside their comfort zone. We then conducted a mediation analysis using PROCESS (Hayes, 2008) to examine whether the relationship between condition and math motivation was mediated by women wanting to step outside their comfort zone. Mediation was not present. Specifically, the indirect effect between wanting to step outside one's comfort zone and math motivation did not reach significance, $p > .05$.

Individual Differences. Next, we wanted to examine whether differences in attachment style moderated the effects of the mom manipulation on math motivation. In order to answer this research question, we conducted two multiple linear regression analyses. For the first analysis, the main effects of condition (write about mom vs. filler task) and the avoidant attachment subscale were entered in Step 1 of a hierarchical regression analysis, and the interaction between condition and avoidant attachment was entered in Step 2. Math identity was controlled for in both steps. The interaction between condition and avoidant attachment style was non-significant,

p = .17. The same process was repeated for the anxious attachment subscale, but no effects were found, p = .37.

Discussion

Experiment 1 provided initial support for the hypothesis that thinking about one's mother increases women's desire to pursue and excel in mathematics. Specifically, women who wrote about a time when their mother was supportive and non-evaluative subsequently reported a greater likelihood of taking non-required math courses and reported a greater desire to pursue and excel in mathematics. Although women who wrote about their mother did report a greater desire to step outside of their comfort zone, we did not find that this mediated women's increased math motivation. It is likely that thinking about one's mother has a host of positive benefits, and we did not identify the specific mechanism for increasing math motivation in Experiment 1. This will be further explored in the subsequent studies.

As far as individual differences in attachment, endorsement of anxious or avoidant attachment styles did not moderate the findings. One may think that a woman with an insecure attachment style may not benefit from thinking about her mother, since it is possible her mother was not a reliable, nurturing caregiver. A possible explanation is that we specifically told women to write about a time when their mother was supportive and non-evaluative, so everyone was construing a positive and comforting memory. Previous research suggests attitudes are construed on the spot based on whatever information is most salient and accessible at the time of the attitude evaluation (e.g., Lord & Lepper, 1999; Schwarz & Bless, 1992; Schwarz & Bohner, 2001; Wilson & Hodges, 1992; Tourangeau, 1992). All of the women included in the analyses were able to generate a positive memory about their mothers. So when women were making their evaluation toward math, a positive and comforting memory of their mothers was likely very salient, regardless

of their differences in attachment. Previous research has shown that people with an insecure attachment style can still recall instances of attachment security, and these memories can be contextually activated, regardless of variations in global attachment style (Baldwin et al., 1996).

Although Experiment 1 provided initial support for the hypothesis, it also raised questions. Whereas individual differences in attachment style did not seem to moderate the findings, other individual differences, such as whether one's mother endorses traditional gender roles or is competent in math, may influence the effectiveness of the manipulation. A mother who generally dislikes math and is very feminine may not inspire her daughter to approach mathematics. Additionally, it is also unclear whether the effect is specific to one's mother, or whether other attachment figures may also produce similar effects on math motivation, such as one's father or best friend. Lastly, finding similar effects with a more behavioral measure of math motivation would also strengthen the validity of the current results. All of these issues will be addressed in Experiment 2.

Experiment 2

The purpose of Experiment 1 was to establish that thinking about one's mother increases women's math motivation, as well as examine whether attachment style influenced the results. Experiment 2 built upon Experiment 1 by examining whether the findings held across different potential sources of attachment (e.g., father and same-sex best friend). We also incorporated a more behavioral measure of math motivation that was adapted from previous research (Forbes & Schmader, 2010) in order to strengthen the generalizability of our primary results. Specifically, women were shown a series of math and verbal problems, and had to choose which problems they wanted to solve. The amount of time spent working on each type of problem was recorded, and total time spent solving math problems served as a measure of math persistence. The central

research question was whether women who wrote about their mother spent more time trying to solve math problems than women who wrote about their father, same-sex best friend, or were in the control condition.

We also incorporated more questions about women's mothers in Experiment 2, such as their endorsement of traditional gender roles and competency in mathematics, to account for more individual differences between mothers. We predicted that women who wrote about a time when their mother was non-evaluative and supportive would show the highest math persistence, or spend the greatest amount of time trying to solve math problems. We thought that women who wrote about their best friend or father may experience some positive benefits, but that mothers in particular would produce the most positive effects. Undergraduates in other studies who were primed with threat, for example, displayed heightened cognitive accessibility to their mother's names, but not other primary attachment figures (Carr & Landau, 2012). In Western cultures one's mother tends to become the preferred attachment figure (e.g., Lamb, 1978; Lytton, 1980; Bretherton, 1985) and continues to remain a stable base for her children that provides emotional support and guidance throughout their lifetime (e.g., Bretherton, 1985).

Lastly, the control condition used in Experiment 1 was not ideal. We were initially hesitant to have women visualize any scenario because we did not want them to accidentally incorporate attachment figures into their writing, but we realized that the control condition should have been more cognitively similar to the manipulation. Experiment 2 addressed this limitation by having women in the control condition visualize and write about being in a new city alone for the first time, and writing about how they would spend their day (see Appendix B).

Method

Participants. The sample consisted of 135 women undergraduates. Women who had an extremely positive attitude toward math were excluded from participating, since their attitudes could not be made more positive. On average, women participants in the sample reported experiencing moderate anxiety when it came to math (M = 5.01, SD = 2.44) on a 1 (*not all anxious*) to 10 (*extremely anxious*) scale when asked on the university-wide prescreen. Five women were excluded for admitting they did not follow directions. An additional five women were excluded for not completing the writing prime (e.g., did not write anything/father not in their life), leaving a total of 125 participants.

Materials and Procedure. The study took place in two parts. During the first session, women completed questions about their mother, father, and same-sex best friend (e.g., gender role endorsement, math competency, empathy), in addition to measures of self-esteem and modern sexism. The questions about attachment figures had to occur in a different session so they did not interfere with the manipulation. Women returned for the second session two days later where they wrote about a time when their mother (n = 31), father (n = 30), or same-sex best friend (n = 33) was non-evaluative and supportive or they visualized being in a new city for the first time (control; n = 31). They then completed a task where they had to choose between solving math or verbal problems, and the amount of time they spent solving each type of problem was recorded.

Individual Differences. Upon arrival to the study, all women were seated at a computer. The women were told the study was interested in how their relationships with close others influenced their visualization and memory ability. They were asked several questions involving perceptions of their mother, father, and same-sex best friend. Specifically, women were asked to

rate their mother's femininity, competency in mathematics, enjoyment of mathematics, how much their mother would want them to take additional math courses, whether they perceived their mother as a role model, whether their mother provided them with unconditional support, importance of making their mother proud, how much they wanted to be like their mother, how empathetic they perceived their mother, and how many hours per week their mother worked. All questions were on a -5 (*not at all*) to +5 (*very much so*) scale, with the exception of how many hours per week their mother worked (Appendix B). The women completed similar items for their same-sex best friend and father. They also completed the same 4-item measure of math identity used in Experiment 1 (used as covariate).

Next, women completed the Inclusion of Other in the Self Scale (IOS; Aron, Aron, & Smollan, 1992) to assess differences in the closeness of mother daughter relationships. The IOS is a single item designed to tap into people's sense of being closely interconnected with another person. The scale consists of several sets of Venn diagrams that vary in the degree to which the two circles overlap. Women were asked to select the Venn diagram that best reflected the degree of overlap between themselves and their mother. A higher IOS score (more overlap between circles) indicated a greater sense of interconnectedness with the target person (Appendix B). It is possible women might have responded to the prime differently based on the closeness they felt with their mother.

Lastly, women completed a 10-item measure of self-esteem (Rosenberg, 1965) and the 8-item Modern Sexism Scale (Swim, Aikin, Hall, & Hunter, 1995). The self-esteem measure was on a 4-point scale, with higher scores indicating higher self-esteem. The Modern Sexism Scale was on a 5-point scale, with higher scores indicating more sexist attitudes. It was possible that women who had very low self-esteem or very strong sexist attitudes would avoid math regardless

of the manipulation, presumably because math is generally perceived as difficult and associated with being a masculine domain (Appendix B).

At the end of session 1, women were given a list of 15 words to memorize. This was to bolster the cover story for having 2 sessions. Women were given one minute to try and memorize the list, and were told they would be asked to recall the words during session 2 of the study. They were then dismissed from session 1.

Attachment Figure Manipulation. At the start of session 2 the women were again seated at a computer. They were told the first part of the session was interested in assessing their visualization ability. Some women were asked to visualize and write about a time when their mom was non-evaluative and supportive (same as in Experiment 1), whereas other women were given the same prompt except "mom" was replaced by "dad" or "same-sex best friend." Women in the control condition were asked to visualize being in a new city alone for the first time, and to describe how they would spend their day. Women in all conditions worked on the task for five minutes.

Dependent Variable. Following the manipulation, participants read that we wanted them to pretest some problems for a future experiment. Specifically, we were interested in which problems they preferred to work on, and the problem solvability. All women were given 10 pairs of math and verbal problems (1 verbal matched with 1 math), and they had to choose which problems to solve. The number of math problems women chosen and the amount of time women spent working on the math problems was recorded. The dependent measure was adapted from previous research on women's mathematics stereotype threat (Forbes & Schmader, 2010). The task consisted of 10 math and 10 remote associates (RAT) problems presented on a series of choice screens. On each screen, women were asked which type of problem they would like to

solve: a math problem (e.g., "Solve for x: 20x-16x+19=7") or a remote associates problem (e.g., "Find a fourth word that somehow relates to the following three words: athlete's, web, rabbit"). After women made their selection, they were taken to a screen with the chosen problem on it, and the time they spent working on the problem was recorded in Qualtrics (Appendix B). The total length of time spent on the math problem screens over the course of the task was calculated for each participant and served as a measure of *math persistence*. Because previous research suggests students may have an automatic preference for verbal over math problems (Nosek et al., 2002; Forbes & Schmader, 2010), we purposively selected RAT problems that were more difficult than the math problems. The RAT and math problems were pretested for difficulty by research assistants, and matched accordingly. Women were given a maximum of three minutes to work on each problem, although most problems should have taken under 30 seconds to solve. They were given scratch paper to work out the problems if needed and were allowed to use a calculator.

Following the dependent measure, participants rated whether they followed instructions and answered truthfully, described what they thought they purpose of the study was, and were debriefed and dismissed.

