

The Effect of Stereotype Threat on Women's Mathematical Performance and Motivation

Vincent Fogliati
Bachelor of Arts – Psychology (Hons)
Macquarie University
Psychology Department

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Summary

According to stereotype threat theory (STT; Steele & Aronson, 1995), negative stereotypes interfere with the performance of their targets, particularly those who are motivated to disconfirm the relevant stereotype. STT also asserts that stereotype threat can eventually lead to reduced motivation in the relevant domain. This thesis presents three experimental studies, presented across two papers, which contribute to an understanding of the effects of stereotype threat on both performance and motivation.

The first two studies explored whether women would be protected from stereotype threat under conditions in which they *acquiesced* to the female-math stereotype. *Stereotype acquiescence* refers to a process whereby stereotype targets: i) expect their group to perform significantly worse than a relevant out-group, and ii) do not aspire to perform as well as the out-group. Study 1 demonstrated that women ($n = 130$) low in self-perceived ability were more likely than those high in self-perceived ability to acquiesce to the female-math stereotype, but were paradoxically protected from stereotype threat. Study 2 ($n = 154$; 108 women and 46 men) showed that women performed worse when informed that there were slight gender differences, than if told that men were considerably mathematically superior. By demonstrating that women who acquiesced to the female-math stereotype were protected from stereotype threat, these studies provide support for STT's assertion that stereotype threat affects the performance of those motivated to disconfirm their stereotyped inferiority.

Finally, Study 3 ($n = 84$; 54 women and 30 men) found that stereotype threat led to reductions in women's mathematical performance and also their motivation to improve following negative feedback. Together, these studies contribute to an understanding of the effects of stereotype threat on both performance and motivation, as well as some of the circumstances under which each of these effects of stereotype threat is most likely to occur.

Certification by Candidate

I certify that this thesis is all my own work and has not been submitted for a higher degree to any other university or institution. Macquarie University Ethics Committee approval was obtained for all aspects of the research presented in this thesis (reference numbers: HE23JUN2006-D04755A, HE28MAR2008-D05753 and HE01MAY2009-D06529).

Vincent Fogliati:

Date:

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Chapter 1

General Introduction

Thesis Overview

Although gender differences in mathematical performance are small and have decreased over the past few decades, (Hyde, Fennema, & Lamon, 1990; Hyde, Lindberg, Linn, Ellis, & Williams, 2008), differences favoring males do emerge in high school, particularly on complex tasks and at higher levels of performance (Ceci, Williams, & Barnett, 2009; Hyde et al., 1990, 2008; Lindberg, Hyde, Peterson, & Linn, 2010). Furthermore, women are underrepresented at the higher levels of mathematical careers, and there is evidence that low levels of motivation for mathematics, relative to men, contribute to this underrepresentation (Ceci & Williams, 2010; Ceci et al., 2009). The present thesis examined whether the stereotype of women's mathematical inferiority can lead women not only to perform worse on mathematical tasks, but also to become less motivated to improve their mathematical ability.

According to stereotype threat theory (STT; Steele & Aronson, 1995), negative stereotypes can interfere with the performance of their targets, particularly those motivated to disconfirm their stereotyped inferiority. A less commonly examined claim of STT is that stereotype threat can lead to disengagement of one's self-esteem from performance outcomes in relevant domains, which in turn can lead to lower motivation and poorer performance. Thus, according to STT, stereotype threat can contribute to performance decrements both by increasing motivational pressure during task performance, and also by reducing stereotype targets' motivation in the long term.

This thesis was designed to investigate these tenets of STT, within the context of women's mathematical performance. First, it explored whether women can be paradoxically buffered from stereotype threat if they *acquiesce* to their group's inferiority, by expecting men to significantly outperform women, and not aspiring to perform as well as men. Evidence for this would support Steele's (1997) assertion that stereotype threat interferes with the performance of those motivated to disconfirm the stereotype. Second, this research examined whether stereotype

threat can lead to reductions in women's motivation to improve following a mathematics test, particularly if they receive personal feedback that is consistent with the stereotype.

The thesis consists of a general introduction (the present chapter), three experimental studies presented across two papers, and a general discussion of the findings¹. In this chapter, a discussion of STT is provided, before a review of the evidence for stereotype threat's effects on performance. The literature on the moderators and mediators of stereotype threat is then discussed, before an outline of evidence for stereotype threat effects on outcomes other than task performance. STT is then considered in a broader social psychological context, with a particular emphasis on the importance of social identity, and the flexibility of responses that negatively stereotyped individuals employ to protect their self-esteem. These factors will be discussed specifically in relation to the foundation they provide for the research papers that follow.

Chapter 2 presents two empirical studies, which provide evidence that women are protected from stereotype threat under circumstances in which they *acquiesce* to the stereotype. Study 1 demonstrates that women low in self-perceived mathematical ability are more likely than those high in self-perceived ability to acquiesce to the mathematical superiority of men, but paradoxically less vulnerable to the effect of stereotype threat on performance. Study 2 manipulates gender differences directly and demonstrates that women who are informed that men are only slightly mathematically superior to women, perform worse than those informed that there are considerable gender differences. In Chapter 3, a third study is presented, which demonstrates that stereotype threat has the capacity to reduce women's motivation to improve following the receipt of negative performance feedback in mathematics.

¹ The thesis is presented in a 'thesis by publication' format, as outlined and recommended by the Macquarie University Higher Degree Research Unit. Although the three experimental studies could potentially be presented as separate chapters, two were combined in the one paper to enhance its prospects for publication. These are presented together in Chapter 2. Also, as a result of the thesis' structure, there is some unavoidable repetition across chapters.

The final chapter reviews these findings and their implications, particularly the empirical support they provide for the central theoretical tenets of STT. The limitations and strengths of this research are also discussed, and recommendations for further research are made.

Background Literature Review

There is a long tradition of social psychological research that has examined the effects of negative stereotypes and stigma² on their targets (Allport, 1954; Crocker & Major, 1989; Lewin, 1941; Tajfel & Turner, 1979; see also Cooley, 1956; Goffman, 1963; Link & Phelan, 2001; Mead, 1934; Merton, 1948; Scheff, 1966, for sociological perspectives). This literature suggests that negative stereotypes can lead to an array of cognitive, affective, motivational and behavioral sequelae. For example, Allport (1954) identified a great diversity of responses to stigma, ranging from passive acceptance of one's stereotyped inferiority and identification with the out-group, to increased in-group identification and enhanced striving for achievement. Allport (1954, p. 143) suggested that while the form of response may vary considerably, negatively stereotyped individuals cannot 'remain indifferent to the ... expectations of others'. More recently, Crocker and Major (1989; see also, Crocker, Major, & Steele, 1998) suggested that although targets of negative stereotypes do not merely internalize their stereotyped inferiority, they are unlikely to be altogether free from negative psychological outcomes.

Among the outcomes identified in stigma and stereotype research, is the potential for negative stereotypes to produce, or at least contribute to, the very characteristics or deficiencies they predict. Merton (1948), for example, suggested that stereotypes can become self-fulfilling prophecies, whereby negative expectancies for stigmatized groups influence their access to resources, and in turn contribute to their poorer performance and eventually lead to differences in ability. Further, Crocker and Major (1989) stated that the self-protective strategies employed by stigmatized individuals have the capacity to reduce the motivation and aspirations, and ultimately the achievements of negatively stereotyped individuals. As suggested by these authors, the poorer

² The term 'stigma' is included in the following paragraphs to reflect the terminology used in a number of the cited texts. In these paragraphs, the term 'stigma' is used interchangeably with 'negative stereotype'. When using these terms, the author is employing Crocker, Major, and Steele's (1998, p. 505) definition of stigma: namely, the possession of 'some attribute, or characteristic, that conveys a social identity that is devalued in a particular social context'. Following these introductory paragraphs, the term 'negative stereotype' is generally employed.

performance of targets of negative stereotypes is then taken as confirmation of the stereotypes' veracity, leading to a cycle in which stereotypes contribute to poorer performance, which in turn strengthen and reinforce the stereotypes.

A potential implication of the effect of negative stereotypes on performance is that they may contribute to the underperformance of a number of stigmatized groups, particularly in academic domains. For example, although gender differences in mathematical performance have diminished in the past few decades (Hyde, 2005; Hyde et al., 1990; Hyde et al., 2008; Lindberg et al., 2010), there is some evidence of female mathematical underperformance from high school onwards (e.g. see Ceci et al., 2009)³, and women are underrepresented in high levels of fields relating to mathematics and science (National Science Foundation, 2011). Furthermore, there are differences in the general academic performance of various racial groups in the United States. Specifically, White and Asian American students tend to perform better than African American, Latino and Native American students (e.g. Jensen, 1980; Ogbu, 1978; Osborne, 2001; Whitworth & Barrientos, 1990). Although some authors have suggested that such discrepancies in outcomes are due to innate differences between groups (e.g. Benbow & Stanley, 1980, 1983; Herrnstein & Murray, 1994), the social psychological research described earlier suggests that at least some of these differences may be accounted for by the stereotypes themselves. Importantly, this approach suggests that such differences are potentially amenable to change.

Stereotype Threat Theory

Steele and his colleagues (Steele, 1997; Steele & Aronson, 1995; Steele, Spencer, & Aronson, 2002), through their formulation of stereotype threat theory (STT), provided a particularly compelling account of how stereotypes contribute to the underperformance of negatively stereotyped groups. Specifically, STT suggests that negative ability-based stereotypes can directly interfere with the performance of their targets in relevant domains. According to

³ As the thesis was prepared in a non-traditional format, 'et al.' is used to indicate the remaining authors on repeat citations within each chapter, rather than across the thesis as a whole.

STT, negative stereotypes pose a threat to the social identity of their targets (Crocker et al., 1998; Steele & Aronson, 1995; Steele et al., 2002). When such a stereotype applies to an individual's performance on a given task, the threat of confirming the stereotype and its self-applicability creates a self-evaluative pressure (Steele & Aronson, 1995; Steele, 1997; Steele et al., 2002). The added burden of this pressure, which is not experienced by individuals who are not negatively stereotyped in that domain, can interfere with task performance and contribute to the relative underperformance of stereotyped groups (Steele, 1997; Steele et al., 2002).

Potential victims of stereotype threat. In contrast to many traditional approaches to the effects of negative stereotypes on their targets (e.g. Allport, 1954; Lewin, 1941), STT asserts that the experience of stereotype threat is not unique to chronically stigmatized groups (Steele, 1997). Moreover, according to STT, stereotype threat is not caused by the traits of negatively stereotyped individuals, or the internalization of their stereotyped inferiority (Steele, 1997; Steele & Aronson, 1995; Steele et al., 2002). Indeed, individuals need not even believe the relevant stereotype for their performance to be affected by its presence. All that is necessary for stereotype threat to occur is an individual's awareness that a negative stereotype applies to a group to which they belong, on a task that is at least somewhat relevant to their identity (Steele, 1997; Steele & Aronson, 1995; Steele et al., 2002). Steele and his colleagues (2002, p. 386) accordingly highlighted the 'group-by-situation variability of stereotype threat'; suggesting that members of a given social group will be potentially vulnerable to stereotype threat whenever a negative stereotype applies to that group's performance in a particular domain. As individuals identify with multiple social groups (e.g. Hewstone, 1996; Shih, Pittinsky, & Ambady, 1999; Tajfel, 1969; Tajfel & Turner, 1979; Turner, Oakes, Haslam, & McGarty, 1994), and groups are often positively stereotyped on some dimensions, but negatively on others (e.g. Glick & Fiske, 2001; Katz, 1981; Katz, Glass, & Cohen, 1973), it is difficult to envisage an individual who is not at some stage susceptible to stereotype threat.

Proposed moderators. Notwithstanding the pervasiveness of stereotype threat, however, STT suggests that there is considerable variability in the frequency and extent to which individuals and groups experience stereotype threat. Steele and his colleagues (2002) highlighted a number of personal characteristics and situational factors that are likely to moderate stereotype threat's effects on performance. As stated in the previous paragraph, stereotype threat is said to affect the performance of those who are at least somewhat identified with the relevant performance domain, and Steele et al. (2002) have suggested that as this identification increases, so will the threat implied by the negative stereotype. Steele and Aronson (1995; Steele et al., 2002) also suggested that stereotype threat is likely to have its greatest effects when individuals experience frustration and difficulty during performance on a relevant task, as such experiences potentially imply that a stereotype target is performing poorly on the task and helping to confirm their group's inferiority. Further, Steele and his colleagues (2002) suggested that the effects of stereotype threat will be greater in the presence of situational cues which increase the cognitive accessibility of the stereotype, such as being asked to indicate one's group membership prior to a test, or being in a numerical minority. In short, STT asserts that stereotype threat is likely to have particularly pernicious effects on performance when an individual experiences difficulty on a task that they care about, and when their negatively stereotyped identity is salient.

Proposed mechanisms. Consistent with the idea that stereotype threat has its greatest effect on the performance of those who are motivated to perform well; early theoretical discussions of STT generally emphasized the role of motivational and affective mechanisms of stereotype threat (Steele, 1997; Steele & Aronson, 1995, see Wheeler, S. C., & Petty, 2001, for a review). For example, Steele and Aronson (1995) suggested that targets of stereotype threat are likely to exert increased effort in attempting to disconfirm the relevant stereotype and its self-relevance, but that the threat posed by the stereotype serves to redirect their attention from the task at hand, thus decreasing their performance efficiency. Further, Steele (1997) suggested that

stereotype threat is an aversive experience and that the emotional reaction to this threat can interfere with task performance. Although Steele and his colleagues (2002) pointed out that there are almost certainly multiple mechanisms of stereotype threat, they suggested that, particularly among individuals who are invested in the performance domain, stereotype threat generally disrupts performance by inducing an evaluation apprehension that comes with the motivation to disconfirm the relevant stereotype.

Potential effects on identification and motivation. In keeping with the social psychological tradition of considering a diversity of responses to being negatively stereotyped, STT asserts that although individuals might be motivated to disconfirm their stereotyped inferiority, the aversive experience of stereotype threat may eventually pressure individuals to disengage their self-esteem from performance (Steele, 1997; Steele & Aronson, 1995; Steele et al., 2002). Over time, this can result in chronic disidentification with the domain, such that one's outcomes in that domain no longer carry any self-evaluative importance (Steele, 1997 Steele et al., 2002). Such disidentification might actually protect individuals from the experience of stereotype threat and its effects on performance, but is likely to have the effect of decreasing motivation and performance aspirations, and ultimately, achievement in the domain (Steele, 1997). Thus, the tenets of STT suggest something of a 'catch-22' for members of negatively stereotyped groups, in that the very identification that is necessary for success in a domain, increases targets' vulnerability to stereotype threat. In turn, this threat can, according to STT lead ultimately to lower identification and motivation.

In the following sections, the extant empirical evidence for stereotype threat is reviewed. Evidence for stereotype threat's capacity to impair the performance of a range of negatively stereotyped groups, across a variety performance domains, will be discussed. Following this is a review of methods that have been demonstrated to alleviate stereotype threat, both through experimental manipulation and field interventions. The evidence for moderators and mechanisms

of stereotype threat will then be considered, before the literature of stereotype threat's effects on identification and motivation is reviewed.

Evidence for Stereotype Threat Effects on Performance

In an early demonstration of the stereotype threat phenomenon, Steele and Aronson (1995) showed that the salience of the stereotype of African Americans' inferior ability in intellectual domains can impair the actual performance of African American students on verbal reasoning tasks. Specifically, African American students performed worse when a test was made ostensibly diagnostic of verbal intelligence, than when presented as a test of problem-solving ability, while the performance of White Americans was not affected by how the test was framed (Steele & Aronson, 1995, studies 1 and 2). Steele and Aronson (1995, study 4) also found that African American students performed worse if they were asked to indicate their race on a demographic form, even if they were not informed that the test was diagnostic of ability. Thus, the stereotype of African Americans' inferior verbal reasoning led to performance decrements under conditions that either increased the situational relevance of the performance domain (verbal intelligence), or the salience of the social group (African Americans). The fact that these effects were obtained through the employment of two distinct and relatively subtle stereotype manipulations suggests a powerful and pervasive effect of stereotype threat, at least on the performance of African American students.

Spencer, Steele and Quinn (1999) also demonstrated that stereotype threat is not unique to the performance of African Americans on intellectual tasks. Specifically, Spencer and his colleagues demonstrated that stereotype threat can interfere with women's mathematical performance. As well as providing an important replication of the stereotype threat phenomenon in a different performance domain and for a different social group from that examined by Steele and Aronson (1995), Spencer et al. (1999) also showed that stereotype threat can be induced by explicitly informing participants that there are group differences on a given performance task.

Their results also provided support for the assertion that stereotype threat is particularly likely to interfere with performance when a task is difficult, as stereotype threat differences emerged on difficult, but not easy mathematical items (Spencer et al., 1999).

Generalizability of stereotype threat. Since these seminal demonstrations of stereotype threat, many studies have replicated the findings that stereotype threat can interfere with the academic and intellectual performance of African Americans (e.g. Aronson, Fried, & Good, 2002; Aronson & Inzlicht, 2004; Blascovich, Spencer, Quinn, & Steele, 2001; Kellow & Jones, 2007; Marx & Goff, 2005; Marx, Ko, & Friedman, 2009), and the mathematical performance of women (e.g. Brown, R. P. & Josephs, 1999; Davies, Spencer, Quinn, & Gerhardtstein, 2002; Johns, Inzlicht, & Schmader, 2008; Johns, Schmader, & Martens, 2005; Keller & Dauenheimer, 2003; Marx & Roman, 2002; O'Brien & Crandall, 2003; Schmader, 2002; Spencer et al., 1999; Thoman, White, Yamawaki, & Koishi, 2008). Moreover, an ever-increasing body of research has demonstrated the pervasiveness of stereotype threat, by demonstrating its effect on the performance of many social groups, in a range of performance domains. For example, stereotype threat has been shown to interfere with the academic performance of Hispanic students (Gonzales, Blanton, & Williams, 2002; Schmader & Johns, 2003), as well as those of low socioeconomic status (Croizet & Claire, 1998; Harrison, Stevens, Monty, & Coakley, 2006). The effects of stereotype threat on performance have also been obtained in domains and groups as diverse as the childcare performance of gay men (Bosson, Haymovitz, & Pinel, 2004), the memory of older adults (von Hippel, W., et al., 2005) and the driving performance of women (Yeung & von Hippel, C., 2008).