Results

Measures. The measure of math persistence used in current analysis was calculated by summing how many seconds it took women to submit an answer for each math problem they chose to solve. Women could not spend longer than three minutes on each problem, and were allowed to type "don't know" if they wanted to skip the problem. On average, women chose to work on about six math problems (M = 6.38 problems, SD = 2.19) and spent around 2-3 minutes total working on math problems (M = 165.05 sec, SD = 113.90). As in Experiment 1, the same

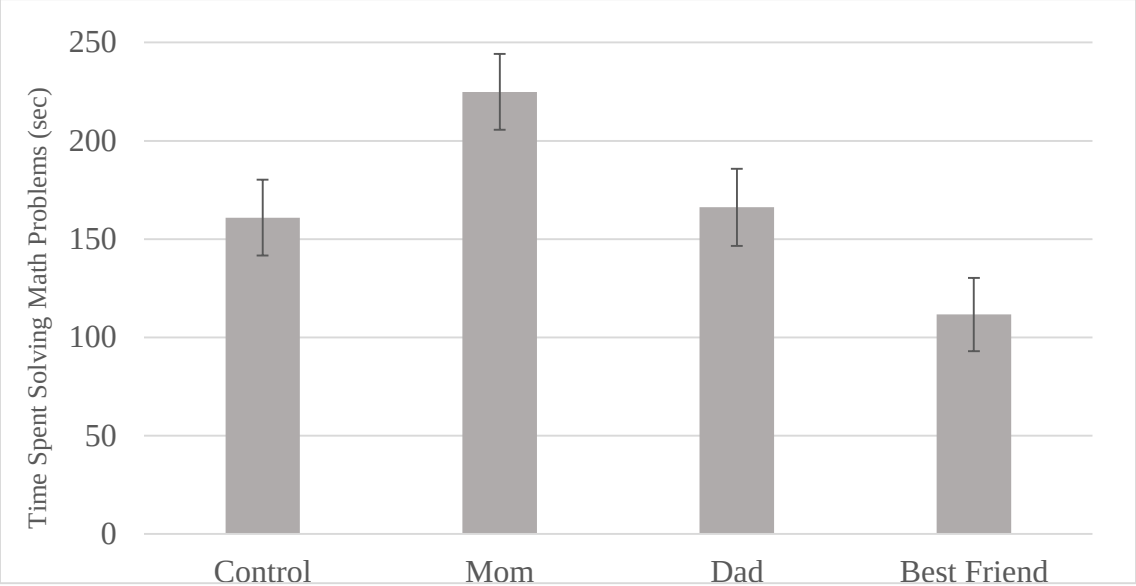
4-item measure of math identity was used a covariate in the analyses (Pronin, Steele & Ross, 2003).

Math Persistence. The current study was interested in whether positive reminders of one's mother (compared to one's father or same-sex best friend) had unique effects on women's math persistence (total time spent trying to solve math problems). A one way analysis of covariance (ANCOVA) was conducted to examine whether women who visualized and wrote about a time when their mother, father, or same-sex best friend was non-evaluative and accepting, or visualized and wrote about being in a new city (control), differed in the total time spent trying to solve math problems. An initial examination of the results revealed that the data violated Levene's Test of Equality of Error Variances ($p = .001$). This violation was likely due to a moderate positive skew observed in the best friend condition. In order to control for moderate positive skew, we performed a square root transformation on the math persistence variable (Howell, 2007; Tabachnick & Fidell, 2007). When the analysis was performed with the transformed variable, the data no longer violated Levene's Test ($p = .16$).

The results of the ANCOVA revealed a significant effect of writing prime (mom vs. dad vs. best friend vs. control) on total time spent working on math problems, $F(3, 120) = 5.47$, $p = .001$, $\eta^2 = .02$ (see Fig 1). The central research question was tested using simple planned contrasts, where women who wrote about their mom were compared to women in each of the other conditions. The planned contrasts revealed women who wrote about their mother spent significantly more time solving math problems ($M = 225.15$ sec, $SD = 132.93$) than women who wrote about their father ($M = 168.79$ sec, $SD = 113.48$), $p = .050$, same-sex best friend ($M = 111.23$ sec, $SD = 75.95$), $p < .001$, or visiting a new city ($M = 158.61$ sec, $SD = 101.85$), $p = .044$.

Figure 1.

Effect of writing prime on time spent working on math problems (math persistence)



Note: Adjusted, non-transformed means are displayed.

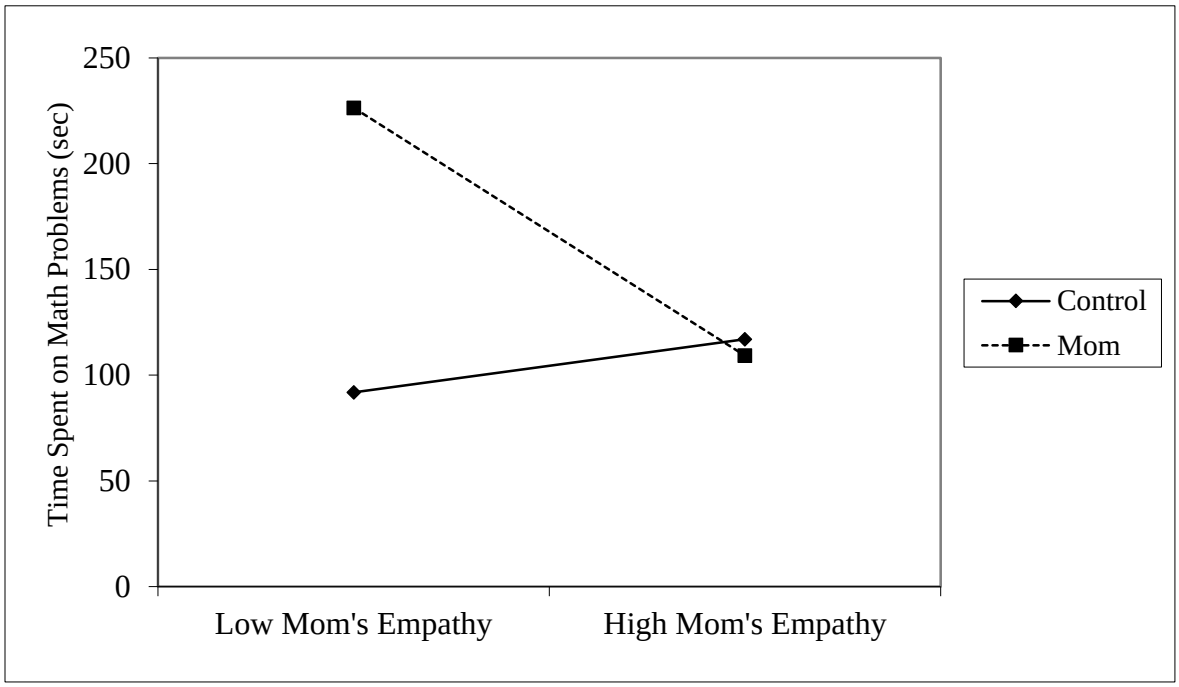
Math Problems Chosen. We also performed an ANCOVA to examine whether the writing prime (mom vs. dad vs. best friend vs. control) had an effect on the total number of math (vs. verbal) problems chosen. The results revealed a significant effect of writing prime (mom vs. dad vs. best friend vs. control) on number of math problems chosen, $F(3, 120) = 4.72$, $p = .004$, $\eta_p^2 = .11$. Simple planned contrasts revealed that women who wrote about their mother attempted more math problems ($M = 7.07$ problems, $SD = 2.11$) than women who wrote about their same-sex best friend ($M = 5.24$ problems, $SD = 2.26$), $p = .001$, but did not significantly differ from women who wrote about their father ($M = 6.80$ problems, $SD = 1.99$) or visiting a new city ($M = 6.52$ problems, $SD = 1.98$), $ps > .05$. Because math persistence better followed the predicted results, we used math persistence as our primary dependent measure in the subsequent analyses.

Individual Differences between Moms. Next, we were interested in examining whether there were individual differences between women's mothers that made the mom manipulation more effective for some participants. Because we were specifically interested in the mom condition, we conducted a series of multiple linear regressions examining women in the control condition vs. women who wrote about their mother. For each analysis, the main effects of condition (write about mom vs. being in a new city) and the individual difference measure (e.g., how feminine mom was, how much mom liked math, how empathetic mom was, etc.) were entered in Step 1 of a hierarchical regression analysis, and the interaction between condition and the individual difference measure was entered in Step 2 (see Appendix E for full list of items). Math identity was controlled for in both steps, and math persistence was entered as the dependent measure. The only significant interaction to emerge was between condition and how empathetic women perceived their mothers to be, $t = 2.35$, $p = .022$ ($\beta = -.36$, $b = -34.50$) (see Fig 2). Following Aiken and West (1991), we probed the interaction by calculating the estimated mean difference for women who scored 1 SD above or below the mean for mom's perceived empathy.

At 1 SD above the mom's empathy mean, women worked on math problems for a similar amount of time regardless of whether they wrote about their mom or not ($p > .05$). At 1 SD below the empathy mean, women who wrote about a time when their mom was accepting and non-evaluative worked on math problems longer compared to women in the control condition ($t = 3.11$, $p = .003$). In other words, women who rated their mothers lower in empathy had higher math persistence after thinking about a time when their mother was non-evaluative and accepting, whereas women who viewed their mothers high in empathy did not differ in math persistence across conditions.

Figure 2.

Effect of mom's empathy and condition (control vs. mom) on time spent working on math problems



We also examined the main effects in each of the above regression analyses for each individual difference measure on women's math persistence. The results indicated that regardless of condition, women who rated their mothers as more feminine spent less time on math problems, t = -2.61, p = .012 (β = - .31, b = -18.62), whereas women who rated their mothers as individuals who enjoyed math spent more time solving math problems, t = 2.23, p = .029 (β = .27, b = 10.12).

Individual Differences between Women. As in Experiment 1, we also conducted a series of multiple linear regression analyses examining whether condition (wrote about mom vs. being in a new city) interacted with women's self-reported self-esteem, modern sexism, and self-other scores with one' mother. For each analysis, the main effects of condition and the

individual difference measure were entered in Step 1 of a hierarchical regression analysis, and the interaction between condition and the individual difference measure was entered in Step 2. Math identity was controlled for in both steps. No significant results were found across analyses, *p*s > .05.

Discussion

Experiment 2 added to the generalizability of our findings by showing that women who thought about a time when their mother was non-evaluative and accepting spent a greater amount of time trying to solve math (vs. verbal) problems, as opposed to the self-report measures of math motivation used in Experiment 1. We were also able to obtain parallel results in Experiment 2 using a better matched control condition--one that involved a task more cognitively similar to the mom priming task than in Experiment 1. The results also suggested there might be something unique about one's mother compared to other possible attachment figures, such as one's best friend or father. Women who wrote about their mother spent a greater amount of time trying to solve math problems than women who wrote about their father, best friend, or visualized being in a new city for the first time. We failed to get an effect for the number of math problems women chose. This was not completely surprising because Forbes & Schmader (2010), from whom we adopted the dependent measure, also only obtained results when examining total time spent on math problems. It is possible that time is a more sensitive measure, likely because some women may have chosen a problem to work on and then immediately typed "don't know."

A surprising finding that emerged was that women spent the least amount of time working on math problems if they were asked to write about a time when their same-sex best friend was non-evaluative and supportive. Perhaps the bond between best friends encourages

support, but does not promote women to approach math. In one study, adolescents and young adults (three age groups: 12–15, 16–19, and 20–28 years) were asked to report how their mother, father, best friend, and romantic partner (if applicable) fulfilled different attachment functions (Markiewicz, Lawford, Doyle, & Haggart, 2006). Best friends (more than other targets) were found to serve as safe havens (i.e., support, comfort, and reassurance) more than for proximity or secure base. Additionally, best friends were used less for attachment functions by the oldest age groups, which is comparable to the college population used in the current study. Mothers, on the other hand, were used as secure base consistently more than fathers or peers for all age groups, and regardless of whether or not participants had romantic partners (Markiewicz et al., 2006). In another study, Trinke and Bartholomew (1997) investigated university students' use of multiple attachment relationships and the relative importance of different figures for the various components of attachment. Participants who did not have a romantic partner ranked their mothers most highly, then fathers, and finally peers, again supporting mothers' special place within the attachment hierarchy, even for young adults.

Another goal of Experiment 2 was to explore whether there were individual differences between mothers that influenced the effectiveness of the manipulation. The only individual difference to emerge in the current study was perceived level of empathy in one's mother. Specifically, women who perceived their mothers to be lower in empathy spent more time working on math problems after thinking about a time when their mom was accepting compared to women who perceived their mom's higher in empathy. This seems surprising, but perhaps women who have fewer positive instances of their mother being non-evaluative and accepting benefit more when such a memory is made accessible. In general, women spent longer on math

problems if their mother also liked math and was perceived as less feminine, but these were only main effects.

Experiment 2 bolstered the findings of Experiment 1, but there were still weaknesses in the current research. Although we manipulated reminders of mom support using different dependent variables, we used the same writing prime in both experiments. If the results were to be applicable in the real world, it is important to know how overt the reminder of mom needs to be in order to have an effect on women's math motivation. Additionally, we have still not identified a mechanism through which thinking about one's mother increases women's math motivation. Experiment 3 will aim to address such questions.

Experiment 3

Experiment 2 showed that women who wrote about their mother's support spent more time trying to solve math problems compared to women who wrote about their father or same-sex best friend, or wrote about being in a new city for the first time. One dimension that still needs to be addressed is the explicitness of the mom manipulation. The manipulation used in Experiments 1 and 2 was extremely overt and explicitly asked women to think and write about a time when their mother was non-evaluative and accepting. This manipulation has been previously successful in alleviating threat due to mortality salience (Cox et al., 2008), but a more subtle manipulation might also be effective. In one example, students who imagined their mother's presence and appearance subsequently put more effort into a verbal task, but only if it was important for them to make their mother proud (Fitzsimmons & Bargh, 2003). This is different from the manipulation used in Experiments 1 and 2 because participants were not overtly told to think of their mother's acceptance and support.

Additionally, other manipulations involving reminders of one's mother have been used to activate secure base schemas. Although having a secure base may be general, previous research suggests the sense of having a secure base can be contextually activated by real or imagined interactions with accessible and responsive others, even among those with chronic doubts about their secure base (Baldwin, 1992, 1997; Mikulincer, Hirschberger, Nachmias, & Gillath, 2001). In one instance, Mikulincer et al. (2001) used ''security priming'' to activate thoughts of attachment figures. One manipulation involved subliminal presentations of pictures that suggested attachment-figure availability (e.g., a Picasso drawing of a mother cradling an infant in her arms). Another manipulation involved subliminal presentation of the names of people who were designated by participants as security-enhancing attachment figures. A third manipulation involved visualizing the faces of security-enhancing attachment figures. Compared to positive non-attachment primes (e.g., pictures of large amounts of money), security priming has consistently been found to have positive effects on mood, mental health and well-being, compassion, prosocial feelings, and tolerance toward out-group members, and these effects occurred regardless of attachment style (e.g., Mikulincer et al., 2001; Mikulincer & Shaver, 2001; Mikulincer, Shaver, Gillath, & Nitzberg, 2005).

Experiment 3 aimed to explore whether explicitness of the mom manipulation influenced women's math motivation. This is an important avenue to explore from a practical standpoint in order to theorize how this research might be applied in real world settings. The central research question was whether women who were exposed to reminders of mother's support, or a more subtle security prime, reported higher math motivation than women who wrote about their mother's appearance or visiting a new city. Women either visualized and wrote about a time when their mother was supportive and accepting (same as Experiments 1 and 2), visualized their

mother's presence and described her appearance (similar to Fitzsimmons & Bargh, 2003), or viewed a sketch of a mother and child (security prime used in Mikulincer et al., 2001). Additionally, women in the control condition imagined and described being in a new city for the first time (same as in Experiment 2). We predicted that writing about *mom's support* would be the most effective for increasing women's math motivation, but exposure to the mother-child sketch (*security prime*) would also produce higher math motivation relative to writing about *mom's appearance* or visiting a new city (*control*). We thought that the mother-child sketch and thinking about mom's support may prime features of the attachment system, such as felt security, whereas describing mom's appearance may not tap into the mother-child relationship. If math makes women anxious, thinking about mom's care and support, whether implicitly or explicitly, might make women feel secure enough to approach and pursue something that may lead them to experience discomfort or anxiety. We thought it was possible the more explicit and personal manipulation of thinking about mom's support might strengthen women's sense of a secure base, or felt security, since we were explicitly telling women to bring to mind positive interactions they have had with their mothers. According to Bowlby (1973), the sense of having a secure base provides individuals with a framework for formulating effective emotion regulation devices, developing positive models of the self and others, and engaging in exploration and risk taking activities. Experiment 3 examined how each of the manipulations affected women's endorsement of their mother as a secure base, which we predicted might mediate the results. Because previous research shows that mothers are endorsed as a secure base consistently more than fathers or peers for all age groups (Markiewicz et al., 2006), we predicted that activating positive experiences with one's mother might lead women to more heavily endorse their mothers as fulfilling the secure base attachment function following exposure to the manipulation.

Finally, Experiment 3 examined whether women reported increased positive affect following the manipulation. Mikulincer and Shaver (2001) found that the contextual activation of the secure base schema (e.g., subliminal exposure to proximity-related words, guided imagination of the secure base script) led to higher reports of positive affect, and these effects were present regardless of differences in attachment style. While we did not think positive affect was driving the effect in the current studies, we did think it was important to rule it out as a potential mediator. Additionally, Experiment 3 used a word completion task to explore whether thoughts of "mom" and "safety" were more accessible for women following the manipulation.

Method

Participants. The sample consisted of 124 women undergraduates. The dependent measure was the same two self-report items used for math motivation in Experiment 1. At the beginning of the semester, all of the women completed the dependent measure on the university-wide prescreen, and baseline math motivation was used as a covariate in the analyses. Women who had the highest possible math motivation were excluded since their attitudes could not be made more positive. Additionally, women who classified themselves as seniors were excluded from participating because one of the dependent measures assessed likelihood of taking math courses in the future. Five women were excluded from the analyses for not completing the writing prime, leaving a total of 119 participants.

Materials and Procedure. Women were randomly assigned to one of four conditions. Some women were assigned the same mom support prime (n = 28) used in Experiments 1 and 2, whereas others received the same control prime (n = 28) from Experiment 2 (visualized being in a new city for the first time). Additionally, some women received a modified version of the maternal support prime where they were instructed to describe what their mother looks like, but

not recall an instance when their mother was supportive (n = 31). The last group of women received a security prime (n = 32) where they were subtly reminded of the general mother-child relationship. Following exposure to one of these conditions, women answered the same two items used in Experiment 1 about their desire to pursue and excel in mathematics and completed some potential mediators.

Mom Manipulations. All women were told the first part of the study was interested in creativity. Participants viewed three pieces of artwork by Pablo Picasso. After looking at each piece of art, women were asked to briefly describe what they saw, report how much they liked the work of art, whether they were familiar with the piece of art, and how the piece of art made them feel (Appendix C). With the exception of the first item, all questions were on 11-point scales ranging from 0 (*not at all/very negative*) to 10 (*very much so/very good*). In the security prime condition, the last picture women viewed was a black-and-white Picasso sketch depicting a mother holding and looking at her baby. This specific sketch has successfully been used as a secure base prime in previous research (Mikulincer et al., 2001). The other pieces of art included in the task were more abstract and included no people. After exposure to the mother-child sketch, women in the security prime condition proceeded to the dependent variable.

Women in the remaining three conditions were told they were going to participate in a different study examining how the valence of their memories influenced their visualization ability. In the *mom's presence and support condition*, women completed the same prime used in Experiments 1 and 2. In the *mom's appearance condition*, women described their mother's physical appearance and visualized her presence, but they were not asked to recall an instance where their mother was non-evaluative and supportive (Appendix C). Lastly, as in Experiment

2, women in the control condition were asked to visualize being in a new city for the first time and describe how they would spend their day.

Dependent Variable. All women then answered the same two items used in Experiment 1 about their desire to pursue and excel in mathematics (Appendix A).

Potential Mediators. Immediately following the dependent variable, women completed several different measures that could potentially mediate the findings (Appendix C). Normally the mediators would be placed before the dependent measure, but in this instance some of the mediators contained questions about one's mother, which could confound the manipulations. Additionally, the dependent measure was very brief, so it is unlikely the manipulation would have worn off when women reached the potential mediators.

First, women were given a short word completion task in order to measure the accessibility of their mother. They were given two word stems that could be completed as one of several different words, but two of the possibilities were "mother" and "mom." For example, the word stem "_ _ TH _ R" could be completed as "mother," but it could also be completed as bother, rather, tether, father, and lather. Additionally, the word stem "_ O _" could be completed as "mom," but it could also be completed as log, cog, box, dog, fog, and hog to name a few. Additionally, we included some word stems related to support and security. The word stem SA_E, for example, could be completed as "safe," or it could be completed as sage, sale, same, and sane.

Women also completed the Positive and Negative Affect Schedule (PANAS), which consists of 20 items that women indicated their agreement with for that *particular moment* (Watson, Clark & Tellegen, 1988). Questions range from 0 (*very slightly/not at all*) to 5

(*extremely*). Examples of positive affect items include proud, determined, and enthusiastic, whereas negative affective items include upset, distressed, and jittery.