The contextual nature of stereotype threat. STT researchers have also provided compelling support for Steele and Aronson's (1995) assertion that stereotype threat is highly contextual, and that its effects are not confined to groups that are traditionally thought of as stigmatized or pervasively stereotyped. For example, White men have been shown to be

susceptible to performance decrements when exposed to stereotypes relating to their social sensitivity relative to women (Koenig & Eagly, 2005), their social intelligence relative to women (Cadinu, Maass, Lombardo, & Frigerio, 2006), and their mathematical performance relative to Asians (Aronson et al., 1999). Further highlighting the contextual nature of stereotype threat, Stone et al. (1999) found that whereas White Americans performed worse than African Americans on a golfing task when it was framed as a test of ‘natural athletic ability’, this pattern was reversed when the task was framed as measuring ‘sports intelligence’.

Moreover, Shih et al., (1999) provided further support for the assertion that stereotype threat is not the result of any stable trait, or internalized inferiority of stereotype targets, but varies according to whichever social identity is salient in a given situation. Prior to completing a mathematics test, Asian women were provided with a questionnaire relating to either their Asian identity or their gender identity (in a control condition, women were provided with a questionnaire unrelated to either identity). Consistent with previous research on the female-mathematics stereotype (e.g. Schmader, 2002; Spencer et al., 1999), women performed worst when their gender identity was salient. However, women’s performance was highest when their Asian identity was salient. This finding, which was replicated among school-age girls (Ambady, Shih, Kim, & Pittinsky, 2001), provides tangible support for the group-by-situation variability of stereotype threat (Steele et al., 2002).

The pervasiveness of stereotype threat is also apparent from the great variety in experimental manipulations that have produced performance decrements among targets of negative stereotypes. For example, stereotype threat performance effects have been obtained by explicitly stating that an individual’s group is inferior on a given task (e.g. Aronson et al., 1999; Cadinu, Maass, Frigerio, Impagliazzo, & Latinotti, 2003; Smith & White, 2002; Smith & Johnson, 2006; Yeung & von Hippel, C., 2008), suggesting that group differences exist, without explicitly stating which group is said to be superior (e.g. Spencer et al., 1999), providing cues of

group identity (Ambady et al., 2001; Shih et al., 1999; Steele & Aronson, 1995) presenting a test as diagnostic of the relevant performance domain (e.g. Croizet & Claire, 1998; Steele & Aronson, 1995), or manipulating whether a stereotype target performs the relevant task in the presence of out-group members (Inzlicht & Ben-Zeev, 2000). This diversity in manipulations of stereotype threat strongly suggests that its effects on performance are not the result of experimental artifact, but instead the predicament of performing a diagnostic task for which a negative self-relevant stereotype is salient.

Alleviating Stereotype Threat

Experimental methods. A key implication of the aforementioned evidence is that stereotype threat, rather than any innate or acquired deficiencies, might account for at least some of the underperformance of a range of negatively stereotyped groups (Steele, 1997; Walton & Spencer, 2009). It follows that if this threat could be alleviated, performance discrepancies between groups might be reduced or even removed. Encouragingly, a plethora of research has provided evidence that experimental manipulations designed to remove stereotype threat can improve the performance of members of negatively stereotyped groups. Targets of negatively stereotyped groups have been shown to perform better when provided counter-stereotypic information about their social group or the performance domain. For example, there is evidence that stereotype targets perform better when told that there are no group differences in a given domain or on a given test (e.g. Keller, 2007; Keller & Dauenheimer, 2003; Smith & White, 2002; Spencer et al., 1999), that a test is fair and unbiased (Good, Aronson, & Harder, 2008; Quinn & Spencer, 2001), or that any group discrepancies in performance are due to effort, rather than innate ability (Thoman et al., 2008). Further, stereotype threat effects have been alleviated when targets have been told that a potentially stereotype-relevant test is measuring a non-stereotyped domain, such as working memory (Schmader & Johns, 2003) or drawing ability (Huguet & Regner, 2007, 2009).

Other methods for alleviating stereotype threat have also proven successful, such as providing re-attributions of feelings of anxiety and arousal (Ben-Zeev, Fein, & Inzlicht, 2005; Johns et al., 2008), providing examples of successful in-group role models (Marx et al., 2009; Marx & Roman, 2002; McIntyre et al., 2005), encouraging individuals to affirm one of their positive characteristics (Martens, Johns, Greenberg, & Schimel, 2006), providing a brief mindfulness meditation intervention (Weger, Hooper, Meier, & Hopthrow, 2011), or making salient a social identity that is *positively* stereotyped in the relevant domain (Ambady et al., 2001; Rydell, McConnell, & Beilock, 2009; Shih et al., 1999). Indeed, even educating negatively stereotyped individuals about the experience of stereotype threat has been shown to lead to improvements in performance (Johns, Schmader, & Martens, 2005). Importantly, in a number of these experiments (e.g. Johns et al., 2008; Spencer et al., 1999; Thoman et al., 2008), individuals in conditions designed to remove stereotype threat have performed better than those for whom *no* mention of their stereotyped identity has been made. Their improved performance in the threat-negating conditions suggests that stereotype threat interferes with its targets' performance in the absence of any experimental manipulation, and that such interference is likely to occur whenever they perform a task in the relevant performance domain.

‘Real-world’ interventions. A number of successful field interventions have provided further evidence that stereotype threat interferes with the real-world performance of its targets, and that alleviating this threat can improve the performance of stereotyped groups (Aronson et al., 2002; Cohen, Garcia, Apfel, & Master, 2006; Good, Aronson, & Inzlicht, 2003; Steele, 1997; Walton & Cohen, 2007). These interventions have employed a range of strategies designed to relieve the burden of stereotype threat, including affirming values through writing (Cohen et al., 2006) and encouraging stereotype targets to re-attribute a low sense of belonging in an academic domain to a universal struggle among students, rather than their group membership (Walton & Cohen, 2007). Aronson and colleagues (Aronson et al., 2002; Good et al., 2003) have also

demonstrated that stereotype threat can be alleviated if targets are informed that intelligence is incremental (i.e. fluid and changeable) rather than fixed and stable (see Dweck, 1999). In a meta-analysis of both experimental and field interventions against stereotype threat, Walton and Spencer (2009) demonstrated that the performance of members of negatively stereotyped is underestimated in standard testing situations, and that removing stereotype threat can ‘recover much of this otherwise lost human potential’ (p. 1137).

Moderators of Stereotype Threat

Individual differences. As hypothesized by Steele and his colleagues (Steele, 1997; Steele & Aronson, 1995; Steele et al., 2002), the degree to which stereotype threat prevents people from performing to their potential appears to be moderated by a range of individual and situational factors. A number of studies support the assertion that stereotype threat is particularly harmful for the performance of those who are motivated to disconfirm the stereotype (Steele et al., 2002). For instance, it has been demonstrated that the effects of stereotype threat are particularly pernicious for individuals who are identified with the relevant performance domain (Aronson et al., 1999; Brown, R. P. & Josephs, 1999; Cadinu et al., 2003; Spencer et al., 1999; Stone et al., 1999, see Walton & Cohen, 2003, for a meta-analytic review). Moreover, it has been found that members of negatively stereotyped groups are particularly susceptible to stereotype threat if they are highly identified with their group (Schmader, 2002; Wout, Danso, Jackson, & Spencer, 2008), if they are self-conscious about their stigmatized status (Brown, R. P. & Piel, 2003), if they are concerned about status in general (Josephs, Newman, Brown, R. P., & Beer, 2003), or if they have an internal locus of control (Cadinu et al., 2006). These studies provide convergent evidence that the more concerned an individual is about their performance on a task, whether because of the importance of the domain (Aronson et al. 1999; Walton & Cohen, 2003), the relevant identity (Brown, R. P. & Piel, 2003; Schmader, 2002; Wout et al., 2008), or their status (Josephs et al., 2003), the greater is their susceptibility to stereotype threat.

Interestingly, although Steele and his colleagues (2002) suggested that one need not endorse a stereotype for it to interfere with task performance, Schmader, Johns and Barquissau (2004) found that endorsement of the female-mathematics stereotype did moderate the effect of stereotype threat on women's mathematical performance. Specifically, among women who were very low in their endorsement of gender differences in mathematical performance, stereotype threat had no effect on their performance on a mathematics test. Conversely, those who were expressed some level of belief in the possibility of gender differences did perform significantly worse in a stereotype threat condition than a no-threat condition. As Schmader et al. (2004) acknowledged, however, rejecting the veracity of a stereotype might not always buffer against stereotype threat, particularly when stereotype targets are burdened with disconfirming the stereotype in the eyes of others. Indeed, other studies have since demonstrated that neither explicit (Huguet & Regner, 2009), nor implicit (Kiefer & Sekaquaptewa, 2007) beliefs in the relevant stereotype necessarily protect stereotype threat targets from performance decrements. Thus, although the relationship between belief in the stereotype and vulnerability to the experience of stereotype threat appears to be complex, it does not seem to be the case that belief in the stereotype is a prerequisite for the effects of stereotype threat on performance.

Situational moderators. STT research has also identified a number of situational factors that moderate the strength of stereotype threat and its effects on performance. Because most experimental STT research is designed to manipulate the degree of stereotype threat between conditions, evidence for the effect of stereotype threat also provides an understanding of factors that moderate the strength of its effects. To illustrate, the aforementioned findings that a negative stereotype's increased salience leads to performance decrements (e.g. Ambady et al., 2001; Shih et al., 1999; Steele & Aronson, 1995), provides evidence both for the existence of stereotype threat, *per se*, and also the moderating effect of the salience of group identity on the strength of stereotype threat in a given situation. Similarly, as mentioned earlier, stereotype threat is more

likely to interfere with performance on tasks that are ostensibly diagnostic of ability (Croizet & Claire, 1998; Steele & Aronson, 1995).

A number of researchers have also provided support for Steele's (1997; Steele et al., 2002) assertion that stereotype threat effects are the greatest on more difficult tasks (Spencer et al., 1999; O'Brien & Crandall, 2003; Neuville & Croizet, 2007). Furthermore, stereotype targets appear to be particularly vulnerable to performance decrements when told that ability in the relevant domain is said to be biological and fixed, rather than acquired and amenable to change (Dar-Nimrod & Heine, 2006; Thoman et al., 2008). Finally, stereotype targets are more likely to perform worse when they are in the presence of out-group members who are either taking a test alongside them (Inzlicht & Ben-Zeev, 2000; Sekaquaptewa & Thompson, 2003), or administering the test (Marx & Goff, 2005).

In sum, although stereotype threat has the potential to interfere with the performance of anybody who is negatively stereotyped in a given domain, the extent of this interference is contingent upon a range of individual and situational factors. Much of this research suggests that stereotype threat effects are stronger when the relevant stereotype is central to an individual's experience during a performance task and when the performance stakes are higher. When a group is negatively stereotyped, its members appear to be particularly vulnerable to stereotype threat when they are highly identified with the group (Schmader, 2002) or when situational cues increase their group's salience (Steele & Aronson, 1995). Similarly, stereotype threat is more likely to affect performance when individuals care about the relevant performance domain (Aronson et al., 1999), and when they are reminded that a task is highly diagnostic of ability (Steele & Aronson, 1995), particularly if it reflects immutable differences (Dar-Nimrod & Heine, 2006; Thoman et al., 2008). Thus, much of the evidence for stereotype threat's moderators suggests that negative performance stereotypes are particularly threatening when there is some motivation to disconfirm their veracity or to perform well in general. Furthermore, as O'Brien

and Crandall (2003) pointed out, the finding that stereotype threat is moderated by task difficulty mirrors research which demonstrates that as task difficulty increases, motivation can have harmful effects on performance (e.g. Zajonc, 1965).

Mechanisms of Stereotype Threat

Self-report measures of threat. Although the above research is consistent with the idea that stereotype threat interferes with performance of individuals by inducing a self-evaluative threat, it does not provide direct evidence for STT's assertion that such a threat mediates the effect of negative stereotypes on performance. A number of researchers, particularly in the early stages of STT research, attempted to provide evidence that threat, most commonly operationalized as self-reported anxiety, mediated the effect of negative stereotypes' salience on performance. However, many of these investigations did not yield strong support for anxiety as a mediator of stereotype threat. For example, while Spencer and colleagues (1999) found that a stereotype threat manipulation led to increased anxiety, this effect was only marginal and did not mediate the effect of stereotype threat on performance. Furthermore, a number of other studies (e.g. Gonzales et al., 2002; McKown & Weinstein, 2003; Schmader, 2002; Stone et al., 1999), found no evidence that stereotype threat led to increased anxiety. Similarly, there has not been strong support for other potential manifestations of threat, such as evaluation apprehension (Aronson et al., 1999; Spencer et al., 1999).

Alternative mechanisms. As has been pointed out, some of these studies relied on self-report measures, and many did not measure anxiety until after the mathematics test was taken, by which time the evaluative threat might have faded (Croizet & Claire, 1998; Osborne, 2007). A number of studies have addressed these methodological limitations and found evidence that stereotype can lead to increases in measures of physiological arousal prior to performance (e.g. Blascovich et al., 2001; Croizet et al., 2004; Murphy, Steele, & Gross, 2007; Osborne, 2007). However, these studies have generally either not found evidence of mediation, or not tested for it.

Moreover, the elusiveness of mediational evidence in early stages of STT research was not unique to variables related to anxiety and arousal. Stereotype threat researchers examined the mediational role of a number of variables, including effort (Aronson et al., 1999; Gonzales et al., 2002; Shih et al., 1999; Smith & White, 2002; Stone, 2002; Stone et al., 1997), expectancies (Cadinu et al., 2003; Rosenthal, Crisp, & Suen, 2007; Sekaquaptewa & Thompson, 2003; Stone et al., 1999), self-efficacy (Oswald & Harvey, 2000/2001; Spencer et al., 1999) and self-handicapping (Croizet & Claire, 1998; Keller & Dauenheimer, 2003; Stone et al., 1999), all of which yielded null, or at best, mixed results. Comprehensive reviews (Smith, 2004; Wheeler, S. C., & Petty, 2001) highlighted the complexity of findings relating to stereotype threat's mediators, mirroring Steele et al.'s (2002) assertion that it is unlikely that stereotype threat is mediated by the one psychological process in all situations.

Mere effort hypothesis. Notwithstanding the potential complexity of stereotype threat, two recent avenues of research suggest intriguing possibilities for the processes through which stereotype threat interferes with task performance. First, the 'mere effort' hypothesis (Jamieson & Harkins, 2007; 2009, see also Harkins, 2006) suggests that stereotype threat paradoxically produces performance decrements on complex tasks by leading to increasing effort. According to the mere effort account (Harkins, 2006; Jamieson & Harkins, 2007, 2009), increased effort on a task activates the use of an individual's dominant, or 'pre-potent' method for solving task items and inhibits other forms of response. On complex tasks, however, pre-potent responses are often inefficient, so increased effort can interfere with task performance on such items. For instance, in the context of mathematical problems, the pre-potent method for most students involves using an equation in a conventional manner to solve a problem (Jamieson & Harkins, 2009; Quinn & Spencer, 2001). This method, however, is inefficient for mathematical problems involving logic and intuition (Jamieson & Harkins, 2009). Consistent with the mere effort account of stereotype threat, Jamieson and Harkins (2009) found that stereotype-threatened women actually performed

better on test items that required the application of equations in a linear fashion, but significantly worse on test items better solved using estimation and logic. This pattern of results suggests that stereotyped women exerted increased effort, and that this effort facilitated their performance on items best solved using the pre-potent method, but markedly impaired their performance on items not amenable to the pre-potent method.

Integrated process model. Second, Schmader and her colleagues (Johns et al., 2008; Schmader & Johns, 2003; Schmader, Johns, & Forbes, 2008) recently formulated an integrated process model of the effect of stereotype threat on performance. According to this model, the presence of a negative stereotype produces in its targets a range of cognitive, affective, motivational and physiological responses. Specifically, Schmader and her colleagues (2008) posited that stereotype threat leads to increased physiological arousal, monitoring of stereotype-related cues, and attempts to suppress thoughts related to either anxiety or the negative stereotype. All of these processes have the capacity to interfere with working memory capacity, which Schmader and her colleagues (2008) suggest is the proximal cause of many stereotype-related performance decrements reported in the literature. A key strength of the integrated process model is that it reflects Steele et al.'s (2002) assertion that stereotype threat is mediated by a range of variables, but integrates them into a coherent and unified account of stereotype threat's effects. Furthermore, the integrated process model provides an understanding of the immediate psychological consequences of stereotype threat, as well as its 'downstream' effects on performance (Schmader et al., 2008).

As well as providing a compelling theoretical account of stereotype threat effects, the integrated process model has received support from a growing number of empirical studies. For example, stereotype threat has been shown to lead to reductions in the working memory of women in the context of mathematical performance (Beilock, Rydell, & McConnell, 2007; Johns et al., 2008; Rydell et al., 2009; Schmader, Forbes, Zhang, & Mendes, 2009; Schmader & Johns,

2003) and Latinos performing a test that is ostensibly diagnostic of general intelligence (Schmader & Johns, 2003). There is also evidence that working memory decrements mediate the effect of stereotype threat on performance (Rydell et al., 2009; Schmader & Johns, 2003), and that experimental manipulations designed to alleviate the effect of stereotype threat can increase working memory of stereotype targets, which in turn can mediate the effect of these manipulations on performance (Forbes & Schmader, 2010; Rydell & Boucher, 2010). Further, Johns et al. (2008) provided evidence that targets of both the female-mathematics and Latino-intelligence stereotypes were more likely than non-threatened participants to engage in strategies of emotional suppression, and that providing them with strategies to reappraise their emotions alleviated the effect of stereotype threat on performance. Together, this research supports the integrated process model's (Schmader et al. 2008) assertion that stereotype threat can lead to a range of psychological processes that divert executive resources from the relevant performance task.

Thus, although evidence for stereotype threat's mechanisms proved elusive in the early stages of STT research, there is a growing body of mediational evidence in support of both the mere effort account (Jamieson & Harkins, 2007; 2009) and the integrated process model (Schmader et al. 2008). These accounts differ with respect to the precise mechanisms through which stereotype threat interferes with performance (see, e.g. Jamieson & Harkins, 2007; Schmader et al., 2008) and a comparative evaluation of these accounts is beyond the scope of this thesis. Importantly, however, both accounts converge to suggest that stereotype threat interferes with performance by inducing a motivational pressure that interferes with performance on complex cognitive tasks.

‘Abiding Effects’ of Stereotype Threat

So far, this introduction has focused on stereotype threat's effects on performance, including moderators and mediators of this effect. However, in early discussions of STT, there

was also a significant focus on the potential for the aversive nature of stereotype threat to eventually lead to disengagement, disidentification and lower motivation and aspirations in domains to which the relevant stereotype applies. Steele (1997, p.622) described this collection of outcomes as the ‘abiding’ effect of stereotype threat, suggesting that disidentification and reduced motivation might potentially lead to greater and more stable performance decrements than the immediate effects of stereotype threat on performance. For example, individuals whose self-concept is no longer associated with their performance in a relevant performance domain might pass up opportunities for improvement (Steele, 1992, 1997), or even remove themselves from relevant situations altogether (Steele, 1997; Steele et al., 2002), both of which are clearly likely to have significant ramifications for achievement outcomes.