Finally, women completed the 16-item Attachment Features and Functions questionnaire (AFF; Tancredy & Fraley, 2006). The AFF assesses the degree to which potential attachment figures (mother, father, or romantic partner) serve each of the four primary attachment functions (Appendix C). Specifically, the AFF taps into how each attachment figure fulfills the need for proximity seeking, a safe haven, a secure base, and prompts separation distress. An example of an item for proximity maintenance includes "I make an effort to stay in contact with my mother," whereas a separation distress item includes "When I am away from my mother, I feel down." The safe haven subscale includes items such as "My mother is a person I count on for advice." Finally, the secure base subscale is composed of items such as "My mother is the person that I count on to always be there for me and care about me no matter what." For the purpose of this study, women rated the degree to which their mother served each particular attachment function on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

Results

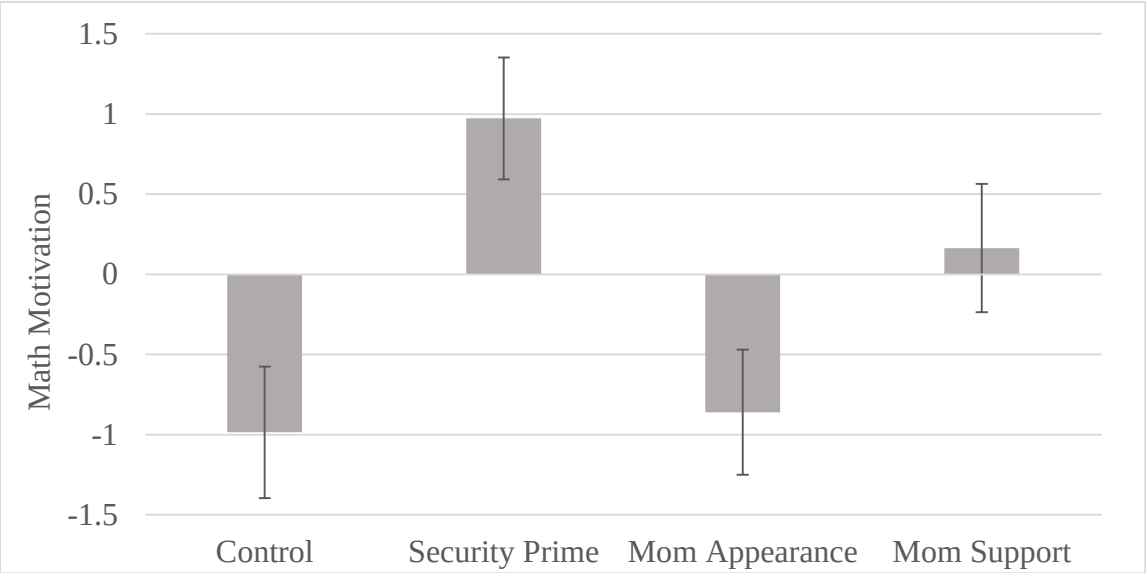
Measures. The measure of math motivation used in the analysis was a composite variable of two questions assessing student's willingness to take unrequired math courses and how important it was for the student to succeed and excel in mathematics ($\alpha = .75$). To control for individual differences in math motivation, baseline math motivation (a composite of the same items taken at the beginning of the semester) was used as a covariate in the analysis.

Effectiveness of different mom primes. The current study was interested in how overt the mom reminder needed to be in order to have a positive effect on women's math motivation. A one-way analysis of covariance (ANCOVA) was performed to see whether women who

visualized and wrote about their mothers being supportive and accepting (*mom's support*) vs. wrote about their mother's physical appearance only (*mom appearance*) vs. viewed a sketch of a mother or child (*security prime*) vs. wrote about being in a new city for the first time (*control*) differed in their subsequent self-reported math motivation. The results revealed a significant effect of condition, $F(3, 114) = 5.69$, $p = .001$, $\eta^2 = .08$ (see Fig 3). In order to test the central research questions, simple planned contrasts were first conducted comparing women who viewed the mother-and-child sketch to all other conditions. Women who viewed the mother-and-child sketch ($M = .89$, $SD = 2.46$) reported higher math motivation compared to women who described their mom's appearance ($M = -.60$, $SD = 3.07$), $p = .001$, or wrote about being in a new city ($M = -1.11$, $SD = 2.72$), $p = .001$. A second set of simple planned contrasts were conducted comparing women who visualized and wrote about their mother's support to all other conditions. Women who wrote about their mom's support reported significantly higher math motivation ($M = .09$, $SD = 2.46$) compared to women who wrote about visiting a new city, $p = .047$, and marginally higher math motivation compared to women who wrote about their mother's appearance, $p = .070$. Women who viewed the security prime or wrote about their mom's support did not significantly differ for math motivation, $p = .147$.

Figure 3.

Self-reported math motivation for women who wrote about their mom's support, mom's appearance, viewed a security prime, or completed a control prompt (adjusted means)



Effect of primes on mood. Because the *security prime* and *mom's support* prime were effective at increasing women's math motivation, a planned contrast was conducted examining women's positive and negative affect in the *security prime* and *mom's support* conditions vs. *mom's appearance* and *control* conditions. There were no significant differences between the groups of women for negative affect, $p > .05$, but the groups of women did significantly differ in positive affect, $F(3, 115) = 3.98$, $p = .010$. Specifically, women in the *security prime* ($M = 29.56$, $SD = 7.10$) and *mom's support* condition ($M = 26.07$, $SD = 6.88$) had higher positive affect than women in the *mom's appearance* ($M = 25.64$, $SD = 7.00$) and *control* condition ($M = 23.32$, $SD = 7.43$). We then conducted a mediation analysis using PROCESS (Hayes, 2008) to examine whether the relationship between condition and math motivation was mediated by women's positive affect. Mediation was not present. Specifically, the indirect effect between positive affect and math motivation did not reach significance, $p > .05$.

Effect of primes on endorsement of mother's attachment functions. All women completed the Attachment Features and Functions questionnaire (AFF). Subscales were calculated for the degree to which women said their mothers fulfilled four primary attachment functions: proximity seeking, a safe haven, a secure base, and prompted separation distress. A series of one-way ANOVA's were conducted to see if scores on each of the attachment function subscales differed between conditions. No significant differences were found, all *p*s > .05.

Effect of primes on word completions. We were also interested in whether women who reported increased math motivation in the *security prime* and *mom's support* conditions solved more word completions with the words "mom," "mother," "secure," and "safe." A series of one-way ANOVA's were conducted examining whether total number of "mom" related completions, total number of "safe" related completions, and total number of completions differed between conditions. No significant differences were found between groups for number of word completions, $p > .05$.

Discussion

Experiment 3 helped confirm our initial findings that thinking about one's mother being supportive and accepting can help increase women's math motivation. If we were to apply this finding to the real world, we thought it might be beneficial to understand how explicit the prime needed to be in order to be effective. Displaying a poster in a classroom of a mother and child takes less work and was more subtle than overtly having students write about their mother being supportive. Additionally, we were interested in teasing out whether the original prime was effective because women were just thinking about their mother, or whether it was thinking about one's mother's support that was driving the effect. In the current study, women who viewed a sketch of a mother and child reported the highest math motivation. This was surprising because

we did not predict the security prime to be more effective than the mom's support prime, although both were effective. Additionally, while the security prime was effective, visualizing and describing one's mother's physical appearance was not effective for increasing women's math motivation. Perhaps there is something important about the representation of the mother-child relationship. Mikulincer et al. (2001, p. 307) chose the Picasso sketch because it "depicted a core component of the secure-base schema—the receipt of caring and comfort from a primary attachment figure (mother)." The mom's support writing prime also involved women writing about a time that their mother demonstrated care and acceptance. Women who were asked to describe their mother's appearance may have been focusing too much on concrete details (clothing, hair, eye color, etc.) rather than the positive feelings and relationship they shared with their mother.

Experiment 3 was unable to identify the mechanism through which the security prime or the mom's support prime increased women's math motivation. We predicted the endorsement of one's mother as a secure base may be higher for women who experienced increased math motivation, but no significant differences were found between groups. In fact, no significant differences were found between groups for any of the four main attachment functions (e.g., proximity seeking, separation distress, safe haven, secure base). It is possible that while women may have experienced more felt security following the manipulation, the felt security did not lead women to evaluate their mothers differently in regards to serving attachment functions than they normally would. Perhaps we were expecting to see changes in something that was too stable of a construct. Women in the security prime and mom's support conditions did report higher positive affect relative to the control and mom's appearance conditions, which is consistent with previous research (e.g. Mikulincer & Shaver, 2001; Pierce & Lydon; 1998;

Mikulincer et al., 2001), although positive affect did not mediate the effect of mom reminders on women's math motivation. We did not predict positive affect would mediate the results; rather, we wanted to rule it out as a possible mediator. There were no differences in the word completions, but perhaps just having mom on the mind is not enough to cause changes in women's math motivation. Women who thought about their mom's appearance should have had "mom" just as accessible as women who wrote about mom's support, yet women who wrote about their mom's appearance did not report increased math motivation.

General Discussion

The recruitment and retention of qualified individuals in STEM careers is essential for stimulating economic growth and innovation. According to the National Math and Science Initiative (*nms.org*), 60% of the job openings in the 21st century will require skills possessed by only 20% of the current workforce. It is estimated the U.S. may be short as many as three million high-skilled workers by 2018. The Obama administration recognizes the importance of training a workforce skilled in STEM, and the President's 2015 Budget will invest $2.9 billion into improving STEM education (White House Office of Science and Technology Policy, 2014). Much of the budget is devoted to improving STEM curriculum and training teachers in STEM. While the recruitment and training of teachers will help facilitate future generations to be more competent in STEM, it may not increase women's desire to pursue a STEM degree or career. Of those that do pursue STEM fields, women represent only 24% of the STEM workforce, (US Department of Commerce, 2011b). Negative stereotypes about women's math ability, stereotype threat, heightened trait math anxiety, lack of role models, and perceptions of math as uncool and unfeminine all contribute to women's underrepresentation in STEM (e.g., Betz, 1978; Steele, 1997; Hyde et al., 1990). The goal of the present set of studies was to find a way to make

women more likely to *approach* STEM courses. More specifically, the central hypothesis was that women who visualized and wrote about a time when their mothers were supportive would be more likely to try something that might normally cause them anxiety: math.

We believed that thinking about one's mother may increase women's desire to pursue math because one's mother is likely perceived as a role model, and confers benefits through being an attachment figure. Previous research on mathematics stereotypes threat supports that exposure to same-sex role models can alleviate math performance decrements in women (e.g., McIntyre et al., 2003; Taylor et al., 2011) and increase women's self-efficacy and identification with STEM among women already taking STEM courses (e.g., Stout et al., 2011; Young et al., 2013). Many of these studies have focused on math performance or the retainment of women already in STEM, but we thought the *recruitment* of women to try STEM courses may require a different kind of role model. If a role model's success seems unattainable or too far out of reach, for example, the role model may actually backfire and leave women feeling like they are not capable of living up to such high standards (Lockwood & Kunda, 1997; Betz & Sekaquaptewa, 2012). We thought one's mother might be more relatable and personal to women compared to experimenter provided role models. When women were asked to generate their own list of role models, for example, "mother" was at the top of the list (Taylor et al., 2011).

In addition to being more relatable than other role models, one's mother also can provide attachment functions that may be particularly helpful when women are deciding whether to take STEM courses. Women experience more trait anxiety when it comes to math compared to men (e.g., Betz, 1978; Hembree, 1988, 1990), and we believed thinking of one's mother could provide a secure base from which women could step outside their comfort zone and approach something that may normally cause them anxiety. Attachment figures serve as a secure base

from which children can explore and learn about their world (see also Hazan & Shaver, 1994; Mikulincer, Shaver, & Pereg, 2003). Children feel most safe exploring their surroundings when their primary attachment figure is present, and they are confident in their caregiver's responsiveness to their needs. As they reach adulthood, individuals develop complementary working models of attachment figures and the self, such that features of the attachment system can be activated even if attachment figures are not physically present (Bowlby, 1982; Mikulincer & Shaver, 2007a). Priming attachment figures in adulthood, for example, can provide emotion regulation benefits, increase feelings of self-worth, and encourage creativity (e.g., Selcuk et al., 2012; Cox et al., 2008; Mikulincer et al., 2011). Consistent with this reasoning, the present studies provide hope that women's math motivation can be improved and suggest that maternal support may play an important and possibly unique role in increasing women's willingness to purse math-related careers.

Women's Math Motivation Can be Improved

The current work drew from ideas in the attachment and role model literature to develop a manipulation that would increase women's math motivation. Three studies supported that women's math motivation can be improved through thinking about mom's support. This is important because the results contribute to the understanding of why women are not pursuing math, and can help shape future interventions. Currently our country is focusing much of its resources on improving competency in math and science, but the current results suggest women's perception of math as unwelcoming to women, or anxiety inducing, is a hurdle that needs to be addressed in order to attract women to STEM. Women's avoidance of math is more complex than their innate mathematical ability. Although we did not pinpoint the exact

mechanism, thinking about mom's support would not have been an effective manipulation if women did not initially feel some insecurity or anxiety when thinking about mathematics.

In the current work, explicitly thinking about mom's support and a subtler manipulation signaling the general mother-child relationship were both effective for increasing women's math motivation. Research examining the effects of role models on the retainment and performance of women in STEM has typically used more overt manipulations. Gender of the professor or experimenter, for example, has been a common manipulation when looking at women's sense of belonging, efficacy, and performance within a STEM domain (e.g., Marx & Roman, 2002; Stout et al., 2011; Young et al., 2013). When examining stereotype threat, reading about successful female role models, manipulating role model similarity and deservingness, or promoting women's group achievements have also been effective at alleviating math performance decrements in women due to threat (e.g., McIntyre et al., 2003; Marx & Ko, 2012; Taylor et al., 2011). The attachment literature, on the other hand, has found success changing attitudes using subtler manipulations. Subliminal presentation of names and faces of attachment figures and even subliminal presentation of words related to the secure base schema (e.g., love, support) have had positive effects on measures of attitudes toward outgroup members and mood (e.g., Banse 1999; Mikulincer et al., 2001; Mikulincer & Shaver, 2001). The current work obtained parallel results on women's math motivation using both an explicit prime where we told women to think about a time when their mother was supportive, and a more subtle prime where we simply showed women a mother-and-child sketch.

One reason we think both types of manipulations were effective for increasing women's math motivation is because attitudes are heavily context-dependent. A number of related conceptual analyses (e.g. Lord & Lepper, 1999; Schwarz & Bless, 1992; Schwarz & Bohner,

2001; Wilson & Hodges, 1992; Tourangeau & Rasinski, 1988) suggest that it is more parsimonious to think of attitudes as evaluative judgments, formed when needed, rather than as enduring personal dispositions that are retrieved from storage. When evaluating a given attitude object (i.e., math), it is likely that only a handful of all possible associations come to mind on any one occasion (Bellezza, 1984; Schwarz & Bless, 1992; Wilson & Hodges, 1992), and the associations that come to mind can vary from one time to the next depending on the context (Sia, Lord, Blessum, Ratcliff, & Lepper, 1997). When women are asked to think about their attitude toward pursuing math, it is possible the thoughts that come to mind involve negative stereotypes about women's math ability, fear of failure, and perceptions of the math environment as being unsuitable for women. These negative associations likely influence women to form a negative evaluative response toward pursuing math. In the current set of studies, we made mom's support salient before women were asked to report their evaluative response to math. Evaluative responses can change from one time to the next though either changing what associations come to mind, or through changing the valence (i.e., strength and direction) of the associations that normally come to mind (Lu, Lord & Yoke, 2015). Thinking of mom's support could have prompted women to generate more positive thoughts when evaluating their attitude toward pursuing math (e.g., "It might hard, but it will be a good challenge), or could have lessened the intensity of the negative thoughts that women normally generate regarding math. Women may have still perceived the math environment as intimidating, for example, but thinking about mom's support could have lessened the degree to which women felt intimidated.

Subjective experiences like mood and emotion can also influence how someone thinks or behaves in a given context (for review see Schwarz, 2010). We believe that women experienced increased security as a result of thinking about their mom's support, and this secure feeling could

have served as a contextual cue that influenced women's evaluation of math. It makes sense that when women feel especially secure and supported, anxiety-inducing attitude objects might be perceived as less threatening. The explicit mom's support prime asked women to recall a time when their mother was supportive, whereas the subtle prime displayed a sketch of a mother cradling and staring into her infant's eyes. Both of the effective manipulations tapped into a mother's love and support, just in different ways. Women who wrote about their mother's appearance did not report increased math motivation, likely because describing the appearance of one's mother can be done without activating thoughts of mom's support. This finding suggests that the mom manipulations are not effective solely because they call to mind one's mother, but that experiencing feelings of security and support seem to be essential for changing women's attitudes toward math.

In addition to showing that self-reports of women's math motivation increased after thinking of mom's support, the current work also extended the findings by incorporating a behavioral measure of math motivation. Sometimes individuals express a positive evaluative response toward an activity, yet admit that they rarely participate in that activity (Ajzen & Fishbein, 1977, 1980). Difficulties in predicting behavior from attitude reports has been addressed by several reviews (e.g., Eagly & Chaiken, 1993, 1998; Lord & Lepper, 1999; McGuire, 1985). In a meta-analysis of 797 studies examining attitude-behavior consistency, the correlation between attitudes and behaviors was moderate at best, and situational constraints like perceived difficulty and social pressure greatly weakened the relationship (Wallace, Paulson, Lord, & Bond, 2005). For this reason, we believed it was important to show that mom's support affected the degree to which women put in effort or persisted at trying to solve math problems. Using a math-choice task that was successful in previous research on women's stereotype threat

(Forbes & Schmader, 2010), women in the current Experiment 2 worked longer on math problems (vs. verbal problems) after writing about a time when their mother was supportive. Establishing that mom's support has effects on both women's attitudes and behaviors toward math strengthen the generalizability of the findings, and signals the importance of making women feel secure and supported when it comes to developing interventions for the recruitment of women to STEM.

Mom as a Unique Role Model

Another interesting finding from the current work was that thinking about mom's support was uniquely effective for increasing women's math motivation. We knew that women often viewed their mother as a role model (Taylor et al., 2011), but it was not clear whether other potential attachment figures could have an effect on women's math motivation. Previous studies examining the effects of attachment figure primes in adulthood used whoever students reported as sources of support (e.g., father, romantic partner, best friend), not exclusively one's mother (e.g., Baldwin, 1994; Baldwin et al., 1996; Banse 1999; Mikulincer & Shaver, 2001). We tested the unique importance of *mom's* support in Study 2 by having some women write about a time when their same-sex best friend or father was supportive. The results supported that only writing about mom's support was effective for increasing women's math motivation.

The idea that thinking about mom was uniquely effective for increasing women's math motivation is consistent with research on attachment. One of the basic tenets of Bowlby's (1973) theory is that interactions with significant others who are available and supportive in times of stress facilitate the formation of a psychological "secure base," or what Sroufe and Waters (1977) called *felt security*. This sense of security can be viewed as an internal cognitive-affective prototype or script (Waters, Rodrigues, & Ridgeway, 1998), where individuals realize that if they

encounter obstacles or a stressful situation, they can approach their attachment figure for support and help. Individuals expect their attachment figure to be responsive and supportive in stressful situations and to provide comfort, and when individuals feel relieved of their distress they are then free to return to other activities. People typically have more than one attachment figure, and each attachment figure can be viewed within a hierarchy that may serve different attachment related functions (Bowlby, 1982). In Western cultures one's mother tends to become the preferred attachment figure (e.g., Lamb, 1978; Lytton, 1980; Bretherton, 1985). Mothers are typically endorsed more as fulfilling the secure base function compared to fathers or peers for all age groups (Markiewicz et al., 2006). Even when one feels threatened in adulthood, mother's names are typically more accessible relative to other attachment figures (Landau & Carr, 2012).

As outlined by Bowlby (1973), the feeling of having a secure base provides people with the groundwork for maintaining well-being, forming positive models of the self and others, developing effective emotion regulation strategies, and engaging in exploration and risk-taking activities. Because mothers are most often endorsed as fulfilling secure base functions, it is possible women in the current study felt more comfortable engaging in an activity that may be perceived as difficult, or a domain where women typically are underrepresented, when thoughts of mom's support were activated. When individuals feel like they have a secure base they are better able to open their schemas to belief-discrepant information (Mikulincer, 1997), so while women may normally perceive math as incompatible with women, felt security from thoughts of mom's support may lead women to perceive math in a different, less threatening, way.