Effects on identification. Although the effect of stereotype threat on engagement and motivation is potentially profound, the majority of extant STT research has focused on the capacity for stereotypes to interfere with performance more directly. There have, however, been some important exceptions. For example, Stoutemyer and Steele (1996; cited in Crocker et al., 1998) demonstrated that stereotype threat reduced women’s identification with mathematics following the receipt of negative feedback. More recently, Harrison et al. (2006) found that stereotype threat led to reduced academic identification among students of low socioeconomic status. There is also evidence that, among African American boys, the correlation between academic performance and self-esteem diminishes over time (Osborne, 1997). Although this latter study does not provide a direct test of stereotype threat, it is consistent with the idea that chronic exposure to stereotype threat can lead to disengagement and disidentification from the relevant performance domain.

Effects on interest and motivation. Further, stereotype threat has been shown to lead to reduced interest, aspirations and motivation. Davies and his colleagues (Davies et al., 2002; Davies, Spencer, & Steele, 2005) demonstrated that women exposed to stereotypic commercials

reported less interest in mathematical careers and vocational options (Davies et al., 2002), and less interest in leadership roles (Davies et al., 2005). In a similar vein, Gupta and Bhawe (2007) demonstrated that stereotype threat leads to lower entrepreneurial intentions among women, while stereotype threat has also been shown to decrease women's interest in attending a conference on mathematics and science (Murphy et al., 2007). Furthermore, Smith, Sansone, and White (2007) found that stereotype threat can lead to performance-avoidance goals, which are associated with lower interest in the relevant domain. Collectively, these studies provide support for Steele's (1997) assertion that stereotype threat can reduce the identification and motivation of its targets.

Summary of Evidence for Stereotype Threat Theory

The STT literature reviewed above suggests that stereotype threat can impair the performance of many negatively stereotyped groups in numerous performance domains (e.g. Schmader, 2002; Steele & Aronson, 1995). Removing stereotype threat, through either experimental manipulation or naturalistic intervention, has also been demonstrated to improve the performance of negatively stereotyped individuals (Johns et al., 2008; Walton & Cohen, 2007). Furthermore, stereotype threat appears to have its greatest effect when the task is assumed to be diagnostic of ability (Steele & Aronson, 1995), when one's stereotyped group is salient (Shih et al., 1999), and when individuals are identified with the group and the performance domain (Aronson et al., 1999). There is also mounting evidence, if not yet entirely conclusive, that stereotype threat often interferes with performance by inducing a motivational pressure (Jamieson & Harkins, 2009; Schmader et al., 2008). Moreover, it has also been demonstrated that stereotype threat can reduce the domain identification and motivation of its targets (Davies et al., 2002, 2005; Gupta & Bhawe, 2007).

The research described above, while providing convincing support for the tenets of STT, represents something of a paradox, in that stereotype threat seems to have the capacity to lead to

a motivational pressure in some circumstances (e.g. Blascovich et al., 2001; Jamieson & Harkins, 2007, 2009; Schmader & Johns, 2003), as well as reduced motivation in others (e.g. Davies et al., 2002, 2005; Gupta & Bhawe, 2007; Murphy et al., 2007). To understand how negative performance stereotypes can lead to either increased motivational pressure, or to decreased motivation, it is worth considering the effect of negative stereotypes in a broader social psychological context. Specifically, the following sections will briefly examine why negatively stereotyped individuals are often motivated to disconfirm their group's stereotyped inferiority, but also the conditions under which negatively stereotyped individuals might accept their group's inferiority and not aspire to disconfirm the relevant stereotype. Further, research on self-protective strategies that individuals engage in to contend with a stereotype of their group's inferiority will be discussed, as well as some of the consequences of these strategies for long-term motivation. Following this, the studies of the present thesis will be introduced.

Social Identity and the Motivation for Positive Self-evaluation

Importance of positive distinctiveness. Social identity theory (Tajfel & Turner, 1979; Turner, 1975, 1978) provides perhaps the most comprehensive theoretical account of why individuals are motivated to maintain positive views of their social groups. Specifically, social identity theory asserts that people's identities derive not only from their personal qualities and characteristics, but also the social groups to which they belong (Brown, R., 2000; Tajfel & Turner, 1979; Turner & Reynolds, 2010). Social identity theory further posits that because of a general motive for positive self-evaluation, people attempt to enhance and maintain positive social identity (Brown, R., 2000; Tajfel & Turner, 1979; Turner, 1975). Moreover, because a given social group is meaningful only in relation to other groups, people are motivated to maintain the *positive distinctiveness* of their groups, relative to others, on valued dimensions (Brown, R., 2000; Haslam, Ellemers, Reicher, Reynolds, & Schmitt, 2010; Hogg, 2000; Tajfel & Turner, 1979; Turner, 1975). Thus, targets of negative performance stereotypes should, in many

circumstances, be motivated to disconfirm their stereotyped inferiority, and potentially be threatened by the stereotype's implication of a negative social identity, particularly in performance domains that are meaningful to them. This assertion, of course, is highly consistent with both the tenets and the findings of stereotype threat theory (e.g. Schmader, 2002; Steele & Aronson, 1995; Steele et al., 2002)

Acquiescence. Importantly, however, social identity theory suggests that there are circumstances in which members of negatively stereotyped groups will not be motivated to disconfirm the relevant stereotype, but will instead *acquiesce* to, or accept, their group's stereotyped inferiority in a particular domain (Ellemers, van Rijswijk, Roefs, & Simons, 1997; Haslam, Salvatore, Kessler, & Reichler, 2008; Tajfel & Turner, 1979; Turner & Reynolds, 2010). Such acceptance of the inferiority of one's group is particularly likely when status differences between their group and a relevant out-group appear *incontestable*, such as when they are perceived as stable, large and legitimate (Brown, R., 2000; Haslam et al., 2008, 2010; Hogg, 2000; Mummendey, Kessler, Klink, & Mielke, 1999; Tajfel & Turner, 1979). In such circumstances, direct competition with the out-group is unlikely to afford the opportunity to enhance social identity, so members of low-status and negatively stereotyped groups should be less motivated to engage directly in competitive inter-group behavior to enhance the status of their group (Tajfel & Turner, 1979; Turner, 1975). Thus, if targets of negative performance stereotypes acquiesce to their group's inferiority on a relevant dimension, they should be less concerned with how their group fares relative to the out-group, and feel less of a motivational pressure to disconfirm the stereotype. If stereotype threat does indeed interfere with performance by inducing a motivational pressure (e.g. Steele & Aronson, 1995), this suggests the intriguing possibility that targets of negative performance stereotypes might be paradoxically protected from stereotype threat if they accept the relevant stereotype and do not aspire to disconfirm its veracity, an hypothesis which is tested in the first two studies of this thesis.

Alternative strategies for maintaining positive identity. Accepting the lower status or inferiority of one's group on a given dimension does not, however, mean that an individual is simply no longer concerned with maintaining positive self-evaluation. Social identity theory highlights the flexibility of strategies that individuals can employ to enhance and maintain positive social identity (Brown, R., 2000; Ellemers et al., 1997; Haslam et al., 2008, 2010; Hogg, 2000; Mummendey et al., 1999; Tajfel & Turner, 1979; Turner & Reynolds, 2010). For example, an individual might contend with a threatened social identity by trying to leave, or distance themselves psychologically from their in-group, downgrading the importance of the relevant dimension or comparing one's group with another negatively-stereotyped group (Brown, R., 2000; Haslam et al., 2010; Tajfel & Turner, 1979). As Tajfel and Turner (1979) pointed out, the use of each of these particular strategies is likely to be a function of subjective beliefs about the relative status of the groups in question. Just as belief in the stability and legitimacy of group differences might discourage direct competition with the out-group, so individuals with such beliefs about their group's status might be more likely to engage in these more direct and less subtle forms of social identity maintenance (Brown, R., 2000; Hogg, 2000; Mummendey et al., 1999; Tajfel & Turner, 1979).

'Self-protective' properties of stereotypes. In a somewhat similar vein, Crocker and Major (1989) identified a range of strategies that targets of negative stereotypes employ to protect their self-esteem (see also, Major & O'Brien, 2005). Specifically, Crocker and Major identified three self-protective strategies: attributing negative outcomes to prejudice, making social comparisons with in-group members rather than out-group members, and devaluing the relevant domain. Each of these strategies provides the opportunity for targets of negative stereotypes to disengage their self-esteem from poor performance feedback relative to the out-group (e.g. Crocker & Major, 1989; Major & Crocker, 1998; Major & O'Brien, 2005). Crucially, however, Crocker and Major pointed out that the use of such strategies has the capacity to ultimately

interfere with performance and reduce motivation. For example, by making comparisons with in-group members, targets of stereotypes should be less concerned with their performance relative to the positively-stereotyped out-group and consequently less motivated to perform at a higher level of performance. Furthermore, individuals who devalue a given performance domain are unlikely to be motivated to achieve positive outcomes in that domain. As Crocker and Major (1989, p. 622) pointed out, these strategies have ‘the potential to lead eventually to systematic group differences in aspirations, skills, and achievement’.

From the discussion above, then, it is apparent that targets of negative stereotypes might often be motivated to disconfirm their group’s stereotyped inferiority in order to enhance their social identity, particularly when they do not accept the superiority of the out-group on the relevant dimension (Haslam et al., 2010; Hogg, 2000; Tajfel & Turner, 1979; Turner & Reynolds, 2010). In some circumstances, however, individuals might accept their group’s stereotyped inferiority and instead engage in alternative strategies that maintain their social identity and protect their self-esteem (Crocker & Major, 1989; Tajfel & Turner, 1979). Such strategies, however, have the potential to lead to disengagement from outcomes in the relevant performance domain, and ultimately to lower motivation and achievement (Crocker & Major, 1989; Haslam et al., 2010). Thus, negative stereotypes might have the capacity to lead to either increased *or* reduced motivation in the relevant domain, depending on a range of factors, including whether a stereotyped individual believes that they have the capacity to disconfirm the stereotype’s veracity. These theoretical perspectives on people’s responses to being negatively stereotyped are consistent with STT’s assertion that stereotype threat can interfere with performance by inducing a motivational pressure, but can also reduce identification, motivation and aspirations (Steele et al., 2002).

The Present Research

The studies in this thesis are designed to examine the effects of stereotype threat on performance and motivation, in relation to the female-mathematics stereotype. By demonstrating these multiple effects of stereotype threat, this thesis aims to continue the legacy of social psychological research that illustrates the range of sequelae of negative stereotypes, as well as the variety of responses to being a member of a negatively stereotyped group (Allport, 1954; Crocker & Major, 1989; Steele et al., 2002; Tajfel & Turner, 1979). Moreover, these studies are designed to examine some of the circumstances under which women are particularly susceptible to performance decrements in the presence of the female-mathematics stereotype, as well as the conditions under which the same stereotype leads to reductions in motivation.

Stereotype Acquiescence

The second chapter presents two studies which examine whether women can be paradoxically protected from stereotype threat under circumstances in which they *acquiesce* to the stereotype of male mathematical superiority. Specifically, *stereotype acquiescence* is operationalized as: a) an expectation that the out-group will significantly outperform the in-group on the relevant task, and b) a failure to aspire to perform as well as the out-group. As stated earlier, individuals who accept the inferiority of their group on a given dimension should be less motivated to attempt to directly compete with the relevant out-group. Thus, in the context of the female-mathematics stereotype, those women who accept the mathematical superiority of men should experience less of a motivational pressure, and thus be buffered from the effect of stereotype threat on performance.

The first study in Chapter 2 was designed to examine which women would be the most likely to acquiesce to the female-mathematics stereotype and to provide an initial test of the acquiescence hypothesis. Specifically, it was predicted that women with low levels of belief in their mathematical ability, relative to those high in self-perceived ability, would be more likely to

accept the stereotyped inferiority of women in general, and would be less likely to aspire to perform as well as men. It was also expected, however, that such women would be *less* vulnerable to the effects of stereotype threat on performance than would women high in self-perceived ability. The second study in Chapter 2 examined the effect of a situational factor on women's acquiescence to the female-mathematics stereotype, by experimentally manipulating the strength of the female-mathematics stereotype. It was expected that women would be vulnerable to stereotype threat if they were informed that men were slightly better than women at mathematics. However, it was expected that if women were informed that men were considerably mathematically superior, they would acquiesce to the female-mathematics stereotype, but be protected from the effect of stereotype threat on performance.

Effects of Stereotype Threat on Motivation

Finally, Chapter 3 presents a third study, which examined the effect of stereotype threat and performance feedback on women's self-esteem and motivation to improve. Women and men were allocated to either a stereotype or no-stereotype condition before completing a mathematics test. They were then provided with either positive or negative performance feedback, after which they completed measures of their self-esteem and motivation to attend mathematical tutorials. It was predicted that stereotype threat would lead to performance decrements among women, but would also provide women with an opportunity to disengage their self-esteem from negative feedback. Further, it was expected that following the receipt of negative feedback, stereotype threat would lead women to be less motivated to improve their mathematical ability.

In sum, this thesis was designed to test two of STT's central tenets. Firstly, the studies in Chapter 2 were designed to demonstrate that stereotype threat leads to performance decrements, particularly under conditions in which stereotype targets do not simply accept their stereotyped inferiority. Secondly, the study presented in Chapter 3 aimed to provide support for the assertion that stereotype threat can lead to reductions in motivation (Steele, 1997; Steele et al., 2002).

Chapter 2

Stereotype Threat and Stereotype Acquiescence in

Women's Mathematical Performance:

The Role of Self-perceived Ability and Perceived Group Differences

Abstract

Stereotype threat theory (STT) asserts that targets of negative stereotypes experience a performance-interfering evaluative threat, which arises from a pressure to disconfirm the relevant stereotype. In the present research, it was hypothesised that women would be paradoxically buffered from stereotype threat under conditions in which they *acquiesced* to the female-mathematics stereotype, by i) expecting men to outperform women, and ii) not aspiring to perform as well as men. Two studies tested the stereotype acquiescence hypothesis. Study 1 showed that women low in self-perceived mathematical ability were more likely than mathematically confident women to acquiesce to the female-mathematics stereotype, but were protected from stereotype threat effects on performance. In Study 2, women exhibited stereotype threat effects when told there was a slight gender difference in mathematics, but not when told there was a large difference. These findings provide evidence for the stereotype acquiescence hypothesis and, in so doing, provide support for STT's assertion that stereotype threat's effects on performance are not the result of an internalization of negative stereotypes, but a motivation to disconfirm them.

Introduction

“I just went out to have fun and I got to swim against the best in the world”

Libby Lenton (“New Record in Swim-Off”, 2007)

The quote above is from a female swimmer who had, moments earlier, broken the world record for women’s 100m freestyle in unusual circumstances: she was swimming alongside Michael Phelps, the man considered to be the world’s premier swimmer. At first glance, her performance appears to be inconsistent with stereotype threat theory (STT; Steele & Aronson, 1995), which asserts that targets of negative stereotypes experience an evaluative threat that interferes with task performance. The context in which this swimmer delivered her performance seemingly met criteria for stereotype threat (see Steele, Spencer, & Aronson, 2002). She was presumably aware of being the target of a negative stereotype, was identified with the relevant domain and swam alongside an out-group member. However, not only was her performance unimpaired by the male swimmer’s presence (indeed, she performed better than any woman had before), her reflections suggest that she had felt, if anything, *less* threatened than she typically would have prior to a race. Importantly, however, her quote implies that she did not seriously consider the prospect of outperforming her male rival and felt no pressure to disconfirm the stereotype of women’s inferior athletic ability. It is possible that by accepting, or *acquiescing* to the stereotype, she was protected from stereotype threat.

The present research examined whether the effect of stereotype threat on women’s mathematical performance (e.g. Spencer, Steele, & Quinn, 1999) is ameliorated under circumstances in which women acquiesce to the female-mathematics stereotype. *Stereotype acquiescence* refers to a process whereby negatively stereotyped individuals accept their group’s stereotyped inferiority in the context of a particular performance task, and do not aspire to perform as well as the out-group. By acquiescing to the inferiority of their group, targets of negative stereotypes should consequently be freed from the evaluative pressure that comes with

attempting to disconfirm the stereotype, and buffered from the effect of stereotype threat on performance. Support for the stereotype acquiescence hypothesis would also be consistent with Steele and Aronson's (1995) assertion that it is the motivational pressure to disconfirm stereotypes, rather than an internalization of stereotyped inferiority, which is primarily responsible for the effects of stereotype threat on performance.

Steele and Aronson's (1995) seminal article on stereotype threat demonstrated that the stereotype of African Americans' inferior intellectual ability can impair the performance of African American students. Since then, it has been demonstrated that negative stereotypes can interfere with the performance of stereotype targets in a range of performance domains. For example, stereotype threat has been shown to affect not only the academic performance of African American students (Steele & Aronson, 1995; Marx & Goff, 2005; Marx, Ko, & Friedman, 2009), but also the academic performance of students of low socioeconomic status (Harrison, Stevens, Monty, & Coakley, 2006), the athletic performance of White Americans (Stone, Lynch, Sjomeling, & Darley, 1999) and the mathematical performance of women (e.g. Schmader, 2002; Shih, Pittinsky, & Ambady, 1999; Spencer et al., 1999; Thoman, White, Yamawaki, & Koishi, 2008), which is the focus of the present research.

A central tenet of STT is that these performance decrements are not caused by internalized inferiority or lowered expectations (Steele et al., 2002). According to STT, people need not even believe that a stereotype is accurate for stereotype threat to occur (Steele, 1997). Rather, stereotype threat is said to arise from the pressure to *disconfirm* the relevant stereotype, which results in performance anxiety that disrupts performance (Schmader, Johns, & Forbes, 2008; Steele, 1997). Indeed, Steele et al. (2002, p.390) have asserted that, because stereotype threat arises from a motivation to avoid conforming to a stereotype in a domain with which one is identified, "the more a person has internalized the negative group stereotype, the less stereotype threat he or she may experience". Just as Steele (1997, p.618) described the continual effort

required to disprove negative stereotypes as “Sisyphean”, so his theory of stereotype threat shares parallels with the tragedy of Oedipus Rex, whose striving to avoid his prophesized fate led paradoxically to its very realization¹.