In addition to potentially conferring unique benefits related to attachment, mothers may also confer unique benefits as a role model. Previous research on role models suggests same-sex role models are more important for women than for men (Lockwood, 2006; Marx, Monroe, Cole,

& Gilbert, 2012). Other factors such as whether women perceive the role model to be deserving of their success (Taylor et al., 2011), whether the role model's success is perceived as attainable (Lockwood & Kunda, 1997), and how similar the role model is to the observer can influence role model effectiveness (Marx & Ko, 2012). In one example, women performed better on a math test under threat after being exposed to a similar female role model (e.g., attended same university, liked similar activities) compared to a less similar role model (Marx & Ko, 2012). Because women share so many experiences with their mother, it is likely they perceive a higher degree of similarity with their mother compared to a fictional or unfamiliar experimenter provided role model. Additionally, while women can differ in whether they perceive a role model as being deserving or undeserving of her success (e.g., Hillary Clinton), most women would probably rate their own mother as being deserving of her success. If mothers have the ability to be personally similar and simultaneously perceived as deserving, they might be unique as role models. Mothers may lack expertise in a particular domain, which some say is important for role model effectiveness (e.g., Lockwood & Kunda, 1997), but perhaps moms have a more general effect on motivation that is not domain specific. In the current work, thinking about mom's support led women to report increased math motivation, even though it seems unlikely that many of participants' moms (or dads) were math experts.

Limitations and Future Directions

The current work provided support for the central hypothesis, that thinking about mom's support increases women's math motivation, in all three experiments. That being said, there are limitations to the current work and questions that need to be addressed in future research. One weakness is the inability to pinpoint what is mediating the relationship between thinking about mom's support and increases in women's math motivation. In the current work we examined

likelihood to step outside one's comfort zone/approach new challenges, positive and negative affect, endorsement of one's mother as fulfilling different attachment functions (i.e., secure base), and accessibility of words like "mom" and "secure." Women who wrote about mom's support did experience increases in saying they would step outside their comfort zone and had higher positive affect, but these did not mediate the relationship. We strongly believed that *felt security* was mediating the relationship, and that was what we were trying to capture with the degree to which women endorsed their mother as a secure base on the Attachment Features and Functions Questionnaire (Tancredy & Freeley, 2006). In retrospect, we still believe felt security is most likely mediating the relationship, but we did not select the most appropriate measure of felt security. Endorsement of one's mother as generally fulfilling the secure base function is different from how secure women feel at a given point in time. We were perhaps expecting to change a construct that was too stable.

It is worth noting that women may not be able to consciously detect feelings of felt security, which may make selecting an appropriate measure difficult. Self-report measures may be affected by motivational biases, and only tap into emotions that are present in a person's stream of consciousness. Emotions and motivations operating on the preconscious level may not be adequately assessed with self-report measures, although preconscious affect can still influence cognitions and behaviors outside a person's awareness (Zajonc, 1984). Subliminally primed representations (i.e., faces and names) of participants' attachment figures and "security primes" (e.g., mother-and-child sketch), for example, can lead to more positive evaluations of Chinese ideographs in an affective priming procedure (Banse, 1999; Mikulincer et al., 2011). Using more implicit measures to tap into felt security, such as an affective priming procedure, may be more sensitive to changes in women's felt security and should be tested in future research.

In addition to identifying more implicit measures that tap into felt security, another construct that could be explored as a potential mediator is threat appraisal. In one example, Mikulincer and Shaver (2001) examined the effects of activating the secure base schema on intergroup bias. Israeli students visualized a loving and supportive person (secure base priming), a happy person (positive affect priming), or a casual acquaintance (neutral priming). Participants then evaluated Russian immigrants (an outgroup Israelis showed strong prejudice toward in the past) and rated the extent to which Russian immigrants posed real and symbolic threats, and elicited intergroup anxiety. Israeli students who visualized a loving and supportive person had more positive attitudes toward Russian immigrants, and this effect was mediated by a reduction in threat appraisal (Mikulincer & Shaver, 2001). We know that women tend to experience anxiety when it comes to math (e.g., Betz, 1978; Hyde et al., 1990), and can experience stereotype threat in certain contexts (e.g., Steele, 1997). The current studies could have benefitted if we measured women's threat appraisal of mathematics after they thought about their mother's support. Good, Rattan, and Dweck (2012) developed a Sense of Belonging to Math scale that assesses how much negative affect people experience in regards to math, and how people think they will be viewed and treated within the math community (e.g., accepted, excluded, respected). Women who think about their mother's support may experience increased felt security, and as a result feel less threatened and anxious about not fitting in with the math community. It may also be beneficial to use more physiological measures of arousal, such as galvanic skin response (GSR). Perhaps women would show less arousal working on math problems after thinking about their mother's support.

The current set of studies focused specifically on whether mom's support had an influence on women's desire to approach mathematics, but it is unclear whether the manipulation applies to

other outcomes. Numerous studies in the attachment literature have found positive effects of thinking about an attachment figure on factors like subjective well-being, prosocial behavior and attitudes, attitudes toward outgroup members, mood, and problem-solving (e.g., Mikulincer et al., 2001; Mikulincer & Shaver, 2001; Mikulincer, et al., 2005; Mikulincer et al., 2011). It is possible, then, that the current manipulation is not necessarily exclusive to having an effect on attitudes toward mathematics, and other possibilities should be tested in further research. Women typically experience threat or mild anxiety toward math, but mathematics is also an in-demand skill set and can potentially improve women's career options. Similar attitude objects that are perceived as threatening, but have potentially positive outcomes, may benefit similarly from the mom manipulation. Taking a class on public speaking, for example, may also induce anxiety but be perceived as beneficial in the long run. Future research should examine whether thinking about mom's support affects women's general sense of risk taking in a wide range of self-beneficial activities. Dispositional security (lower scores on anxiety and avoidance) has been associated with higher scores on self-report measures of novelty seeking (e.g., Carnelley & Ruscher, 2000), trait curiosity, (Mikulincer, 1997), and exploratory interest (e.g., Green & Campbell, 2000), but it is unclear whether a contextual security prime would produce changes on these types of measures. It is also possible that thinking about a particular attachment figure's support may have different effects on different goals or domains. Thinking about a best friend's support may be more effective than mom's support in a relevant social context, like getting up the nerve to ask someone out on a date.

In the current study, increases in math motivation were specific to women who thought about their mother's support or were exposed to the security prime (mother-and-child sketch). Directing women to think about their father's support or best friend's support did not have an

effect on women's math motivation. One avenue we did not explore was directing women to think about their romantic partner/significant other. Feeney and Van Fleet (2010; for a review) have conducted several studies examining the interplay between attachment and exploration in adulthood, but they have focused primarily on romantic partners as attachment figures. In one example, Feeney and Thrush (2010) gave a romantic couple a novel and challenging laboratory task to solve. Only one partner could work on the task, while the other could remain in the room and offer support. Romantic or marital partner's availability and supportiveness during the task helped participants to persist longer at the activity while also avoiding anxiety. In another example, Feeney (2007) had couples complete surveys about their partner's behavior (e.g., availability and support), videotaped couples interacting, and followed the couples over time as they worked toward achieving important goals. Reports of one partner's availability and support were associated with reports of the other's perceived independence and self-efficacy, engagement in independent exploration, and ability to achieve independent goals (Feeney, 2007). We chose not to use romantic partners in the current study because it would have taken some time to recruit women within our college sample who were in serious romantic relationships. One's mother is a stable attachment figure that a woman often relies on throughout her lifetime, but that does not mean a romantic partner could not also serve similar functions. Future studies could recruit women who were in romantic relationships and test whether thinking about their partner's support had similar effects on women's math motivation.

Another interesting finding was that women benefitted from thinking about mom's support regardless of most individual differences we measured between perceptions of mothers. The only significant individual difference to emerge was that women who rated their mothers as being lower in empathy benefitted more from thinking about a time when their mother was

supportive. According to the dependency-paradox, the availability and responsiveness of an attachment figure is what drives felt security, and when individuals feel secure they are able to explore their environment most effectively and confidently (Feeney, 2007; Fenney & Thrush, 2010). The reasoning underlying the dependency-paradox is that it is easier for individuals to engage in behaviors that will enhance their personal growth (e.g., accepting challenges, exploring, trying new things, and taking risks) when they know someone will provide comfort and reassurance if they encounter a setback. Perhaps women who perceive their mothers to be lower in empathy are the women who benefit most from the contextual activation of their mother's support because they are not as habitually confident in their mother's responsiveness to their needs—an empathy contrast effect. It is important to note that in the current study women rated their mothers as being very high in empathy on average, and even at 1 SD below the mean, mother's empathy scores were still above the scale midpoint. The distinction was between mothers who were above average and extremely high in empathy, which is a subtle difference. Including mother's level of empathy in Experiment 2 as an individual difference was exploratory in nature, and before more definite conclusions can be drawn, the results would need to be replicated in a future study.

We also did not find that dispositional attachment style moderated the findings. Previous studies have supported that priming a secure base or attachment figure can have positive effects on a variety of behaviors regardless of dispositional security (e.g., Baldwin et al., 1996; Mikulincer et al., 2001; Mikulincer & Shaver, 2009), but it may be beneficial to test the mom's support manipulation on a more diverse sample. Participants in the current studies were predominantly White and attended a wealthy private institution, and it is likely that women with a secure attachment disposition were overrepresented in the sample. It may be that the

effectiveness of the manipulation would be lost if we specifically targeted women who we knew had an insecure attachment style. Additionally, more variation in dispositional attachment styles would also likely result in more pronounced individual differences in perceptions of mothers. It is doubtful, for example, that the manipulation would still be effective if women perceived their mothers as having little or no empathy. Perceived mom empathy would also likely influence how easy or difficult it was for women to generate a detailed instance of their mother's support. Thus future studies may also benefit by assessing the subjective ease of visualization. When idea generation is perceived as easy, people typically think that the ideas must be more accurate than when idea generation is perceived as difficult (e.g., Wänke, Bohner & Jurkowitsch, 1997; Haddock, Rothman & Schwarz, 1996). In one instance, people who found it easy to generate a few positive characteristics of BMW cars subsequently reported greater behavioral intentions to purchase a BMW than did people who found it difficult to generate many positive characteristics (Wänke, Bohner & Jurkowitsch, 1997). If women have a harder time recalling a specific instance of their mother's support, they may come to the conclusion that their mother is not as supportive compared to someone who immediately has an example of their mother's support pop into their head. In short, future studies should have a more representative sample in order to more accurately assess individual differences in attachment and the influence of individual differences in perceptions of mothers, and should also control for factors such as subjective ease of visualization.