The idea that negative stereotypes can lead to a self-evaluative threat has a long history in social psychology (Allport, 1954; Brickman & Bulman, 1977; Goffman, 1963). There is also considerable evidence that evaluative pressure and anxiety can impair performance (e.g. Baumeister, 1984; Keough & French, 2001; Sarason, 1980). Taken together, this research suggests that negative stereotypes have the potential to impair performance through performance anxiety. Accordingly, much STT research has investigated anxiety as a potential mediator of stereotype threat effects on performance. This research, however, has yielded mixed results (see Smith, 2004 and Wheeler, S. C. & Petty, 2001 for reviews). More recently, studies have found evidence of stereotype threat leading to increased physiological arousal (e.g. Blascovich, Spencer, Quinn, & Steele, 2001; Osborne, 2006), but these studies have not found evidence that increased arousal mediates the effect of stereotype threat on performance.

Although there remains little direct evidence that self-reported anxiety or physiological arousal mediates stereotype threat, two bodies of recent research provide evidence that evaluative pressure plays a central role in stereotype threat. First, Schmader et al.’s (2008) integrated process model asserts that the pressure to disconfirm stereotypes leads not only to physiological arousal and negative affect, but also a tendency to monitor stereotype cues and suppress negative thoughts and emotions, all of which impair performance by diverting executive resources from the relevant task. Consistent this model, Schmader and Johns (2003) found that the effect of the female-mathematics stereotype on women’s mathematical performance was mediated by decreased working memory. A growing number of studies have provided further support for

¹ The authors do not mean to suggest that targets of negative stereotypes are destined to perform more poorly than their non-stereotyped or positively stereotyped counterparts! Many STT researchers have been able to mitigate or erase stereotype threat effects experimentally (e.g. Martens, Johns, Greenberg, & Schimel, 2006; Rydell & Boucher, 2010) and using “real-world” interventions (e.g. Cohen, Garcia, Apfel, & Master, 2006; Walton & Cohen, 2007).

Schmader et al.'s integrated process model (Regner et al., 2010; Rydell, McConnell, & Beilock, 2009; Schmader, Forbes, Zhang, & Mendes, 2009).

Second, Jamieson and Harkins' (2007; 2009) 'mere effort' account asserts that evaluative pressure leads stereotyped individuals to invest increased effort. According to the mere effort account, this increased effort leads to the greater use of and persistence with the 'prepotent' method: the solution strategy most likely to be employed in a given performance situation. The most common prepotent method for solving mathematical problems involves the linear use of equations (Quinn & Spencer, 2001), a method often ineffective for solving complex mathematical problems, thus impairing performance on mathematics tests. Supporting the mere effort account, Jamieson and Harkins (2009) found that negatively stereotyped women performed better than non-stereotyped women on test items amenable to the prepotent method, but performed much worse on items better solved using reasoning and logic. Although Schmader et al. and Jamieson and Harkins' accounts are not in full agreement regarding the mechanisms of stereotype threat, both support the view that stereotype targets are motivated to disprove the stereotype, and that the subsequent evaluative pressure impairs performance.

Steele and his colleagues (Steele, 1997; Steele et al., 2002) suggested that individuals who internalize their stereotyped inferiority, and are not motivated to disconfirm the stereotype, will not be as threatened by its presence. Support for this assertion is provided by studies showing that the effects of stereotype threat on performance are small, or not present at all, for stereotype targets with low levels of identification with the relevant performance domain (Aronson et al., 1999; Spencer et al., 1999; Stone et al., 1999), as well as those with low levels of identification with the stereotyped group (Schmader, 2003). Presumably, individuals who are not invested in a given performance domain and not highly identified with their group, would be relatively unconcerned about whether their performance helps to disconfirm the stereotype of their group's inferiority, and relatively free from a self-evaluative threat.

Moreover, it has been demonstrated that an external locus of control can paradoxically provide a buffer against stereotype threat (Cadinu, Maass, Lombardo, & Frigerio, 2006). Specifically, Cadinu and her colleagues demonstrated that stereotype threat led to performance decrements among stereotype targets who had an internal locus of control, but not those with an external locus of control. Individuals with an external locus of control are often less motivated and feel less responsible about their own performance (Rajamohan, 1978; Rotter, 1966). As Cadinu and her colleagues (2006, p.194) suggested, it is possible that individuals with an internal locus of control projected this sense of responsibility to their stereotyped group, ‘burdening themselves with the responsibility of making the group look bad, or trying to save the group from confirming the stereotype’, whereas those with an external locus did not burden themselves with the same responsibility. In a similar vein, Brown, R. P. and Josephs (1999) showed that the effects of stereotype threat on women’s mathematical performance were nullified when a test was framed as a measure of ‘exceptional’ ability, a level to which many women are unlikely to aspire in the context of the negative stereotype. Brown, R. P. and Josephs asserted that framing the test in this way removed the ‘burden of proof’ and in turn protected women from an evaluative threat.

A burden of proof is unlikely to weigh heavily on stereotyped individuals who simply accept their group’s ostensible inferiority and do not attempt to perform as well as the out-group. In their seminal discussion of intergroup relations, Tajfel and Turner (1979) asserted that although people are generally motivated to maintain positive social identities, there are circumstances in which negatively stereotyped people *acquiesce* to, or accept their group’s inferiority relative to an out-group on a given dimension. Moreover, because direct competition with an apparently superior out-group is unlikely to provide the opportunity to enhance social identity, individuals who accept the superiority of the out-group should be less concerned with the how their group compares with the out-group on that dimension, and less likely to aspire to disconfirm the stereotype. Acquiescence to a self-relevant stereotype should be particularly likely

when status differences between one's own group and an out-group appear stable and large (Brown, R., 2000; Haslam et al., 2008; Hogg, 2000 Tajfel & Turner, 1979). Thus, when individuals expect the out-group to considerably outperform their in-group, they should be less likely to aspire to perform as well as the out-group and consequently be relieved of an evaluative pressure to disconfirm the stereotype. In turn, such individuals should be relatively free from stereotype threat's effects on performance.

The Present Research

The aim of this research was to test the stereotype acquiescence hypothesis in the context of women's mathematical performance. It was predicted that targets of the female-mathematics stereotype would be protected from stereotype threat under conditions in which they *acquiesced* to the stereotype. In keeping with the definition provided earlier, stereotype acquiescence is operationalized as: i) an *expectation* that one's group will perform worse than the relevant out-group on a relevant performance task, and ii) a level of performance *aspiration* below that expected for the out-group. Importantly, stereotype acquiescence does not necessarily imply disengagement or disidentification from a relevant domain (e.g. Major & Schmader, 1998; Nussbaum & Steele, 2007). For example, the swimmer described at the start of this paper was almost certainly highly engaged in swimming. However, she did not appear motivated to disconfirm the stereotype regarding gender differences in swimming, nor threatened by the prospect of swimming alongside an out-group member, which potentially protected her from stereotype threat.

Thus, in the present studies, it was predicted that under circumstances in which women acquiesce to the female-mathematics stereotype, they will also be buffered from the effect of stereotype threat on performance. Evidence for the stereotype acquiescence hypothesis would provide support for a central tenet of STT: that the pressure to disconfirm negative stereotypes, rather than their internalization, is principally responsible for stereotype-related performance

decrements. This research also investigated the conditions under which stereotype acquiescence occurs. The first study examined the role of an *individual difference*: women's self-perceived mathematical ability. Women who were low in self-perceived mathematical ability were expected to be more likely to acquiesce to the female-mathematics stereotype, but less vulnerable to the effect of stereotype threat on performance. The second study examined the effect of a *situational factor*: information provided to women regarding the magnitude of gender differences. It was predicted that women would acquiesce to the stereotype, and be buffered from stereotype threat, when they had low perceptions of their own ability and when they were informed that men were considerably mathematically superior to men.

Study 1

Study 1 was designed first to demonstrate the effect of an individual difference on women's tendency to acquiescence to the female-mathematics stereotype, and second to provide an initial test of the stereotype acquiescence hypothesis. Specifically, it was reasoned that, because people often project their own attributes onto in-group members (e.g. Robbins & Krueger, 2005), women who were low in self-perceived mathematical ability should be particularly likely to *expect* women in general to perform worse than men. Further, because these women not only had poor perceptions of their own ability, but were also expected to be more likely to accept the mathematical superiority of men in general, it was predicted that they would also be less likely to *aspire* to disconfirm the stereotype by performing as well as men². However, it was also expected that women low in self-perceived ability would be paradoxically less vulnerable to the effect of stereotype threat on performance. To test these predictions, women were asked to rate their mathematical ability, before being allocated to either a stereotype

² It is worth mentioning that the swimmer described at the beginning of the study was *not* low in self-perceived ability. Instead, she was likely to have acquiesced to the female-athletics stereotype because of exposure to information suggesting that there are considerable gender differences in athletic performance. An analogy to this situation is presented in Study 2, which manipulates the ostensible magnitude of gender differences in mathematics. However, the purpose of Study 1 was to test whether women would be more likely to acquiesce to the female-mathematics stereotype if they perceived their own mathematical ability as poor.

or no-stereotype condition. They were then informed that they would complete a mathematics test. Women were then asked to indicate their expectancies for each gender, as well as their own performance aspirations, before completing the test.

It was hypothesized, first, that women low in self-perceived ability, relative to those high in self-perceived ability, would acquiesce to the stereotype by expecting greater gender differences in performance on the test and aspiring to a lower level of performance relative to men. Second, it was hypothesized that self-perceived ability would moderate the effect of stereotype threat on performance, such that women high in self-perceived ability would perform worse under stereotype threat, while those low in self-perceived ability would be unaffected by stereotype threat condition.

Method

Participants and design. The sample consisted of 130 women, with a mean age of 20.68 years ($SD = 5.04$), who were enrolled in psychology courses at a large Australian university and participated for course credit. The majority of participants were White (72.9%) and the remainder was Asian (12.0%), Middle Eastern (7.5%) and Indian/Sri Lankan (6.1%). Two participants did not report ethnicity. The study consisted of two stages. In the first, pre-experimental stage, participants completed a measure of their self-perceived mathematical ability. In the second, experimental stage, participants were randomly allocated to one of two experimental conditions (no-stereotype or stereotype) and indicated their gender expectancies and performance aspirations, before finally completing a mathematics test.

Materials.

Pre-experimental questionnaire. This questionnaire included items which asked participants to indicate their age, ethnicity and gender. They were also presented with the sentence: “I am better at mathematics than ____% of other University students” and asked to fill

in the space, which provided a measure of their self-perceived mathematical ability, relative to other students.

Stereotype manipulation. Participants in the stereotype threat condition were informed that: “Studies have provided evidence that males generally perform better than females on this test. In studies so far, the mean score for male students has been approximately 115 and the mean score for female students has been approximately 85.” Those in the no-stereotype condition were told: “Studies have provided evidence that males and females generally perform equally well on this test. That is, in studies so far, both male and female students have received an average score of 100.” This explicit manipulation of the female-mathematics stereotype is similar to that used in a number of other STT studies (e.g. Aronson et al., 1999; Cadinu, Maass, Frigerio, Impagliazzo, & Latinotti, 2003; Smith & Johnson, 2006; Yeung & von Hippel, C., 2008). Although this manipulation potentially made the female-mathematics stereotype salient even for women in the no-stereotype condition, such a design can remove stereotype threat by rendering the stereotype *irrelevant* on a given task (Spencer et al., 1999). Also, it should be noted that in the stereotype condition, the scores of both men and women differed from their scores in the control condition; that is, the ostensible mean score for men was higher and the mean score for women was lower. The decision to manipulate the mean scores of both genders was necessary in order to keep the overall mean constant across conditions. For example, if scores on a test are scaled around a mean of 100, and the mean for women is said to be lower, then the mean for men will be higher than the overall mean.

Gender expectancies. To measure gender expectancies, participants were asked to indicate the scaled score they expected the average male and female student from their own University to attain³.

³ In this study, exploratory measures of women’s self-expectancies and mathematical attitudes were also initially gathered. However, as they do not directly relate to the stereotype acquiescence hypothesis, and for the sake of brevity, they are not included in this paper.

Performance aspirations. This scale consisted of nine items that measured the scaled score to which participants aspired (e.g. “I aim to receive a scaled score of ____” and, “I will be satisfied if I receive a scaled score of ____”). The scale’s reliability was $\alpha = .97$.

Mathematics test. The test consisted of 30 items of a range of difficulty levels from the quantitative section of the Graduate Record Examination. Participants were told that the test was a valid measure of mathematical ability. All items were multiple-choice, with one correct response out of either four or five response options. The test items were administered in a booklet and participants indicated their responses on computer. Participants were given fifteen minutes to complete as many items as they could. Scores on the mathematics test were computed by first adding the number of correct responses. To adjust for guessing, participants were then deducted $(1/n \text{ response options})$ points for each incorrect response. Thus, participants were deducted .2 of a point if they incorrectly answered a question with five response options and .25 of a point for incorrect responses to questions with four response options. This correction for guessing is in line with the scoring used in the GRE general test (Educational Testing Service, 2003).

Procedure. Each testing session included two to five participants. They were seated at separate computers and asked not to interact with one another. In the first stage, participants completed the pre-experimental questionnaire, administered in a pen-and-paper format. To disguise the fact that their responses on this measure related to the main part of the experiment, they were told that the questionnaire was part of separate research from the “Tertiary Mathematics Education Centre”. Next, in the experimental stage, participants were directed to follow the instructions on the computer screen at their desk. The instructions stated that participants would perform a mathematics test, after which they would receive performance feedback. They were told that the test was scaled according to norms from Australian Universities, such that the mean scaled score for students was 100. They were then presented with either the stereotype or no-stereotype information. Participants were then shown examples

of mathematical items similar to those they would encounter in the test, before indicating their expectancies for each gender and their aspirations for their performance. They then performed the mathematical test. Finally, participants were debriefed as to the purpose of the experiment.

Results

Data analysis. As expected with random assignment of participants to condition, there was no difference in self-perceived ability between experimental conditions, $F_s < 1.0$, *ns*. To examine the effect of stereotype condition and self-perceived ability on participants' degree of acquiescence to the female-mathematics stereotype, a mixed model analysis of covariance was conducted. This analysis, similar to that employed by Rosenthal, Crisp and Suen (2007), allowed a test of the effects of stereotype condition and self-perceived ability on participants' expectancies for the performance of women, and aspirations for their own performance, all relative to their expectancies for the relevant out-group (men). Next, a multiple regression was conducted to test the effect of self-perceived ability and stereotype condition on participants' test performance. An overall alpha of $p < .05$ was employed for analyses in both this study and Study 2, and Bonferroni adjustments were applied for all comparisons that were not planned a priori.

Acquiescence. A 3 (Target: female expectancy, male expectancy, aspiration) x 2 (Stereotype Condition: no-stereotype, stereotype threat) mixed model analysis of covariance was conducted, with target a within-subjects factor and stereotype condition a between-subjects factor. Self-perceived ability was included as a covariate. The analysis yielded a main effect for target, $F(2, 123) = 27.02$, $p < .0005$, partial $\eta^2 = .31$, which was qualified by two higher-order interactions. First, there was a significant target by stereotype condition interaction, $F(2, 123) = 19.86$, $p < .0005$, partial $\eta^2 = .24$. Follow-up tests of simple effects revealed that in the no-stereotype condition, participants' expectancies for men ($M = 85.22$), expectancies for women ($M = 84.54$), and performance aspirations ($M = 82.88$), did not significantly differ, $t_s < 1.20$, *ns*. In the stereotype condition, however, participants' expectancies for men

($M = 97.19$) were significantly greater than their expectancies for women ($M = 84.13$), $t(124) = 9.48, p < .0005$, and their performance aspirations ($M = 83.08$), $t(123) = 7.50, p < .0005$. There was no difference between stereotypes participants' expectancies for women and their aspirations, $t(123) = 0.65, p = .52$. Although not central to hypotheses, this analysis revealed that women in the stereotype condition expected greater gender differences and aspired to a lower level of performance, relative to their expectancies for men, than did those in the no-stereotype condition.

Second, the hypothesized target by self-perceived ability interaction was also significant, $F(2, 123) = 12.34, p < .0005$, partial $\eta^2 = .17$. This interaction is depicted in Figure 1.

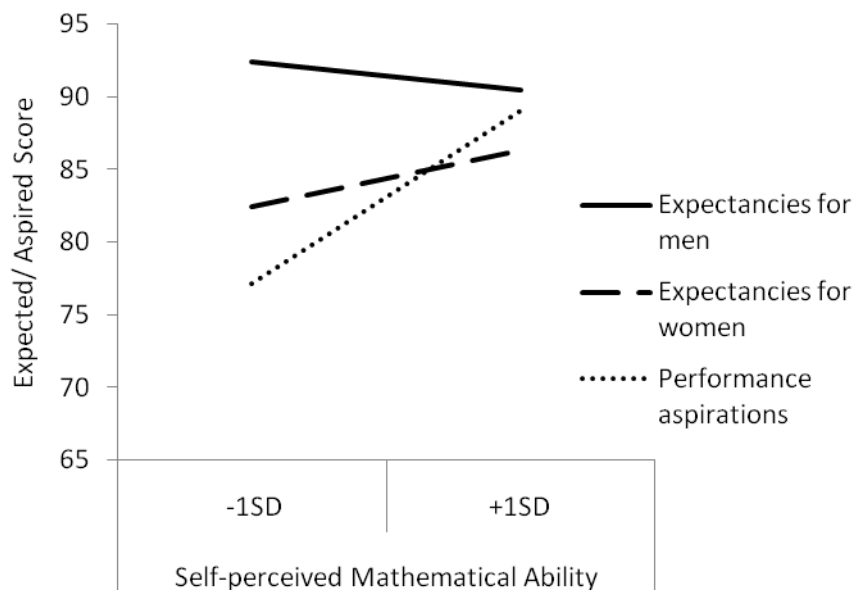


Figure 1. Expectancies for men, expectancies for women, and performance aspirations as a function of self-perceived ability.

Because there were three levels of expectancy target, this overall interaction was explored in more detail. Specifically, within-subject interaction contrasts were conducted to examine separately the effect of self-perceived ability on: i) the difference between expectancies for men and *expectancies for women* and ii), the difference between expectancies for men and women's

aspirations. These analyses, respectively, provided tests of whether women low in self-perceived ability would, as hypothesized, be more likely than those high in self-perceived ability to:

i) expect greater gender differences, and ii) aspire to a level of performance significantly below that of men.

Difference between expectancies for women and expectancies for men. This analysis revealed a significant interaction between self-perceived ability and expectancy target (female v. male), $F(1, 124) = 8.23, p = .005$, partial $\eta^2 = .06$. To examine this interaction further, the difference between participants' expectancies for women and their expectancies for men was measured at one standard deviation above and below the mean for self-perceived ability. These analyses revealed that women high in self-perceived ability did have higher expectancies for men ($M = 90.21$) than for women ($M = 86.30$), $F(1, 124) = 7.40, p = .01$, partial $\eta^2 = .06$. However, women low in self-perceived ability expected a greater difference between men ($M = 92.18$) and women ($M = 82.41$), $F(1, 124) = 47.63, p < .0005$, partial $\eta^2 = 0.28$. The significant *interaction* between self-perceived ability and expectancy target demonstrates that although women both high and low in self-perceived ability expected a gender difference, those low in self-perceived ability, as hypothesized, expected this difference to be significantly greater.