Finally, while the current work supported that thinking of mom's support was effective for increasing women's math motivation, it is unclear if the manipulation would also work on men. The current work chose to target women because they are underrepresented in STEM and experience more math anxiety than men. That being said, our country would benefit from more

participation in STEM fields in general, not just by women. Men and women face different challenges when it comes to STEM. Women must contend with negative stereotypes about their mathematics ability, and find a way to belong in an environment that is dominated by men. We think mom's support makes women feel an increased sense of security, and as a result they are more likely to venture out into foreign territory and try something challenging. Men, in contrast, should not perceive math as particularly unwelcoming and anxiety-provoking. Their reasons for avoiding STEM may have to do more with a general lack of motivation. Men's share of total college enrollment, for example, has fallen from 71% in 1947 to 43 % in 2005 (e.g., Conger & Long, 2010), and even when men decide to pursue college, they complete their degrees at lower rates than females (Snyder, Dillow, & Hoffman, 2008). Women also have higher grades on average in high school compared to men, but do not outperform men on standardized tests, suggesting women may have greater non-cognitive skills like self-discipline and dependability that contribute to college success (e.g., Jacob, 2002; Peter & Horn, 2005; Riegle-Crumb, 2007). It seems that men may be developing more of a general disinterest in school compared to women, and if this is the case, then more rigorous STEM domains may be particularly unappealing. In order to develop an effective manipulation for men, it is important to first understand that men may be experiencing a lack of academic motivation when it comes to postsecondary education, not the more focused math insecurity that afflicts so many women.

Concluding Remarks

The current work provided support for the hypothesis that women who think about their mother's support are more likely to approach mathematics. Although the current work does not provide an immediate application, it does address an important problem and helps further understanding of why women are not entering STEM. In order to remain competitive with the

rest of the world, it is essential for our country to both recruit and retain qualified applicants to STEM careers. Our country is focusing its efforts on improving STEM education, but the current work supports that women's avoidance of STEM is not purely attributable to a lack of ability. The finding that thinking about mom's support leads women to report they are more likely to approach math and actually persist longer on math problems suggests that a large part of their math avoidance may stem from deep seeded insecurity, likely caused by cues in women's environment signaling that math is for men. Moving forward, future interventions need to work toward combatting negative stereotypes about women and their math ability, and portraying math as a domain that is safe and welcoming toward women. From elementary school through college, we need to make the environment for mathematics and math-related activities as supportive as Mom.

Appendix A

Demographic questions

Please answer the following questions.

What is your current major?_____
What is your age?_____
What is your gender? (Please Circle) Male Female
What ethnicity do you most strongly identify with? (Please circle)

White/Caucasian Black/African American Asian Hispanic/Latino(a) Native American Other

What is your current class level?_____
What is your overall GPA?_____

Math Identity Questions (Pronin, Steele & Ross, 2003)
Items on a 0 (not at all skilled/important) to 10 (extremely skilled/important)

How would you rate your own **mathematics** skill?
How important is this skill to you?
How important is this skill to your sense of self?
How important is for you to score well on **mathematics** standardized tests?

Experiences in Close Relationships Scale (Brennan, Clark, & Shaver, 1998)

1. I'm afraid that I will lose my partner's love.
2. I often worry that my partner will not want to stay with me.
3. I often worry that my partner doesn't really love me.
4. I worry that romantic partners won't care about me as much as I care about them.
5. I often wish that my partner's feelings for me were as strong as my feelings for him or her.
6. I worry a lot about my relationships.
7. When my partner is out of sight, I worry that he or she might become interested in someone else.
8. When I show my feelings for romantic partners, I'm afraid they will not feel the same about me.
9. I rarely worry about my partner leaving me.
10. My romantic partner makes me doubt myself.
11. I do not often worry about being abandoned.
12. I find that my partner(s) don't want to get as close as I would like.
13. Sometimes romantic partners change their feelings about me for no apparent reason.
14. My desire to be very close sometimes scares people away.
15. I'm afraid that once a romantic partner gets to know me, he or she won't like who I really am.
16. It makes me mad that I don't get the affection and support I need from my partner.
17. I worry that I won't measure up to other people.
18. My partner only seems to notice me when I'm angry.
19. I prefer not to show a partner how I feel deep down.
20. I feel comfortable sharing my private thoughts and feelings with my partner.
21. I find it difficult to allow myself to depend on romantic partners.
22. I am very comfortable being close to romantic partners.

23. I don't feel comfortable opening up to romantic partners.
24. I prefer not to be too close to romantic partners.
25. I get uncomfortable when a romantic partner wants to be very close.
26. I find it relatively easy to get close to my partner.
27. It's not difficult for me to get close to my partner.
28. I usually discuss my problems and concerns with my partner.
29. It helps to turn to my romantic partner in times of need.
30. I tell my partner just about everything.
31. I talk things over with my partner.
32. I am nervous when partners get too close to me.
33. I feel comfortable depending on romantic partners.
34. I find it easy to depend on romantic partners.
35. It's easy for me to be affectionate with my partner.
36. My partner really understands me and my needs.

Mom Writing Prime
In Experiment 2, instances of "mother" was replaced by "father" or "same-sex best friend"

This part of the experiment is interested in your visualization and verbal fluency skills. Please read the following prompt and work on the task for the next 5 minutes. You will not be able to continue with the study until 5 minutes has passed. After the timer reaches zero, you may click the arrow at the bottom of the page to move on. Try to work on the task for a full 5 minutes, but if you finish early please sit at your computer quietly until it is time to move on.

Please write about a time where your mother (or motherly figure) expressed a positive opinion of you. That is, write about a time when your mother was non-evaluative and simply accepted your for who you are. Try to visualize being in the presence of your mother (i.e., imagine her eye color, hair color, sound of her voice) and express the thoughts and feelings associated with your mother by writing in the space provided. Include as much detail as possible.

Control Task (Used in Experiment 1 only)

This part of the experiment is interested in your visualization and verbal fluency skills. Please read the following prompt and work on the task for the next 5 minutes. You will not be able to continue with the study until 5 minutes has passed. After the timer reaches zero, you may click the arrow at the bottom of the page to move on. Try to work on the task for a full 5 minutes, but if you finish early please sit at your computer quietly until it is time to move on.

Below are words that represent different categories of objects. For each category, try to come up with as many objects as you can think of that are a part of that category. For example, if the category is "Fruit," acceptable responses would include banana, apple, orange, ect.

Category 1: Vegetables
Category 2: Birds
Category 3: Animals that live in the ocean
Category 4: Trees
Category 5: Things you might see in the desert

Control Prompt (Experiments 2 and 3)

This part of the experiment is interested in how well people can visualize information depending on how positive or negative the information is being visualized. Please read the following prompt and work on the task for the next 5 minutes. You will not be able to continue with the study until 5 minutes has passed. After the timer reaches zero, you may click the arrow at the bottom of the page to move on. Try to work on the task for a full 5 minutes, but if you finish early please sit at your computer quietly until it is time to move on.

Imagine you are alone and in a new city for the first time. What city popped into your head? Try to visualize being in the city and describe what it looks like. Try to imagine the buildings, shops, sights, and sounds of the city. What sorts of things would you want to do? Where would you explore? In the space provided, please write a detailed description of how you would spend the day in the city you visualized.

Potential Mediators (Experiment 1)

How likely are you to attempt a task if there is a strong possibility you might not perform well?

How likely are you to attempt things that are outside of your comfort zone, or that you have little previous experience with?

How likely are you to approach challenges that may be outside your normal skill set?

How open are you to new experiences, especially when you're unsure of the outcome?

**All of these questions are on a sliding scale in Qualtrics, ranging from 0 (not all likely/often/open) to 100 (extremely likely/often/open).*

Dependent Variable (math motivation questions; Experiments 1 and 3)
Other majors included to disguise purpose

1. On a scale of -5 (not at all likely) to +5(extremely likely), how likely is it that *you will take unrequired courses* in each of these areas?

   Political Science, **Math**, English, Business, Biology, Psychology, Kinesiology, Computer Science, Engineering, History

2. On a scale of -5 (not at all important) to +5 (extremely important), how important is it for you personally to be successful and excel in each of these areas?

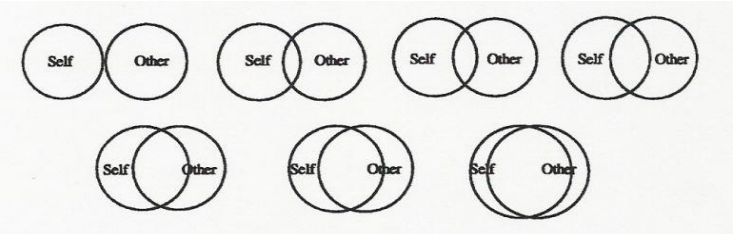
   Political Science, **Math**, English, Business, Biology, Psychology, Kinesiology, Computer Science, Engineering, History

Appendix B

Items examining individual differences between mothers (Experiment 2)
Similar items asked for father and same-sex best friend
Items on a -5 (not at all) to +5 (very much) scale

To what degree does your mother embody or represent traditional female gender roles?
How feminine do you think your mother is?
How much would your mother want you to take additional English courses?
How much would your mother want you to take additional mathematics courses?
How competent do you think your mother is in traditionally masculine domains (e.g., fixing things, changing a tire, assembling things)?
To what degree does your mother enjoy mathematics?
How good is your mother at mathematics?
To what degree does your mother enjoy English?
How good is your mother at English?
How much do you think your mother empathizes with you, or is able to understand and share your feelings?
To what degree does your mom provide you with unconditional support?
To what degree do you perceive your mom as a role model?
How much are you able to empathize with your mother, or understand and share her feelings?
How much do you want to be like your mother?
How important is it for you to make your mother proud?

Please select the picture below that best describes your relationship with your mother, where your mother is the "other person."



What is your mother's profession (if unemployed or stay at home mom, please say so)?

Approximately how many hours per week does your mother work?

Stay at home mom or currently unemployed
Less than 20 hours per week
20-30 hours per week
30-40 hours per week
More than 40 hours per week

Rosenberg Self-Esteem Scale (Experiment 2)
For each item, participants could select strongly disagree, disagree, agree, or strongly agree.

1. I feel that I am a person of worth, at least on an equal plane with others.
2. I feel that I have a number of good qualities.
3. All in all, I am inclined to feel that I am a failure.
4. I am able to do things as well as most other people.
5. I feel I do not have much to be proud of.
6. I take a positive attitude toward myself.
7. On the whole, I am satisfied with myself.
8. I wish I could have more respect for myself.
9. I certainly feel useless at times.
10. At times I think I am no good at all.