Difference between women's aspirations and their expectancies for men. There was again a significant interaction between self-perceived ability and target (aspirations v. male expectancies), $F(1, 124) = 24.841, p < .0005$, partial $\eta^2 = .17$. As with the gender differences analysis, differences between targets were examined at one standard deviation above and below the mean for self-perceived ability. This revealed that women high in self-perceived ability aspired to a level of performance ($M = 89.03$) that was equivalent to their expectancies for men ($M = 90.21$), $F(1, 124) = 0.46, p = 0.49$. However, women low in self-perceived ability aspired to a level of performance ($M = 77.10$) that was significantly below their expectancies for men

($M = 92.18$), $F(1, 124) = 60.91$, $p < .0005$. Thus, consistent with hypotheses, women who were low in self-perceived ability were significantly less likely to aspire to perform as well as men.

Mathematics test score. A multiple linear regression was conducted to examine the effect of self-perceived ability and stereotype condition on participants' mathematical performance scores. Included in this analysis were a dummy-coded variable for stereotype condition, the continuous measure of self-perceived ability, and the interaction between these two variables. This analysis is summarized in Table 1.

Table 1. *Multiple Linear Regression Analysis Predicting Math Test Score from Stereotype Condition and Self-perceived Ability*

Predictor	Test score	
	β	ΔR^2
		.18***
Stereotype Condition ^a	.08	
Self-perceived Ability	.11***	
Stereotype Condition X Self-perceived Ability	-.08*	

^a Coded as 0 = no-stereotype, 1 = stereotype

* $p < .005$ ** $p < .001$ *** $p < .0005$

As predicted, the analysis yielded a significant two-way interaction between stereotype condition and self-perceived mathematical ability, $\beta = -.08$, $p = .004$. Following the procedures recommended by Aiken and West (1991), a series of simple slopes analyses were conducted to examine this significant interaction. The simple slopes representing the effect of stereotype condition were evaluated at one standard deviation above and below the mean of self-perceived mathematical ability, and at the mean of self-perceived ability ($M = 45.13$, $SD = 19.45$). As predicted, when self-perceived ability was high, women in the stereotype condition scored

significantly lower than did those in the no-stereotype condition, $\beta = -1.51$, $p = .05$. The effect of stereotype condition was not significant at the mean of self-perceived ability, $\beta = .08$, $p = 0.88$. Somewhat unexpectedly, when self-perceived ability was low, women in the stereotype condition scored significantly *higher* than did those in the no-stereotype condition, $\beta = 1.67$, $p = .03$. This interaction is depicted in Figure 2.

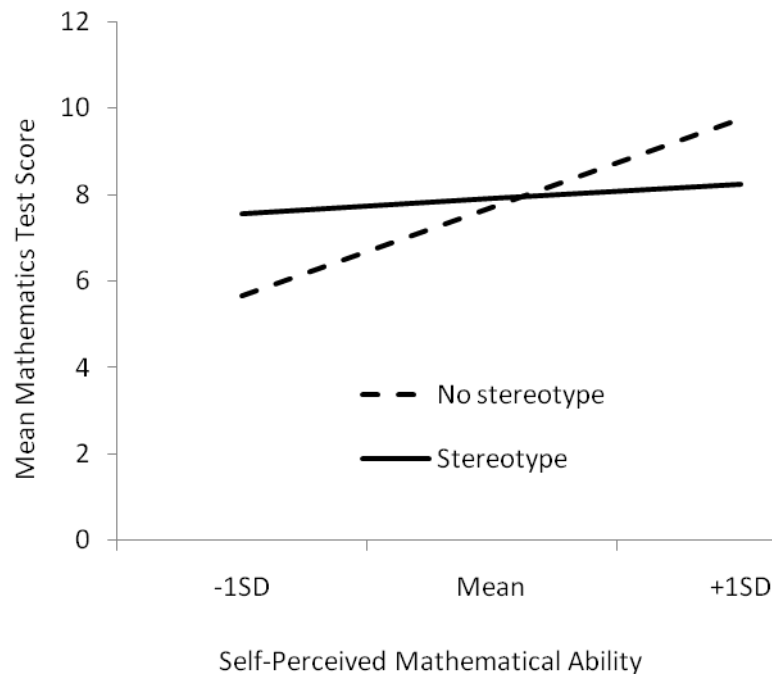


Figure 2. Mathematical performance as a function of stereotype condition and self-perceived ability.

Discussion

The results of Study 1 provide initial support for the stereotype acquiescence hypothesis. Women low in self-perceived mathematical ability, relative to those who perceived themselves as mathematically proficient, expected greater gender differences in performance on a mathematics test and aspired to a lower level of performance relative to men; it was precisely these women who were protected from the harmful effects of the female-mathematics stereotype on performance. Indeed, although it was predicted that the performance of women low in self-perceived ability would be unaffected by the presence of stereotype information, these women

performed significantly *better* in the stereotype condition. Conversely, women who considered themselves as mathematically skilled, expected greater parity in the performance of men and women, and also aspired to perform as well as men, but performed significantly worse when in the presence of the female-mathematics stereotype.

These results are conceptually consistent with Brown, R. P. and Josephs' (1999) 'burden of proof' interpretation. Brown, R. P. and Josephs demonstrated that women can be protected from stereotype threat if a mathematics test is framed as a measure of 'exceptional' ability, which many women do not expect to possess, nor aim to achieve. Similarly, in this study, the presence of the female-mathematics stereotype did not impair the performance of women low in self-perceived ability, who had no burden of disproving the female-mathematics stereotype, as they expected men to considerably outperform women, and did not aspire to perform as well as men. A burden of proof interpretation may also explain why the presence of a negative stereotype improved the performance of women low in self-perceived ability. It is possible that, in the no-stereotype condition, these women were under pressure to disconfirm *personal* mathematical incompetence. However, information that women generally performed worse than men provided a potential attribution for their anticipated level of performance and mitigated an individual-level evaluative threat. This parallels Burkley and Blanton's (2008) finding that women who received negative feedback following a mathematics test reported higher self-esteem if they endorsed the female-mathematics stereotype. In both cases, the presence of stereotypic information potentially removed threatening evaluative information about one's own prospective or past performance.

Thus, these results support the hypothesis that women low in self-perceived ability are more likely to acquiesce to the female-mathematics stereotype. As these women were also protected from stereotype threat, the findings of this study are consistent with the assertion that stereotype acquiescence can provide a buffer against such threat. However, it is also possible that some other characteristic of women with negative perceptions of their mathematical ability might

have at least partly accounted for their invulnerability to stereotype threat. For example, Steele (1997) asserted that women confident in their mathematical ability are likely to have a relatively high level of mathematical identification, and it has been demonstrated that women high in mathematical identification are more vulnerable to stereotype threat (Aronson et al., 1999; Spencer et al., 1999; Stone et al., 1999). Thus, a low level of mathematical identification may have partly contributed to women low in self-perceived ability being unthreatened by the stereotype. Notwithstanding this limitation, this study did identify an individual difference that influenced women's degree of stereotype acquiescence, with those low in self-perceived ability more likely to expect significant gender differences and less likely to aspire to perform as well as men. It seems probable that such acquiescence to the stereotype removed a burden of proof and protected these women from stereotype threat.

To provide further support for the stereotype acquiescence hypothesis, a second study was conducted to examine whether a *situational* factor that leads to stereotype acquiescence can also protect women's performance from stereotype threat. Namely, this study examined whether women would be more likely to acquiesce to the female-mathematics stereotype, but paradoxically less vulnerable to stereotype threat, if they were exposed to information that there are considerable gender differences in mathematical performance. This would help to further demonstrate that if women acquiesce to the female-mathematics stereotype, whether as a result of individual differences or environmental factors, they will be less affected by stereotype threat.

Study 2

In the second study, information about the extent of gender differences in mathematics was experimentally manipulated. It was expected that if women were informed that there were *considerable* gender differences in mathematics, they would be more likely to acquiesce to the mathematical superiority of men, but would also be less vulnerable to stereotype threat than women informed that men are only *slightly* mathematically superior. This is in line with Tajfel

and Turner's (1979) suggestion that people are more likely to acquiesce to their group's inferiority if they consider the status difference between their group and a relevant out-group as large, and that similarity between groups influences whether an individual will be concerned with their performance relative to the out-group. Thus, women who are informed that there are large gender differences in mathematics should feel less of a burden of disproving the negative stereotype and therefore be less susceptible to the effect of stereotype threat on performance than women who are told that there are only small gender differences.

To test this, participants were told that they were to complete a mathematics test, and informed either that there were no gender differences on the test, that men were slightly superior to women or that men were considerably superior. A control condition was also included, in which participants received no information about gender. Previous stereotype threat studies have included explicit no-stereotype threat conditions, in which the given stereotype is rendered irrelevant (e.g. Quinn & Spencer, 2001; Spencer et al., 1999), or conditions in which the *salience* of the stereotype is minimized (e.g. Steele & Aronson, 1995; Stone, 2000). The present study allowed a comparison of these two forms of 'no-stereotype' condition. Men were also included in Study 2, to allow a comparison of the mathematical performance of men and women in each condition and to ensure that any detrimental effects of stereotype condition on performance were unique to women. It was hypothesized that women who were informed of only slight differences in mathematical ability would perform worse than men, and worse than women in the control, no-stereotype and large gender differences conditions. However, those informed of considerable gender differences were predicted to acquiesce to the female-mathematics stereotype, but to perform as well as men, and as well as women in the no-stereotype and control conditions.

Method

Participants and design. The sample consisted of 108 women and 46 men, with a mean age of 20.26 years ($SD = 4.16$), who were enrolled in psychology courses at a large University

and received course credit for their involvement. Most participants were White (58.2%) and the remainder was Asian (18.3%), Middle Eastern (13.1%), Indian/Sri Lankan/Pakistani (7.2%) and African (2.6%). Participants were randomly allocated to one of four experimental conditions (no-stereotype, mild stereotype, extreme stereotype and control), before completing a range of measures, including a mathematics test. Two female and one male student reported suspicion of experimental deception at the end of the experimental session and were removed from analyses, leaving a sample of 106 women and 45 men.

Materials. The gender expectancy and aspiration measures from Study 1 were retained for the present study. Additional or modified materials for Study 2 are outlined below.

Stereotype manipulation. All participants were informed that the mean scaled score on the test was 100. Control participants were provided with no further information. Participants in the no-stereotype condition were told: “Male and female students have generally performed equally well on this test. That is, both male and female students have received an average scaled score of 100”. Those in the mild stereotype condition were informed that: “Male students have outperformed female students on this test, but only slightly. Male students have received an average scaled score of 103. Female students have received an average scaled score of 97”. Participants in the extreme stereotype condition were told that: “Male students have considerably outperformed female students on this test. Male students have received an average scaled score of 130. Female students have received an average scaled score of 70”. The large difference in the extreme stereotype condition was important to test the stereotype acquiescence hypothesis. However, it raised the possibility that women in this condition might be protected from stereotype threat simply because they did not believe the manipulation and consequently discounted the experiment and the test’s validity. To rule out this possibility, a measure of the test’s perceived validity was included.

Feedback validity. This scale consisted of four items measuring belief that feedback on the test would be valid. An example item from the scale, which had a reliability of $\alpha = .77$, was, “My feedback on this test will provide a true reflection of my mathematical ability”. All items were on 7-point Likert scales from 1 = *completely disagree* to 7 = *completely agree*.

Mathematics test. The test was almost identical to that used in Study 1. However, three test items were removed because almost every participant in Study 1 answered them correctly and another four were removed because almost every participant answered them incorrectly.

Procedure. The procedure was similar to that of Study 1, but there were some minor changes. First, whereas only female participants were included in Study 1, participants of both genders were included in the present study. Some testing sessions included only male participants, some only female participants and others were mixed-gender. Second, participants completed a slightly different set of measures, as outlined in the Materials section above. After exposure to the stereotype information, participants completed the gender expectancy and performance aspiration measures, followed by the feedback validity scale and then the mathematics test. Third, participants in the control condition did not complete measures of their expectancies for men and women. This was to minimize control participants’ exposure to cues of the female-mathematics stereotype.

Results

Acquiescence. To examine the effect of gender and stereotype condition on participants’ gender expectancies and aspirations, a 2 (Participant Gender) x 3 (Stereotype Condition: no-stereotype, mild stereotype, extreme stereotype) x 3 (Target: male expectancy, female expectancy, aspiration) mixed model analysis of variance was conducted, with target the within-subjects factor, and gender and stereotype condition between-subjects factors. This analysis yielded significant main effects for target, $F(2, 105) = 36.89, p < .0005$, partial $\eta^2 = .41$, stereotype condition, $F(2, 106) = 7.29, p = .001$, partial $\eta^2 = .12$, and gender, $F(1, 106) = 6.35$,

$p = .01$, partial $\eta^2 = .06$. Also significant were two-way interactions between gender and target, $F(2, 105) = 4.95$, $p = .009$, partial $\eta^2 = .09$, and condition and target, $F(4, 210) = 16.04$, $p < .0005$, partial $\eta^2 = .23$.

These results were all qualified by a three-way gender by stereotype condition by target interaction, $F(4, 210) = 2.86$, $p = .02$, partial $\eta^2 = .05$. To explore this interaction in further detail, follow-up pairwise comparisons were conducted. These comparisons examined differences between target at each combination of gender and stereotype condition. Because of the large number of comparisons, only those significant at the Bonferroni-adjusted alpha of $p < .002$ are reported below. The relevant means are provided in Table 2. These follow-up comparisons revealed that, in the extreme stereotype condition, male participants' expectancies for women ($M = 82.27$) were lower than their expectancies for men ($M = 120.00$), $t(105) = 9.67$, $p < .0005$, and lower than their aspirations for their own performance ($M = 121.97$), $t(105) = 4.44$, $p < .0005$. Thus, men in the extreme stereotype condition expected men to outperform women, and aspired to perform significantly better than women. Further, female participants in the extreme stereotype condition had higher expectancies for men ($M = 111.46$) than expectancies for women ($M = 82.45$), $t(105) = 9.88$, $p < .0005$, and aspirations for their own performance ($M = 94.27$), $t(105) = 4.44$, $p < .0005$. Thus, this confirmed that women in the extreme stereotype condition acquiesced to the stereotype by: i) expecting significant gender differences in performance, and ii) not aspiring to perform as well as they expected men to perform. No other comparisons were significant.

Table 2. *Mean (Standard Error) Expectancies for Men, Expectancies for Women, and Performance Aspirations, by Participant Gender and Stereotype Condition*

	Participant gender					
	Male			Female		
	No stereotype	Mild stereotype	Extreme stereotype	No stereotype	Mild stereotype	Extreme stereotype
Expectancies for men	88.33 (4.54)	100.00 (1.79)	120.00 ^a (3.99)	89.42 (3.45)	94.85 (2.53)	111.46 ^a (3.82)
Expectancies for women	88.50 (4.53)	96.09 (1.09)	82.27 ^b (5.77)	87.69 (3.26)	89.00 (2.84)	82.54 ^b (3.02)
Performance aspirations	86.81 (4.62)	107.04 (6.04)	121.97 ^a (6.17)	90.66 (4.44)	85.25 (4.40)	94.27 ^b (4.29)

Note. Within each column, figures with different subscripts were significantly different, using the Bonferroni-adjusted alpha of $p < .002$.

Feedback validity. To ensure that any effects of stereotype threat condition on test score could not be accounted for by differences in the perceived validity of the test, a 2 (Gender) by 4 (Stereotype Condition) analysis of variance was conducted on the feedback validity measure. This analysis revealed no significant effects of gender, stereotype condition, or their interaction, on feedback validity, all F s < 3.50 , *ns*. Further participants' test scores were analyzed with feedback validity entered as a control variable. This did not affect the significance of any results, so feedback validity was dropped from the test score analysis.

Mathematics test score. Participants' test scores were subjected to a 2 (Gender) x 4 (Stereotype Condition: no-stereotype, mild stereotype, extreme stereotype, control) analysis of variance. This analysis yielded only a significant main effect for gender, $F(1, 142) = 14.88$,

$p < .0005$, partial $\eta^2 = .10$, with men performing significantly better ($M = 8.75$) than women ($M = 6.50$). However, because it was hypothesized, *a priori*, that the effect of gender on performance would be significantly greater in the mild stereotype condition than in the other three conditions, an interaction contrast was conducted to compare the effect of gender in the mild stereotype condition, with the effect of gender in the other conditions combined. This interaction contrast yielded a significant interaction between gender and condition, $t(142) = 2.78$, $p = .04$. As hypothesized, the difference between men and women's performance was highly significant in the mild stereotype condition (male: $M = 9.05$, female: $M = 4.72$, $t(142) = 3.76$, $p < .0005$). Although the effect of gender was also significant in the other conditions combined, this effect was smaller (male: $M = 8.65$, female: $M = 7.09$, $t(142) = 2.33$, $p = .02$). Further, separate tests of simple effects were conducted to examine the effect of gender within each of the other three conditions (control, no-stereotype and extreme stereotype). This analysis revealed that the effect of gender on performance was not significant in any of these conditions on their own (all $ts < 1.50$, *ns*).

Follow-up analyses were then conducted to test the effect of stereotype condition within each gender. As hypothesized, these analyses revealed a significant effect of stereotype condition for women, $F(3, 142) = 3.57$, $p = .02$ partial $\eta^2 = .07$. Pairwise comparisons revealed that women in the mild stereotype condition performed significantly worse ($M = 4.72$) than did those in the no-stereotype ($M = 7.00$, $t(142) = 2.47$, $p = .02$), extreme stereotype ($M = 7.49$, $t(142) = 3.03$, $p = .003$), and control ($M = 6.77$, $t(142) = 2.27$, $p = .03$) conditions. There were no differences in women's performance between the no-stereotype, extreme and control conditions, all $ts < 0.80$, *ns*. The effect of condition was not significant for men, $F(3, 142) = .08$, $p > .95$. The effect of gender and stereotype condition on performance is depicted in Figure 3.

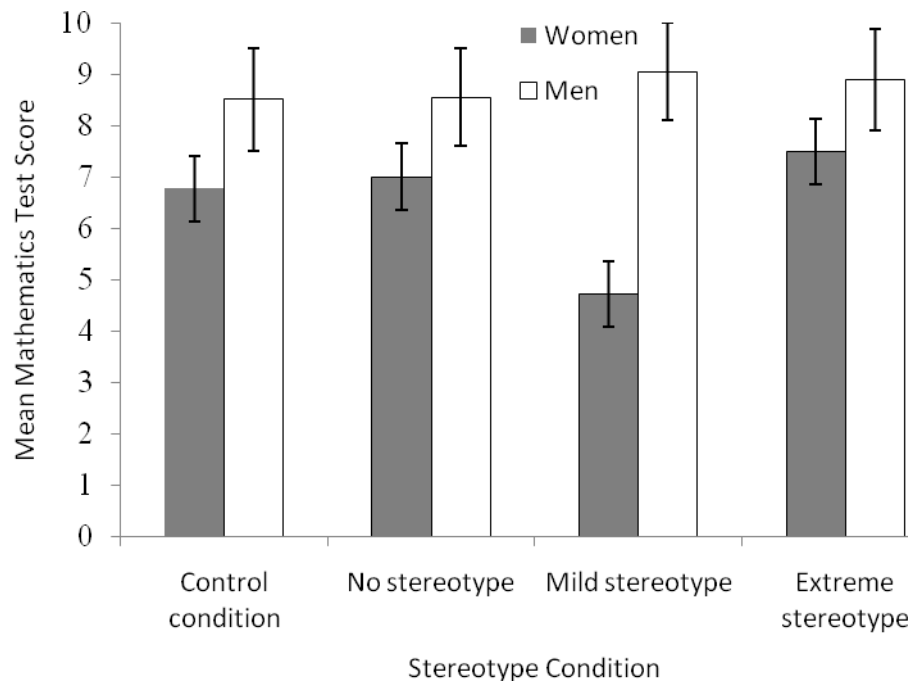


Figure 3. Mathematical performance as a function of stereotype condition and gender. Error bars represent standard errors.

Discussion

These results provide further support for the stereotype acquiescence hypothesis. Women who were informed of only slight gender differences performed worse than men and worse than women in all other conditions, whereas women who were told that men were considerably mathematically superior to women, acquiesced to the stereotype, but performed as well as men and as women in the no-stereotype and control conditions. Like the swimmer introduced at the start of the paper, women did not appear to experience stereotype threat when they were led to believe that the out-group was considerably superior. For women in the mild stereotype condition, the stereotype was salient, relevant to the test they performed, and small enough for there to be a degree of uncertainty and ambiguity regarding its veracity. Their relatively poor performance suggests that this set of conditions was significantly more threatening than that faced by men, and by women for whom the stereotype was either not salient (control condition), not relevant (no-stereotype condition), or not in doubt (extreme stereotype condition).

The lack of doubt regarding gender differences that was implied in the extreme stereotype condition may have relieved women of the uncertainty of whether they would underperform relative to men, as well as the pressure of attempting to outperform this positively-stereotyped out-group. This assertion is supported by women's gender expectancy and aspiration ratings. Women in the extreme stereotype condition expected women to perform significantly worse than men, indicating that they did not carry a burden of proof, which was reflected in their superior performance to women in the mild stereotype condition. Their reported performance aspirations also suggest that they were not attempting to disconfirm the out-group.

The results also demonstrate that women in the extreme stereotype condition were not simply protected from stereotype threat because they discounted the test's validity or disbelieved the stereotype information. Very few participants expressed recognition of deception, either during the testing sessions or the debrief that followed. Those who did were excluded from analyses and statistically controlling for the perceived validity of performance feedback had no influence on results, suggesting that the effect of condition on performance was not confounded by differences in perceived validity of the test.

Further, because stereotype information was experimentally manipulated, the results of this study cannot be accounted for by an individual difference, such as participants' personal identification with mathematics. The stereotype acquiescence hypothesis provides a parsimonious account of why women were protected from stereotype threat both when they had generally low expectations for their own mathematical ability (Study 1) and when they were informed that men are considerably mathematically superior to women (Study 2).

General Discussion

The findings of the present research support the stereotype acquiescence hypothesis: when women had low perceptions of their own ability, or were informed that men were considerably superior, they were more likely to acquiesce to the female-mathematics stereotype, but were also

buffered from its deleterious effects on performance. Conversely, women with positive perceptions of their ability, and those informed that the difference between men and women was small, were less likely to expect gender differences and more likely to aspire to perform as well as men. However, these were the very women who suffered performance decrements in the presence of stereotype threat. Evidence for the stereotype acquiescence hypothesis emerged among women low in self-perceived ability in Study 1, and as a result of manipulating information about gender differences in mathematics in Study 2. Together, these studies providing converging evidence that stereotype acquiescence buffered women from stereotype threat.

The findings of the present research, although counter-intuitive, are consistent with some of the central tenets of STT. It has been asserted, for example, that stereotype threat is the pressure that comes with a motivation to disconfirm negative stereotypes (Brown, R. P. & Josephs, 1999; Steele, 1997; Steele & Aronson, 1995). Furthermore, Steele et al (2002) suggested that stereotype targets might be less threatened if they internalize the relevant stereotype. This research provides support for these claims, by demonstrating that negatively stereotyped people who do not accept their group's inferiority are particularly vulnerable to stereotype threat. This is consistent with Steele and colleagues' (Steele, 1997; Steele et al., 2002) assertion that stereotype threat appears not to be the result of an internalization of negative stereotypes, but rather a motivation to disprove them.

The findings of these studies are also consistent with two of the most convincing accounts of stereotype threat's mechanisms. First, recall that Schmader et al.'s (2008) integrated process model posits that stereotype threat interferes with performance through a range of processes, including the monitoring of stereotype cues to resolve ambiguity related to the stereotype, as well as the suppression of stereotypic thoughts. By definition, acquiescent individuals expect their stereotyped inferiority to be confirmed, which relieves them of ambiguity regarding its veracity.

Further, such individuals do not aspire to disconfirm the stereotype, removing the need to suppress stereotypic thoughts. Thus, acquiescence is likely to free individuals from at least two of the processes that would, according to Schmader et al., otherwise divert resources from the task at hand. Second, Jamieson and Harkins' (2007; 2009) mere effort account suggests that stereotyped individuals invest extra effort, which paradoxically interferes with performance. Acquiescing to the stereotyped inferiority of one's group should remove this motivational pressure, thus buffering individuals from performance decrements. Although there are some important differences between the integrated process model and the mere effort account, both assert that evaluative pressure is central to stereotype threat, and suggest that individuals might be protected from the effect of stereotype threat on performance under circumstances in which they acquiesce to the relevant stereotype, as was the case in the present research.

At first glance, the findings of the present study appear inconsistent with those of Schmader, Johns, and Barquissau (2004), who found that women were more susceptible to stereotype threat if they were higher in endorsement of the female-mathematics stereotype. However, it is important to note that items in Schmader et al.'s stereotype endorsement measure appeared to assess belief that the stereotype *might* be true (e.g. 'It is possible that men have more mathematical ability than do women'). Further, women in Schmader et al.'s study had, on average, very low levels of stereotype endorsement. For example, those low in stereotype endorsement (one standard deviation below the mean) scored 1.45 on a five-point scale, suggesting a very low level of belief in even the *possibility* that the stereotype was true. On the other hand, women who were relatively high in stereotype endorsement (one standard deviation above the mean) appeared to be somewhat uncertain about whether the stereotype might be true (3.55 on the five-point scale).

Interestingly, it has been suggested that stereotype threat interferes with performance partly because of uncertainty regarding a stereotype's veracity (e.g. Schmader et al., 2008; Steele

et al., 2002). The results of both Schmader and colleagues' (2004) research, and the present studies, are consistent with this assertion, in that they suggest that the effects of stereotype threat are reduced when an individual either firmly rejects (Schmader et al. 2004), or strongly acquiesces to (the present study), their group's stereotyped inferiority. Although the present research provides initial evidence that some levels of acquiescence can be protective, a potentially fruitful avenue for future research would be to identify if there is a threshold at which an individual's level of belief in their group's stereotyped inferiority renders the stereotype unthreatening.

It is also important to consider the findings of the present research alongside those of Dar-Nimrod and Heine (2006), who found that women performed worse when informed that gender differences in mathematics are due to innate biological factors, than when told that such differences are the result of experiential factors. Similarly, Thoman et al. (2008) found that women performed worse when informed that gender differences are due to ability, rather than effort. It might appear that these findings are inconsistent with the stereotype acquiescence hypothesis, as women should be more likely to acquiesce to their inferiority if they believe that this inferiority is due to immutable factors. However, women in these studies were unlikely to have accepted the innate accounts of gender differences entirely and without question, and exposure to such accounts would in fact be particularly threatening for those who are motivated to disprove their inferiority. Indeed, Steele (1997, p.625, italics added) stated that the threat imposed by ability-related stereotypes is that 'one *could* confirm or be seen as having a fixed limitation inherent to one's group', implying that the potential that such a stereotype is true would be particularly threatening, not that acceptance of such a stereotype is necessary for stereotype threat to occur. Thus, the findings of Dar-Nimrod and Heine (2006) and Thoman and colleagues (2008) are not at all inconsistent with the suggestion that in some circumstances, acquiescence to one's stereotyped inferiority can provide a buffer against stereotype threat.

The present research also highlights some intriguing connections between STT and other social psychological theories. For example, social identity theorists have suggested that intergroup competition and conflict are more likely when a relevant out-group is perceived as similar (Hogg, 2000; Tajfel & Turner, 1979). This assertion is itself an intergroup extension of social comparison theory, which asserts that people are motivated to compare themselves with similar but slightly superior others (Festinger, 1954), especially when they are motivated to perform well in a given domain (Wheeler, L. 1966), but that such comparisons can be threatening to one's self-esteem (Morse & Gergen, 1970). The present research suggests that these social and intergroup comparative processes manifest in performance situations as a motivational pressure under circumstances in which an out-group is stereotyped as superior, but perceived as sufficiently similar in ability to provide a relevant comparative target. Although a direct test of these hypotheses was beyond the scope of this research, future consideration of the social comparison and intergroup process involved in a given performance situation is likely to provide a greater understanding of the conditions in which a negative stereotype is most threatening.

It is important to make clear that the authors do not suggest that negatively-stereotyped individuals should be encouraged to acquiesce to their stereotyped inferiority. Such acquiescence to the out-group's superiority might lead to chronic disidentification from a given domain (Steele, 1997), or at least a lowering of standards for evaluating one's own or in-group's ability (Biernat, Manis, & Nelson, 1991). Indeed, there is recent evidence that women exposed to mathematics-related stereotype threat are less motivated than non-stereotyped women to improve their performance following the receipt of negative feedback (Fogliati & Bussey, 2011). Thus, chronic acquiescence to a given stereotype might lead to reduced engagement in the relevant domain, which in turn could affect future performance.

The present research, by demonstrating that women high in self-perceived ability are vulnerably to stereotype threat, supports Steele's (1997) assertion that stereotype threat is

particularly likely to impair the performance of the ‘vanguard’ of a given group; those individuals who are otherwise most capable of disconfirming their group’s inferiority. This research further suggests that social *groups* might be particularly vulnerable to stereotype threat when there is uncertainty regarding their relative status in a given domain, as is the case for women’s mathematical ability and the academic ability of certain racial groups. In both cases, some authors have claimed that genetic factors best account for group differences, because performance differences emerge even when individuals in the underperforming groups are provided with the external resources deemed necessary to succeed in that domain (Benbow & Stanley, 1980; 1983; Herrnstein & Murray, 1994). The current research suggests, however, that it is precisely these individuals whose performance is likely to be the most affected by social psychological factors.

Limitations and Future Research

The present research is not without its limitations. Both studies examined stereotype threat and acquiescence in the context of women’s mathematical ability, limiting the degree to which these findings can be generalized to other groups. Given the generalizability of STT to a range of negatively stereotyped groups, as well as evidence that evaluative pressure mediates the effect of stereotype threat on performance (Jamieson & Harkins, 2007; 2009; Schmader et al., 2008), it seems likely that stereotype acquiescence has the capacity to relieve the this pressure for members of a range of groups. However, the extent to which stereotype targets do acquiesce to their group’s inferiority is likely to depend on a range of factors, including information to which they have been exposed regarding the extent of group differences.

Furthermore, both studies employed explicit manipulations of stereotype threat, in which participants were directly provided information regarding the relative performance of men and women. Although these manipulations allowed an initial test of the stereotype acquiescence hypothesis and provided a context for participants to indicate their expectancies for each gender,

it is uncommon for individuals to receive stereotype information so directly in naturalistic settings. Future research is needed to determine whether stereotype acquiescence occurs in response to less direct stereotype cues.

Finally, the mechanisms through which stereotype acquiescence provides a buffer against stereotype threat require further examination. As suggested earlier, Schmader et al.'s (2008) integrated process model and Jamieson and Harkins' (2007; 2009) mere effort account both appear to provide plausible explanations of why performance decrements occur under conditions of stereotype threat, as well as why individuals who acquiesce to their stereotyped inferiority appear to be protected from these decrements. An examination of both of these models under conditions of stereotype threat and stereotype acquiescence has the capacity to shed further light on the processes through which stereotype threat impairs performance.

Conclusion

The present research suggests that stereotype threat is not the result of a passive acceptance of stereotypes, but instead an active, motivated attempt to disconfirm them. Ironically, as negatively stereotyped individuals and groups approach the threshold of disconfirming their inferiority in a given domain, they are potentially the most susceptible to a performance-interfering evaluative threat. Stereotype threat thus has the potential to maintain discrepancies in the outcomes of social groups, even when targets of negative stereotypes otherwise have the skills and motivation to succeed. It is our hope that the research here presented contributes to a more complete understanding of stereotype threat. As this understanding grows, stereotype targets will be better equipped with the means to overcome stereotype threat without having to acquiesce to negative stereotype content. In turn, those members of negatively stereotyped groups who are motivated to disconfirm their own and their group's inferiority, will be better enabled to achieve these very ends and to perform to their potential.

Chapter 3

Stereotype Threat Reduces Motivation to Improve:

Effects of Stereotype Threat and Feedback on Intention to Improve
Mathematical Ability

Abstract

According to stereotype threat theory, negative stereotypes impair performance and can also lead to reduced engagement and motivation in the relevant domain. Although there is much evidence of stereotype threat's effects on performance, there has been less research examining its effects on disengagement and motivation. The present study examined whether the female-mathematics stereotype not only impairs women's performance, but also buffers their self-esteem from negative feedback and reduces their motivation to improve. Participants (54 female and 30 male undergraduate students) were allocated to either a stereotype or no-stereotype condition, before taking a mathematics test. They were then provided with either positive or negative feedback and asked to rate their state self-esteem. Finally, participants indicated the likelihood that they would attend mathematics tutorials. As hypothesized, women exposed to stereotype threat performed worse than non-stereotyped women. Stereotyped women were also less motivated than non-stereotyped women to attend mathematics tutorials after receiving negative feedback. Furthermore, although men had higher self-esteem if they received positive rather than negative feedback, the valence of feedback had no effect on the self-esteem of women, regardless of stereotype condition. Results are discussed in terms of their implications for stereotype threat's effects, both acute and chronic, on a range of outcomes.

Introduction

When Lawrence Summers, then president of Harvard, controversially suggested that innate differences in mathematical and scientific ability contribute to the underrepresentation of women in the fields of science and engineering (Summers, 2005), his comments drew the reprobation of a number of scholars (e.g. Muller et al., 2005). This censure was in part due to a recognition that the female-mathematics stereotype, which Summers' comments reflected and potentially helped to perpetuate, can impair the actual mathematical performance of women through a range of means (e.g. Bussey & Bandura, 1999; Eccles, 1987; Schmader, 2002; Spencer, Steele, & Quinn, 1999; Zhang, Schmader, & Forbes, 1999). Although his comments regarding innate differences received much attention, Summers also made the somewhat less provocative assertion that the *primary* cause of gender differences is a differential motivation between men and women to dedicate long hours to high-powered jobs in science and engineering. The present study explored whether the stereotype of women's mathematical inferiority may contribute to the very differences in motivation that Summers cited as the most important cause of gender discrepancies in these fields. More specifically, this study was designed to examine whether the female-mathematics stereotype not only impairs performance on a mathematical task, but also decreases women's motivation to improve their mathematical ability, particularly following individual performance feedback that conforms with the negative stereotype.

Stereotype Threat

According to stereotype threat theory (STT; Steele, 1997; Steele & Aronson, 1995), negative stereotypes interfere with the performance of their targets by inducing a self-evaluative threat, leading to a level of performance that is not commensurate with their true ability (Steele, 1997; Steele & Aronson, 1995). A wealth of evidence suggests that stereotype threat can indeed impair the performance of women on mathematical tasks (e.g. Brown, R. P., & Josephs, 1999; Davies, Spencer, Quinn, & Gerhardstein, 2002; Gonzales, Blanton, & Williams, 2002; Johns,

Inzlicht, & Schmader, 2008; Johns, Schmader, & Martens, 2005; Keller & Dauenheimer, 2003; O'Brien & Crandall, 2003; Schmader, 2002; Shih, Pittinsky, & Ambady, 1999; Spencer et al., 1999). Further, stereotype threat has been shown to affect the performance of other negatively stereotyped groups, such as African Americans in intellectual domains (e.g. Steele & Aronson, 1995; Marx & Goff, 2005) and White Americans in athletic domains (e.g. Stone, 2002; Stone, Lynch, Sjomeling, & Darley, 1999), demonstrating that these effects are not due to any intrinsic characteristic of women, but rather the experience of being the target of a negative stereotype.

An important tenet of STT, and one that distinguishes it from many other theories of social causes of gender differences in mathematics, is that the stereotype of female mathematical inferiority need not be internalized, nor even endorsed, for it to impair performance (Steele, Spencer, & Aronson, 2002). Instead, stereotype threat is said to arise from the pressure to *disconfirm* the relevant stereotype. Indeed, stereotype threat appears to have the greatest effect on the performance of those who are highly engaged with the relevant performance domain (Aronson et al., 1999). Moreover, there is growing evidence that stereotype threat does induce a self-evaluative and motivational pressure. For example, stereotype threat manipulations have been shown to lead to increased effort (Jamieson & Harkins, 2007, 2009), diminished executive functioning (Rydell, McConnell, & Beilock, 2009; Schmader, Forbes, Zhang, & Mendes, 2009; Schmader & Johns, 2003) and an increased tendency to engage in strategies of emotional suppression (Johns et al., 2008). Stereotype threat has also been shown to increase blood pressure (Blascovich, Spencer, Quinn, & Steele, 2001), activation of the cardiovascular system (Murphy, Steele, & Gross, 2007) and skin conductance (Osborne, 2007), as well as to reduce heart rate variability, which is often used as an index of mental load (Croizet et al., 2004). These findings of the effects of stereotype threat on a diverse range of cognitive, affective and motivational processes are consistent with the assertion that targets of stereotype threat endure an evaluative pressure when their group membership is made salient.