Modern Sexism Scale (Experiment 2)
Items on a 1 (strongly disagree) to 5(strongly agree) scale

1. Women often miss out on good jobs due to sexual discrimination.
2. It is rare to see women treated in a sexist manner on television.
3. Society has reached the point where women and men have equal opportunities for achievement.
4. It is easy to understand the anger of women's groups in America.
5. Over the past few years, the government and news media have been showing more concern about the treatment of women than is warranted by women's actual experiences.
6. Discrimination against women is no longer a problem in the United States.
7. On average, people in our society treat husbands and wives equally.
8. It is easy to understand why women's groups are still concerned about societal limitations of women's opportunities.

Math Persistence Measure (Dependent Variable; Experiment 2)

Instructions

Before we have you take the memory test, we would like you to pretest some math and verbal problems for a future experiment. There are 10 items in all. For each item, you can choose to solve a **math problem OR a verbal problem**. Please try to solve whatever item you choose to work on. We are trying to determine which problems people prefer to solve, and the difficulty of each problem. For the math items you may use the calculator available on your computer. Go to the start menu and select "calculator", or type "calculator" in the search box at the bottom of the start menu.

After you select which problem you would like to solve, you will have a maximum of three minutes to solve the problem before you are automatically advanced to the next item.

Don't try to solve the problem until you have selected "math" or "verbal" from the choice screen.

The **math problems** will consist of basic arithmetic and algebra.

The **verbal problems** will consist of remote associations. If you aren't familiar with remote association problems, there will be 3 words that can be linked together through one concept. **Below are some examples**.

Find a fourth word that is related to the following 3 words: cream, skate, water

The correct answer for this problem would be "ice." This is because you can have *ice cream*, *ice skate*, and drink *ice water*.

One more example.

Find a fourth word that is related to the following 3 words: desert, ice, spell

The correct answer for this problem would be "dry." This is because a *desert is dry*, there is *dry ice*, and people can go through a *dry spell*.

If you are ready, please begin. If you are confused, please ask the experimenter for clarification.

For each problem you must enter an answer to advance. So if you are unsure or can't solve the problem, just type "don't know."

1. Which of the following problems would you prefer to work on?

A. **Math:** Lee worked 22 hours this week and made $132. If she works 15 hours next week at the same pay rate, how much will she make?

B. **Verbal:** Find a fourth word that is related to the following 3 words: Widow, Bite, Monkey

2. Which of the following problems would you prefer to work on?

A. **Math:** You purchase a car making a down payment of $3,000 and 6 monthly payments of $225. How much have you paid so far for the car?

B. **Verbal:** Find a fourth word that is related to the following 3 words: Barrel, Root, Belly

3. Which of the following problems would you prefer to work on?

A. **Math:** The city council has decided to add a 0.3% tax on motel and hotel rooms. If a traveler spends the night in a motel room that costs $55 before taxes, how much will the city receive in taxes from him?

B. **Verbal:** Find a fourth word that is related to the following 3 words: Hall, Car, Swimming

4. Which of the following problems would you prefer to work on?

A. **Math:** If an object travels at 5 feet per second, how many feet does it travel in one hour?

B. **Verbal:** Find a fourth word that is related to the following 3 words: Cotton, Bathtub, Tonic

5. Which of the following problems would you prefer to work on?

A. **Math:** Joey starts reading at the top of page 103 and stops at the bottom of page 204. How many pages has he read?

B. **Verbal:** Find a fourth word that is related to the following 3 words: Sore, Shoulder, Sweat

6. Which of the following problems would you prefer to work on?

A. **Math:** If the price of a computer was decreased from $1000 to $750, by what percent was the price decreased?

B. **Verbal:** Find a fourth word that is related to the following 3 words: Coin, Quick, Spoon

7. Which of the following problems would you prefer to work on?

A. **Math:** Solve for x: $-10X + -19 = 19 + -8X$

B. **Verbal:** Find a fourth word that is related to the following 3 words: Cracker, Union, Rabbit

8. Which of the following problems would you prefer to work on?

A. **Math:** A school charity sale raised $4800. One quarter of this was taken to cover expenses. Three quarters of the remainder was given to Charity A and the rest to Charity B. How much did Charity B receive?

B. **Verbal:** Find a fourth word that is related to the following 3 words: Skunk, Kings, Boiled

9. Which of the following problems would you prefer to work on?

A. **Math:** Grace has 16 jellybeans in her pocket. She has 8 red ones, 4 green ones, and 4 blue ones. What is the minimum number of jellybeans she must take out of her pocket to ensure she has one of each?

B. **Verbal:** Find a fourth word that is related to the following 3 words: Surprise, Wrap, Care

10. Which of the following problems would you prefer to work on?

A. **Math:** In a test a student got a mark of 49. His report card showed that he had scored a 70 percent. What was the maximum mark on the test?

B. **Verbal:** Find a fourth word that is related to the following 3 words: Silk, Cream, Even

Appendix C

Mom Manipulations (Experiment 3)
Last picture in series is security prime.

The first part of the study is interested in your creativity. You will be shown a series of paintings. For each painting we would like you to describe what you see and report your emotional reaction to the piece of art, as well as how much you like the piece of art. Please answer truthfully.





Questions following each picture (Experiment 3)

Please briefly describe what you see in the current piece of artwork, or what you think the artist is trying to depict.

How familiar are you with this piece of art?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Very much so

How much do you like this piece of art?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Very much so

How would you classify your emotional reaction to this piece of art?

0	1	2	3	4	5	6	7	8	9	10
Very negative										Very positive

New Mom Writing Prime (Experiment 3, continued)

Security prime condition skipped this part. *Control condition and mom's support prime are the same as in Experiment 2* (see Appendix B)

This part of the experiment is interested in how well people can visualize information depending on the valence of recalled information. Please read the following prompt and work on the task for the next 5 minutes. You will not be able to continue with the study until 5 minutes has passed. After the timer reaches zero, you may click the arrow at the bottom of the page to move on. Try to work on the task for a full 5 minutes, but if you finish early please sit at your computer quietly until it is time to move on.

Maternal Presence Only

Imagine your mother is present in the room with you right now. Try to visualize being in the presence of your mother and describe in detail what she looks like. Try to imagine her eye color, hair color, what she is wearing, and the sound of her voice. In the space provided, please write a detailed description of your mother as if she was standing right in front of you.

Potential Mediators (Experiment 3)

Word Completions

We are also interested in your word fluency ability. On the next page you will be given 2 word stems. Please complete the word stems as fast as you can, with whatever word first pops into your mind. Hit submit button as soon as you are finished. This activity will be timed.

1. _ _ TH _ R (mother)
2. _ O _ (mom)
3. SA_E (safe)
4. _ _ _URE (secure)

PANAS (Watson, Clark & Tellegen, 1988)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you are feeling each of these emotions at this moment. Use the following scale to record your answers.

1	2	3	4	5
Very Slightly/ Not at all	A little	Moderately	Quite a Bit	Extremely

_____Interested	_____Distressed
_____ Excited	_____Upset
_____ Strong	_____Guilty
_____ Scared	_____Hostile
_____Enthusiastic	_____ Proud
_____Irritable	_____ Alert
_____Ashamed	_____ Inspired
_____Nervous	_____Determined
_____ Attentive	_____Jittery
_____ Active	_____ Afraid

Attachment Features and Functions questionnaire (AFF; Tancredy & Fraley, 2006)

Instructions: Take a moment to reflect on your current relationship with your mother, father, and romantic partner. Keep in mind that if you had a relationship with this person, but he or she is now deceased or no longer in your life, reflect on the relationship that existed when he or she was in your life. Please read the following statements, and after each statement rate the extent to which each of the five relationships best completes the statement (i.e., substituting each relationship into the blank). Use the following scale for all of your responses:

1	2	3	4	5	6	7	8	9
STRONGLY DISAGREE								**STRONGLY AGREE**

1. My _____ is the person that I would *want* to go to, to help me feel better when something bad happens to me or I feel upset.
   _____ mother _____ best friend
   _____ father
2. I make an effort to stay in contact with my _____.
   _____ mother _____ best friend
   _____ father
3. If I achieved something good, my _____ is the person that I would tell first.
   _____ mother _____ best friend
   _____ father
4. My _____ is the person that I would like to be able to count on to always be there for me and care about me no matter what.
   _____ mother _____ best friend
   _____ father
5. My life would be severely disrupted if my _____ was no longer a part of it.
   _____ mother _____ best friend
   _____ father
6. My _____ is a person whom I count on for advice.
   _____ mother _____ best friend
   _____ father
7. My _____ is the first person that I think of when I have a problem.
   _____ mother _____ best friend
   _____ father
8. My _____ is the person that I would *actually* go to, to help me feel better when something bad happens to me or I feel upset.
   _____ mother _____ best friend
   _____ father

9. It is important to me to see or talk with _____ regularly.
_____ mother _____ best friend
_____ father

10. My _____ is a person whom I do not like to be away from.
_____ mother _____ best friend
_____ father

11. My _____ is the first person that I would turn to if I had a problem.
_____ mother _____ best friend
_____ father

12. My _____'s death would have a great impact on me.
_____ mother _____ best friend
_____ father

13. If my _____ was no longer accessible to me, I would feel greatly distressed.
_____ mother _____ best friend
_____ father

14. My _____ is my primary source of emotional support.
_____ mother _____ best friend
_____ father

15. When I am away from my _____, I feel down.
_____ mother _____ best friend
_____ father

16. My _____ is the person that I would *actually* count on to always be there for me and care about me no matter what.
_____ mother _____ best friend
_____ father

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ABSTRACT

"M" IS FOR THE MILLION THINGS SHE GAVE ME: EFFECTS OF PRIMING MOTHER'S SUPPORT ON WOMEN'S MATH MOTIVATION

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Compared to other countries, the U.S. is lagging behind in the number of degrees awarded in science, technology, engineering, and mathematics (STEM), and there is concern whether we will be able to meet the future occupational demand. Women in particular are a group that is vastly underrepresented in STEM fields, making up less than 25% of the employees in STEM. The current experiments examined whether women who thought about a time when their mother was supportive subsequently reported increased math motivation. Women experience more anxiety when it comes to math compared to men because of things like negative stereotypes about women's mathematics ability, a lack of role models, and perceptions of the math environment as being very masculine. We hypothesized that thinking of one's mother could activate benefits through being an attachment figure. More specifically, we thought priming mom's support could serve emotion regulation benefits and encourage exploration through activating women's sense of having a "secure base." In the current studies, women undergraduates who wrote about a time when their mother was supportive reported greater math motivation (Study 1) and persisted longer at solving math problems (Study 2) compared to women who did not write about their mom. Additionally, women who wrote about their same-sex best friend or father did not experience the same

increases in math motivation (Study 2), suggesting that thinking of one's mother confers unique benefits. Women who viewed a sketch of a mother and child also reported increases in math motivation (Study 3). Theoretical implications are discussed.