Effect of Stereotype Threat on Engagement and Motivation

According to STT, exposure to this pressure can, over time, lead targets of negative stereotypes to lower their aspirations and protectively *disengage* their global self-esteem from outcomes in the domain in which the stereotype applies (Steele, 1997; Steele & Aronson, 1995). This assertion follows the work of Crocker and Major (1989; Major, Spencer, Schmader, Wolfe, & Crocker, 1998), who claimed that stereotype targets often disengage their self-esteem from performance. Crocker and Major (1989; see also Major et al., 1998) further suggested that members of negatively stereotyped groups can disengage their self-esteem either by *devaluing* the relevant domain, or *discounting* the feedback they receive, attributing it to bias or prejudice, rather than ability. Both of these processes of disengagement from negative feedback provide the opportunity for individuals to maintain a positive self-esteem despite being members of groups that experience negative outcomes in meaningful performance domains.

In support of the claim that stereotype targets psychologically disengage their self-esteem from performance in the relevant domain, it has been demonstrated that members of negatively stereotyped groups often have levels of global self-esteem that are as high, or even higher than their positively stereotyped counterparts (Greenwald & Farnham, 2000; Twenge & Crocker, 2002) and that the self-esteem of members of negatively stereotyped groups is often less contingent on feedback in the stereotyped domain than is the self-esteem of non-stereotyped individuals (Osborne, 1995, 1997), particularly when the stereotype is primed (Major et al., 1998). Steele and his colleagues (Steele, 1997; Steele et al., 2002; Crocker, Major, & Steele, 1998) have asserted that although disengagement represents an acute strategy to deal with a given threat to self-esteem, this has the potential to lead to more chronic disidentification, such that the relevant performance domain ceases to be a basis for self-evaluation. This process, while potentially protective of self-esteem, is likely to deprive stereotype targets of a source of

motivation, which might in turn lead to lower levels of long-term aspirations and achievement (Crocker & Major, 1989; Steele, 1992, 1997; Steele et al., 2002).

As Davies, Spencer and Steele (2005) pointed out, there is a relative dearth of research into the effects of stereotype threat on engagement and motivation. There is, however, some evidence that stereotype threat can reduce stereotyped individuals' interest, domain identification and aspirations in relevant performance domains. For example, it has been demonstrated that women exposed to stereotype threat report less interest in college majors and careers in quantitative domains (Davies et al., 2002), as well as leadership aspirations (Davies et al., 2005). Stereotype threat has also been shown to decrease women's entrepreneurial intentions (Gupta & Bhawe, 2007) and women's interest in attending a mathematics, science and engineering conference (Murphy et al., 2007). It appears, then, that as Steele and his colleagues asserted (e.g. Steele, 1997; Steele et al., 2002), stereotype threat has the potential not only to lead to poorer performance on a task, but also to lower levels of identification and motivation.

The pressure for negatively stereotyped individuals to disengage their self-esteem from performance is likely to be particularly strong following experiences of frustration and failure (Crocker et al., 1998; Steele, 1997). Although targets of stereotype threat might be motivated to disconfirm the stereotype during performance on a test, once they receive personal feedback that they have performed poorly, their only recourse may be to employ strategies for protecting their self-esteem (Crocker & Major, 1989). For example, Burkley and Blanton (2008) found that providing women with the opportunity to endorse the female-mathematics stereotype buffered their global self-esteem from negative feedback, and also that after negative feedback, women were more likely to endorse the female-mathematics stereotype, suggesting that the endorsement of a negative stereotype might be employed for the purposes of protecting self-esteem. As Burkley and Blanton (2008, p. 48) stated, 'the very stereotype that leads individuals to fail also at times may allow them to live more comfortably with these failures'.

This ‘comfort’ provided by negative stereotypes, however, has the potential to translate to lower levels of identification (Steele, 1997). Indeed, Stoutemyer and Steele (1996; cited in Crocker et al., 1998), found that, after receiving negative feedback, women under stereotype threat reported lower levels of mathematical identification than did non-threatened women. Although Steele (1997) asserted that such disidentification might deprive stereotype threat targets of a source of motivation, there is as yet no direct evidence that stereotype threat reduces motivation following negative feedback. Such a finding would have profound implications, as it would suggest that stereotype threat has the capacity not only to impair a given individual’s performance, but also to reduce his or her motivation to take measures to improve.

The Present Research

The present study was designed to replicate the finding that exposure to the female-mathematics stereotype impairs women’s mathematical performance, and also to examine the impact of this stereotype on women’s self-esteem and motivation to improve. This study addresses the lack of stereotype threat research that focuses on motivational outcomes and also responds to a call from Major and O’Brien (2005) for research to examine multiple effects of stereotypes on its targets within the one study. To examine these multiple effects of the female-mathematics stereotype, male and female students were either informed that men are superior to women at mathematics, or that there are no gender differences. They then completed a mathematics test, after which they were provided with either positive or negative feedback, and asked to complete a measure of their self-esteem. As it was theorized that stereotype threat would affect the degree to which individuals disengaged their general self-concept from negative mathematical feedback, a global measure of self-esteem was employed (Rosenberg, 1965), rather than a measure of mathematical self-esteem (e.g. Boehnke, 2005). Finally, to measure motivation to improve, participants were asked to indicate the likelihood of attending free remedial mathematics tutorials run by the University. It was hypothesized, first, that women

under stereotype threat would perform worse on a mathematical task than non-threatened women. Second, it was hypothesized that among women who received negative feedback, those in the stereotype condition would have higher levels of global self-esteem than those in the no-stereotype condition. Third, it was hypothesized that women in the stereotype condition would rate themselves as less likely than non-stereotyped women to attend mathematical tutorials after receiving negative feedback.

Method

Participants and Design

Fifty-four women and 30 men participated in the experiment. Their mean age was 19.92 years ($SD = 4.18$). All participants were enrolled in an introductory psychology course at a large Australian university and received course credit for their participation. The majority was White (75.0%) and the remainder was Asian (13.1%), Indian (7.1%) and Middle Eastern (4.8%). The study consisted of two stages. The first stage involved the completion of a mathematics test and employed a 2 (Gender) \times 2 (Stereotype Condition: no-stereotype, stereotype) factorial design. In the second stage, participants received either positive or negative test performance feedback, before completing measures of their self-esteem and the perceived likelihood of attending mathematical tutorials. This stage employed a 2 (Gender) \times 2 (Stereotype Condition) \times 2 (Performance Feedback: positive, negative) design.

Although there was roughly the same number of participants in each cell within gender, there were more female participants in the *no-stereotype; positive feedback* condition (17) than there were in the other three conditions (12-13 each). Further, a relatively large number of participants (14) did not complete the mathematical tutorial measure, which was administered at the end of the experiment: six were participating in a session when the building in which the experiment took place was evacuated for a fire drill, five did not complete the experiment in the allotted time and three reported awareness of deception during debriefing. However, there were

no significant effects of gender, stereotype condition or feedback valence condition on the number of participants who did not complete this measure. The final numbers of participants in each cell are included in Table 1 (see Results section).

Materials

Mathematics test. The test consisted of 30 multiple-choice questions from the Graduate Record Examination. The items were a mixture of ‘solve’ and ‘comparison’ items (see e.g. Jamieson & Harkins, 2009)¹. The test was administered in a paper booklet, but participants were asked to indicate their responses on computer. For each question, there was one correct response out of either four or five response options. Participants’ scores were computed by adding the number of correct responses and then deducting ($1/n$ response options) points for each incorrect response. This meant that participants were deducted .2 of a point if they incorrectly answered a question with five response options and .25 of a point for incorrect responses to questions with four response options. This correction is consistent with the scoring used in the GRE general test (Educational Testing Service, 2003).

Self-esteem. A modified version of the Rosenberg Self-Esteem Inventory (RSEI; Rosenberg, 1965) was employed to measure participants’ self-esteem. The RSEI is a global measure of self-worth and includes items such as, ‘I feel that I am a person of worth, at least on an equal basis with others’. Following the procedure of Major et al. (1998), the wording of these items was changed, such that participants were asked to indicate how they felt ‘at this moment’. Also, items that included the words, ‘I usually feel’ were changed to, ‘Right now I feel’. This change of wording was made so that the scale measured participants’ state, rather than trait self-esteem. Items that included negative statements, such as, ‘Right now, I think I am no good at all’, were reverse-scored and a mean was computed, with higher scores indicating more positive self-esteem. The reliability of the scale in the present study was $\alpha = 0.85$.

¹ Question type was included in analyses, but not involved in any significant main effects or interactions.

Tutorial intentions. This measure took the form of an advertisement and a two-item questionnaire from the *Macquarie University Numeracy Centre*, which is an actual service on campus that provides free remedial tutorials throughout the semester. The tutorial sessions are designed to provide assistance for mathematics and statistics courses at the University, including a core statistics course for psychology students. The advertisement described the Numeracy Centre and explained how it could assist students to improve their numeracy skills. Attached to the advertisement was a sheet of paper, on which participants were asked to indicate the likelihood that they would attend Numeracy Centre ‘drop-in’ sessions in the semester, as well as the likelihood that they would attend scheduled workshops run by the Numeracy Centre. Each of these items employed a 7-point Likert scale, from 1 = Not at all likely to 7 = Extremely likely. These two items formed a scale of tutorial intentions, which showed high internal consistency ($\alpha = 0.86$). Participants were told that these questions were designed to provide the Numeracy Centre with information regarding the number of students who were likely to attend throughout the semester. Participants were asked to tear off this sheet of paper and hand it to the experimenter, who would return it to the Numeracy Centre.

Procedure

In each testing session, two to six participants were seated at separate computers and asked not to interact with one another. Stereotype and feedback conditions were randomly pre-entered into the computer, and participants were allocated to a computer on the basis of the order of their arrival at the testing session. They were then directed to follow the instructions on the computer. The instructions stated that they were to work on a mathematics test, after which they would receive performance feedback. As in Burkley and Blanton (2008), participants were informed that their score was determined on the basis of both accuracy and speed. This was designed so that participants would be less able to determine their level of performance and would consequently be more likely to believe the feedback they received. Participants were told

that the test was scaled according to norms from Australian Universities, and that the mean scaled score for students was 100. They were then presented with either the stereotype or non-stereotype information.

Participants in the no-stereotype condition were informed: “Studies have provided evidence that males and females generally perform equally well on this test. That is, in studies so far, both male and female students have received an average score of 100.” In the stereotype threat condition, participants were told: “Studies have provided evidence that males generally perform better than females on this test. In studies so far, the mean score for male students has been approximately 115 and the mean score for female students has been approximately 85.²” This manipulation of stereotype threat, in which participants were explicitly informed that the stereotyped group performs worse than an out-group, follows the methodology of a number of other STT studies (e.g. Aronson et al., 1999; Cadinu et al., 2003; Smith & Johnson, 2006; Smith & White, 2002; Yeung & von Hippel, C., 2008). It should also be noted that in the stereotype condition, the scores of *both* men and women differed from their scores in the control condition. Specifically, participants were informed that men scored above the mean (115) and women scored below the mean (85). The decision to manipulate the ostensible mean scores of both genders, rather than keeping one of these scores constant between conditions, was a necessity given the nature of scaled scores and the fact that there are only two relevant groups. If, for example, scores on a test are scaled around a mean of 100 (as was stated to participants), and women are said to perform lower than this average, then the mean of men will, by definition, be higher than the overall mean of 100.

After they had been exposed to the stereotype information, participants were asked to begin the test. They were told that the test was a valid measure of mathematical ability and were

² An observant reader might notice that the stereotype manipulation in this study is the same as that used in the first study of Chapter 2, despite the main effect of stereotype condition not being significant in the study in Chapter 2. The present study was in fact conducted first chronologically, but was presented after the studies in Chapter 2, as this order of presentation better facilitates a logical story of the thesis’ findings.

given 15 minutes to complete as many items as they could. Once 15 minutes had elapsed, participants received false feedback. Those in the positive feedback condition were informed that they had obtained a scaled score of 114. Those in the negative feedback condition were told that they had obtained a scaled score of 86. This false feedback design, similar to that employed by Major et al. (1998), and Burkley and Blanton (2008), allowed a test of the effect of feedback valence on men and women's self-esteem, in both the no-stereotype and stereotype conditions. It was also designed so that the negative performance feedback was roughly equivalent to the mean for women in the stereotype condition, though not being exactly the same, so as to avoid recognition of deception. This provided a test of whether negative feedback had less effect on the self-esteem of women if it conformed to stereotyped gender differences.

Once they had received their feedback, participants completed the RSEI. They were then handed the advertisement from the Numeracy Centre and asked to answer the attached questions about their intentions to attend tutorials. Following the experiment, participants were asked to describe what they thought was the purpose of the experiment. They were then informed of its true purpose and told that both the stereotype and the feedback information were false. However, participants were told that the Numeracy Centre was real, and were encouraged to keep the advertisement and to attend the tutorials.

Results

Data Analysis

Three separate analyses of variance were conducted. The first examined the effect of gender and stereotype condition on participants' score on the mathematics test. The other two analyses of variance assessed the effect of gender, stereotype condition and feedback condition on participants' post-feedback self-esteem and tutorial intentions. For each of the three dependent variables, outlier diagnostics were conducted. These revealed that there were no significant outliers on any of these variables. Bonferroni adjustments were employed according to the

number of comparisons in each analysis. For the three hypothesized comparisons, however, an overall alpha of $p < .05$ was employed.

Mathematics Test Score

A 2 (Gender) x 2 (Stereotype Condition: no-stereotype, stereotype) analysis of variance was conducted on participants' test scores, and revealed a significant main effect for gender, $F(1, 77) = 9.26, p = .003$, partial $\eta^2 = .11$. This main effect was qualified by the predicted gender by stereotype group interaction, $F(1, 77) = 4.09, p = .047$, partial $\eta^2 = .05$ (see Figure 1).

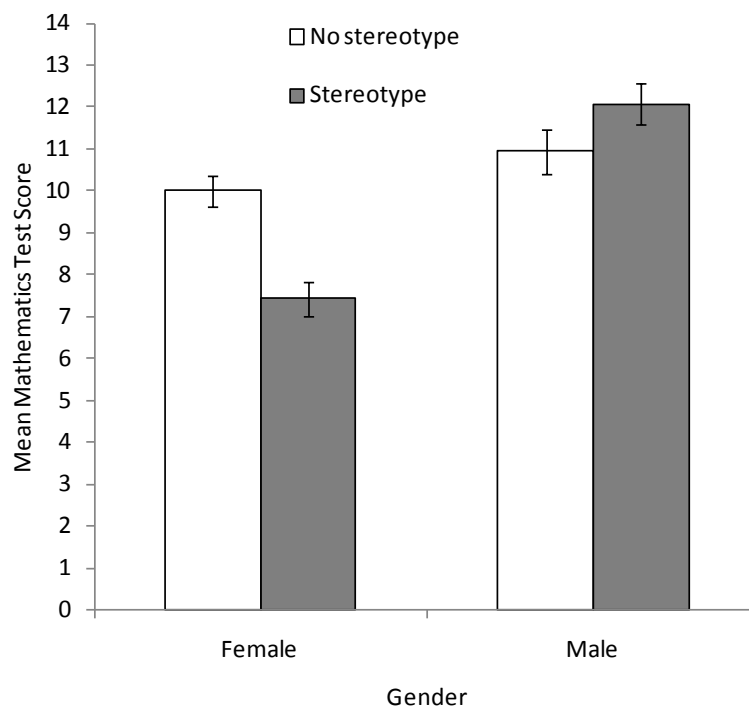


Figure 1. Mean mathematics test score as a function of gender and stereotype condition. Error bars represent standard errors.

Pairwise comparisons revealed that whereas women performed significantly better in the no-stereotype condition ($M = 10.00$) than in the stereotype condition ($M = 7.43$), $t(77) = 2.31$, $p = .02$, the performance of men was not affected by condition, (no-stereotype: $M = 10.94$, stereotype: $M = 12.07$, $t(77) = -0.77, p = .44$). It is also worth noting that while men outperformed women in the stereotype condition, $t(77) = 3.59, p = .001$, gender had no effect on performance in the no-stereotype condition, $t(77) = 0.72, p = .47$.

Self-esteem

Post-feedback self-esteem was analyzed with a 2 (Gender) x 2 (Stereotype Condition) x 2 (Feedback Condition: positive, negative) analysis of variance. The only effect to attain significance was an interaction between gender and feedback, $F(1, 72) = 5.84, p = .02$, partial $\eta^2 = .08$. Follow-up comparisons revealed that men reported significantly lower self-esteem if they received negative feedback ($M = 4.83$) than if they received positive feedback ($M = 5.50$), $t(72) = 2.52, p = .01$, whereas the valence of feedback had no effect on women's self-esteem (positive feedback: $M = 5.35$, negative feedback: $M = 5.49$, $t(72) = -0.69, p = .49$). Also, while women's self-esteem was significantly higher than men's when they received negative feedback, $t(72) = -2.71, p = .008$, gender had no effect on self-esteem in the positive feedback condition, $t(72) = 0.65, p = .52$. There were no significant main effects or interactions involving stereotype condition on participants' post-feedback self-esteem.

Tutorial Intentions

Finally, to examine the effect of stereotype and feedback conditions on men and women's reported likelihood of attending Numeracy Centre tutorials, a 2 (Gender) x 2 (Stereotype Condition) x 2 (Feedback Condition) analysis of variance was conducted. This revealed a main effect of gender, $F(1, 62) = 4.90, p = .03$, partial $\eta^2 = .07$, with women reporting a greater likelihood of attending the Numeracy Centre ($M = 3.62$) than did men ($M = 2.75$). This main effect was qualified by the predicted three-way gender by stereotype condition by feedback interaction, $F(1, 62) = 4.45, p = .04$, partial $\eta^2 = .07$ (see Table 1). Planned comparisons were conducted to examine the hypothesized effect of stereotype condition on women's motivation to attend Numeracy Centre courses following negative feedback. As hypothesized, among women who received negative feedback, those in the stereotype threat condition reported a significantly lower likelihood of attending Numeracy Centre courses ($M = 2.56$) than did women in the no-stereotype condition ($M = 4.00$), $t(62) = 2.04, p = .046$. For men in both feedback valence

Table 1. *Mean (Standard Error) Intentions to Attend Mathematics Tutorials by Gender, Stereotype Condition and Feedback Valence*

Feedback valence	Female				Male			
	No stereotype		Stereotype		No stereotype		Stereotype	
	<i>n</i>	<i>M</i> (<i>SE</i>)	<i>n</i>	<i>M</i> (<i>SE</i>)	<i>n</i>	<i>M</i> (<i>SE</i>)	<i>n</i>	<i>M</i> (<i>SE</i>)
Positive	16	3.63 ^{a,b} (0.37)	9	4.28 ^a (0.57)	5	3.10 (0.80)	8	2.63 (0.49)
Negative	10	4.00 ^a (0.65)	9	2.56 ^b (0.36)	7	2.29 (0.49)	6	3.00 (0.50)

Note. Within each gender, figures with different superscripts were significantly different, using an alpha of $p < .05$.

conditions, and women who had received positive feedback, stereotype condition had no effect on their rated likelihood of attending Numeracy Centre courses, all $t_s < 1.05$, *ns*. Although not a planned comparison, and not significant to the Bonferroni-adjusted alpha of $p < .0125$, it is also worth noting that women in the stereotype threat condition rated themselves as marginally significantly less likely to attend Numeracy Centre courses after receiving negative feedback ($M = 2.56$, as above) than after receiving positive feedback ($M = 4.28$), $t(62) = 2.37$, $p = .02$. Conversely, feedback valence had no effect on the reported likelihood of attending Numeracy Centre courses among men and women in the no-stereotype condition, all $t_s < 1.00$, *ns*.

Discussion

The results of this study demonstrate that the same stereotype that impairs women's mathematical performance can also reduce their motivation to improve following negative performance feedback. Women in the stereotype threat condition performed significantly worse on a mathematics test than did men, and than women in the no-stereotype condition. Furthermore, following the receipt of negative feedback, stereotyped women reported themselves as significantly less likely to attend mathematical tutorials than did non-stereotyped women.

Stereotype condition had no effect on the performance or post-feedback motivation of men, suggesting that its unique effects on women's performance and motivation were due to women being targets of a negative stereotype regarding mathematical ability. These findings add to a small but growing literature regarding the effects of stereotype threat on outcomes other than performance (e.g. Blascovich et al., 2001; Davies et al., 2002, 2005; Gupta & Bhawe, 2007; Harrison, Stevens, Monty, & Coakley, 2006; Marx & Goff, 2005; Murphy et al., 2007; Purdie-Vaughns, Steele, Davies, Dittmann, & Crosby, 2008). Further, they suggest that the effect of stereotype threat on women's mathematical performance can be compounded over time through its effects on motivation to improve.

Although it was also found that women had generally higher levels of motivation to attend mathematical tutorials than men, it is important to note that these tutorials were designed to assist students who anticipated difficulties in their mathematical coursework. Given the endorsement by many people of the female-mathematics stereotype (e.g. Blanton, Christie, & Dye, 2002), as well as the finding that women are generally less interested in mathematical careers and academic activities (Ceci, Williams, & Barnett, 2009; Lubinski & Benbow, 2006), this main effect likely reflects a greater belief among women that they need help in mathematics, rather than women having higher levels of generic mathematical motivation, *per se*. Moreover, this main effect of gender does not negate the finding that stereotype threat reduced women's motivation to improve following negative feedback.

Disengagement

It was also predicted that the female-mathematics stereotype would buffer women's global self-esteem from negative feedback. However, stereotype condition had no effect on women's post-feedback self-esteem. At first glance, this perhaps appears to cast doubt on stereotype threat's effects on engagement in the relevant performance domain. However, women's self-esteem was unaffected by feedback valence in *both* the stereotype and no-

stereotype conditions, whereas men reported lower self-esteem if they received negative feedback than if they received positive feedback. This suggests the possibility that women were more likely to have *chronically* disidentified from mathematics (Crocker et al., 1998; Steele, 1997; Steele et al., 2002). Women in the present study, who would almost certainly have had exposure to the female-mathematics stereotype, may have been disidentified with mathematics regardless of stereotype condition, which protected their self-esteem from negative feedback in both the no-stereotype and stereotype threat conditions. This is consistent with evidence that targets of negative stereotypes protectively disengage their self-concept from relevant domains (Osborne, 1997) and more specifically with research that women have lower levels of engagement with and interest in mathematics (see Ceci et al., 2009).

An alternative explanation for the null effect of feedback on women's self-esteem is that the female-mathematics stereotype may have been salient for women in *both* the no-stereotype and stereotype threat conditions. Indeed, in both conditions, participants received information about gender in relation to mathematical ability. In a similar vein, Major et al (1998) found that while negative feedback led to lower self-esteem for African American students when their race was not primed, African American students appeared to disengage when an intellectual task was described as racially biased, but also when it was described as racially fair. The latter two manipulations are analogous to the present study's stereotype threat and no-stereotype conditions, respectively. The no-stereotype condition potentially alleviated the effect of stereotype threat on performance by decreasing the likelihood that the stereotype was *relevant* to outcomes on the test (as in Spencer et al., 1999). However, the *salience* of the mathematics stereotype in both conditions potentially provided women with the means to protectively disengage their self-esteem after receiving negative performance feedback.

It seems likely that the unresponsiveness of women's self-esteem to feedback in both conditions was due either to women's chronic disidentification in response to stereotype threat or

to the stereotype's salience in both the stereotype and no-stereotype conditions. Neither of these interpretations is at all inconsistent with the assertions of STT (Steele, 1997; Steele & Aronson, 1995; Steele et al., 2002). However, further research is needed to determine whether an experimental manipulation of stereotype threat can, in the right circumstances, lead to differential self-esteem among women following feedback on a mathematical test.

Potential Mechanisms of Lowered Motivation

As mentioned earlier, however, an important finding of the present study is that stereotype leads to differences in women's motivation following negative feedback. Given that these differences cannot be explained entirely by disengagement, it is worth considering what may have accounted for the effect of stereotype condition on women's post-feedback motivation. One possibility is that women who were in the stereotype threat condition and received negative feedback were driven to avoid the domain of mathematics altogether (Steele, 1997; Steele et al., 2002). Steele and his colleagues (2002) made the important distinction between disengagement, which is a psychological process of disconnecting performance outcomes from self-esteem, and *domain avoidance*, which entails a literal avoidance of situations in which the relevant stereotype applies. In the present study, although women in both stereotype conditions apparently disengaged their self-esteem from negative feedback, this does not preclude the possibility that the mathematical test itself was an aversive experience for women in the stereotype condition (as perhaps suggested by their poorer performance). Just as Steele (1997, p.618) suggested that women can avoid the aversive experience of female-mathematics stereotype threat 'by moving across the hall from math to English class', so women in the present study were more likely to avoid mathematical tutorials following negative feedback, if they had earlier been exposed to stereotype threat.

Another potential explanation for stereotyped women's low motivation following negative feedback is that they had lower expectancies and self-efficacy for improvement. Steele

and Aronson (1995) suggested that although stereotype threat interferes with performance primarily through a self-evaluative pressure, it can also reduce performance expectancies over time. Consistent with this assertion, there is evidence that negative stereotypes can reduce performance expectancies, (Cadinu et al., 2003; Rosenthal et al., 2007), and even negate the effects of positive individual feedback on expectancies (Stangor, Carr, & Kiang, 1998). Moreover, Aronson and his colleagues (Aronson, Fried, & Good, 2002; Good, Aronson, & Inzlicht, 2003) argued that stereotypes imply that a given ability is fixed, which can lead to a belief that performance cannot be significantly improved (Dweck, 1986, 1999), and there is evidence that women exert less effort when exposed to an ability-based stereotype (i.e., men are innately better at mathematics) than when exposed to an effort-based stereotype (i.e., men expend more effort at mathematics) (Thoman, White, Yamawaki, & Koishi, 2008). Given the research demonstrating the profound effect of self-efficacy on motivation and persistence (Bandura, 1997; Bandura & Cervone, 2000; Bussey & Bandura, 1999), it is possible that women who were informed of both their group's and their own inferiority were less motivated because of a decreased belief in their capacity for improvement

Finally, the stereotype threat manipulation might have changed the meaning of the feedback provided and its relevance to self-appraisals. Biernat, Manis, and Nelson (1991) demonstrated that people's evaluation of their qualities and abilities are influenced by stereotype information. Blanton et al., (2002) further showed that the female-mathematics stereotype influences women's *self*-evaluations following feedback. Thus, women who received negative feedback in the present study might have evaluated themselves less negatively if they earlier received information suggesting that women generally perform at a similar level. In turn, this might have reduced motivation by decreasing their perceived need for improvement. Indeed, although the negative performance feedback in the present study was designed to equate to the average performance of women in the stereotype threat condition, the score was in fact slightly

higher than the stated mean for women. However, it is important to note that the motivation of stereotyped women who received negative feedback was lower than women who received *positive* feedback, suggesting that their low levels of motivation cannot be explained entirely by a perception that their performance did not need improvement.

Limitations and Future Research

As the present study primarily focused on disengagement and its potential effect on motivation, women's post-feedback self-efficacy and self-evaluations were not assessed. This precludes firm conclusions regarding the causes of lower motivation among stereotyped women who received negative performance feedback. The absence of mediational evidence parallels the early stages of stereotype threat research, in which evidence emerged for the effect of stereotype threat on performance (Brown, R. P., & Josepfs, 1999; Spencer et al., 1999; Steele & Aronson, 1995), before there was a clear understanding of its mediators (e.g. see Smith, 2004; Wheeler, S. C., & Petty, 2001, for reviews). Although Davies et al (2005) demonstrated that stereotype threat's effects on leadership aspirations are mediated by activation of the relevant stereotype, further research is needed to elucidate the processes through which stereotype threat impairs motivation in general. However, although the present study found no mediational evidence, it does provide evidence that the valence of feedback is a potential moderator of stereotype threat's effects on motivation.

Another limitation of the present research is the lack of a neutral feedback condition, or a condition in which no performance feedback was provided. Thus, the effect of feedback valence on stereotype threatened women's motivation might have been the result of negative feedback decreasing motivation, positive feedback increasing motivation, or a combination of both. More generally, there were only two levels of performance feedback provided, suggesting the need for caution in generalizing the current findings to women's motivation following negative feedback of a different extent. It is unclear, for example, how stereotype threat might affect women's

motivation if they receive feedback that they have performed only slightly below the mean, or below the mean for their stereotyped group. The present study's results do, however, suggest that stereotype threat can reduce women's motivation to improve following the receipt of feedback that is consistent with female's stereotyped mathematical inferiority.

Further, although the present study found that women's self-esteem was unaffected by feedback valence, suggesting disengagement from mathematical performance, it is unable to provide conclusive evidence as to whether negative feedback led women to *devalue* math or *discount* their feedback (Crocker & Major, 1989; Major et al., 1998). As discussed earlier, both of these processes provide stereotyped individuals the opportunity to disengage their self-esteem from negative outcomes, and both potentially account for women's disengagement in the present study (Crocker & Major, 1989; Major et al., 1998). However, women's disengagement in *both* the no-stereotype and stereotype conditions provides evidence that discounting cannot entirely account for their disengagement. Indeed, women in the no-stereotype condition were informed that the genders performed *equally well* on the mathematics test. Thus, it is unlikely that women in this condition discounted their feedback on the basis of test bias. It seems more feasible that women in both conditions had chronically disidentified from outcomes in mathematics, unperturbed by poor performance regardless of whether they perceived the test as biased or not.

Finally, the small number of male participants precludes firm conclusions regarding the interactive effect of stereotype condition and feedback valence on their self-esteem and motivation to improve. Although the main hypotheses related to women's self-esteem and motivation, further research is needed to determine whether the gender-mathematics stereotype also influences the post-feedback motivation of men. It should also be noted, however, that feedback valence did have an effect on the self-esteem of men, suggesting that they were less likely than women to disengage their self-esteem from mathematical outcomes. Further, men

performed slightly better in the stereotype condition, suggesting that the detrimental effect of stereotype threat on performance was unique to women.

Implications

These limitations notwithstanding, the present study's findings have important implications for the effect of stereotype threat on women's mathematical motivation. Although participants' behaviors were not directly measured, stereotype threat had a significant effect on intentions to attend mathematical tutorials during the semester. Behavioral intentions are often highly predictive of actual behavior, particularly when there is a relatively short delay between the intention and the behavior in question (Azjen, 2005; Fishbein & Azjen, 2010; Randall & Wolff, 1994; Sheeran & Orbell, 1998). Thus, the findings of this study provide evidence that stereotype threat has the potential to make its targets less likely to engage in behavior that can lead to improvement in the relevant performance domain. Although the effects on motivation were unique to women who received negative feedback, this is of considerable significance, not only because these women are likely to be the most in need of improvement, but because there is ample evidence that stereotype threat increases the likelihood of poor performance (and thus negative feedback) among its targets (e.g. Spencer et al., 1999; Steele & Aronson, 1995). Thus, the presence of a negative stereotype has the potential to impair the performance of its targets, and subsequently to reduce their motivation to rectify such performance.

By demonstrating the effect of stereotype threat on both performance and motivation, the present study provides important support for the two central foci of STT (e.g. Steele, 1997). First, it adds to the considerable body of knowledge demonstrating the effect of stereotype threat on performance. Second, it replicates more recent findings that stereotype threat can reduce its targets' motivation and aspirations (Davies et al., 2005; Gupta & Bhawe, 2007). This supports Steele's (1997) assertion that although stereotype threat interferes with the performance of individuals who are the most motivated to disconfirm the relevant stereotype, it also has the

potential over time to paradoxically undermine such motivation. In turn, though unmotivated individuals might be buffered from stereotype threat, *per se*, they are also more likely to forego opportunities to improve in the relevant domain. While Steele and his colleagues (2002; Steele, 1997) have suggested that reduced motivation is likely to be an outcome of chronic exposure to stereotype threat, the present study's findings demonstrate that a situational manipulation of stereotype threat, together with negative feedback, has the capacity in the short term to dissuade women from taking steps that would be likely to improve their mathematical ability.

Conclusion

Lawrence Summers' (2005) suggestion that gender differences in mathematics and science reflect innate differences, while controversial, reflected a broader societal stereotype. Although Summers also highlighted the potential contribution of gender differences in motivation, he largely overlooked the capacity for the stereotype itself to contribute to the very performance differences it predicts. The present study demonstrated that there are a number of paths through which the female-mathematics stereotype can contribute to women's underrepresentation in mathematics. Not only does the stereotype have the potential to impair performance, it can also contribute to lower motivation in women, potentially discouraging them from taking opportunities to improve their performance. These findings highlight the importance of a serious consideration of social psychological factors, and particularly stereotype threat, when attempting to understand women's underrepresentation in mathematics. With an increased understanding of the range of stereotype threat's consequences, comes the potential to further redress gender imbalances in mathematics and science.

Chapter 4

General Discussion

Overview of Findings

The findings of this thesis provide further evidence that stereotype threat has the capacity to interfere with women's mathematical performance and motivation. This thesis has also demonstrated some of the circumstances under which stereotype threat is more likely to interfere with performance. Specifically, it was shown that women high in self-perceived ability and those informed of only slight gender differences in mathematics were particularly vulnerable to stereotype threat. Conversely, women who were low in self-perceived ability and those who were told that men are considerably mathematically superior, were more likely to *acquiesce* to the mathematical superiority of men, but performed as well as, or in some cases better than, individuals in no-stereotype and control conditions. This thesis has also demonstrated that stereotype threat can lead to a reduction in the motivation of women who receive negative feedback on a mathematics test. The key findings of this thesis will be reviewed in detail below. The theoretical and practical implications of these findings will then be discussed, followed by an outline of the main strengths and limitations of the thesis. Directions for future research will then be provided, before a summary of the key conclusions of the thesis.

Chapter 2 presented the *stereotype acquiescence* hypothesis, which states that targets of negative stereotypes will be buffered from threat-related performance decrements under circumstances in which they acquiesce to the relevant stereotype, by accepting the stereotyped inferiority of their group and not aspiring to a level of performance that would help disconfirm the stereotype. Two studies were conducted to test the stereotype acquiescence hypothesis. Study 1 demonstrated that women low in self-perceived ability were more likely than those high in self-perceived ability to acquiesce to the stereotyped inferiority of women. Specifically, these women were more likely to expect significant gender differences on a test, and less likely to aspire to perform as well as men. It was exactly these women who were not only protected from stereotype threat, but actually performed *better* in the presence of a stereotype threat manipulation.

The second study in Chapter 2 tested the stereotype acquiescence hypothesis by experimentally manipulating information about gender differences and examining the effect on acquiescence and performance. It was found that women who were told that there were slight gender differences in performance performed worse than those in control and no-stereotype conditions. On the other hand, women who were informed of *considerable* gender differences were significantly more likely to acquiesce to the stereotyped superiority of men, but performed as well as those in the no-stereotype and control conditions, and significantly better than those in the mild stereotype condition. Thus, the second study provided evidence for the stereotype acquiescence hypothesis by demonstrating that when women were informed that men were considerably superior to women, they acquiesced to the female-mathematics stereotype, but were paradoxically protected from stereotype threat. Taken together, the first two studies of this thesis provide convergent evidence for the stereotype acquiescence hypothesis. In both studies, the conditions that led women to acquiesce, either as a result of an individual difference (Study 1) or a situational manipulation (Study 2), were also protected them from the effect of stereotype threat on performance.

The study presented in Chapter 3 provides evidence that stereotype threat can lead not only to poorer performance, but also reduced motivation to improve in the relevant domain, particularly following negative feedback. Specifically, women exposed to stereotype threat performed worse on a mathematics test than men, and than women not exposed to stereotype threat. Furthermore, following the receipt of negative feedback, women in the stereotype threat condition reported significantly less interest in attending remedial mathematical tutorials. This study also found that whereas men's self-esteem was lower if they received negative rather than positive feedback, women's self-esteem was not affected by feedback valence, regardless of stereotype condition. This suggests that women in general are chronically less identified with mathematics than men (Crocker, Major, & Steele, 1998; Steele, 1997). However, it also raises the

question of why the stereotype threat manipulation did lead to lower levels of motivation among women following negative feedback, given that this finding cannot be accounted for by stereotyped women being less motivated because their self-esteem was disengaged from mathematical outcomes. As discussed in Chapter 3, it is possible that the stereotype threat manipulation made women want to avoid the domain of mathematics (Steele, 1997), or reduced their belief in their capacity to improve their performance. Although further research is needed to explore the mechanisms through which stereotype threat can lead to reduced motivation, the study reported in Chapter 3 suggests that such reductions in motivation are particularly likely when an individual has received feedback that their performance conformed to their group's stereotype inferiority.

In sum, the papers presented in this thesis demonstrate the capacity for stereotype threat to interfere with both the performance and motivation of their targets. The studies in Chapter 2 found that women low in self-perceived ability, and those who were exposed to information that men are considerably mathematically superior to women, were more likely to acquiesce to the female-mathematics stereotype, but less vulnerable to stereotype threat. While these studies are consistent with an assertion that those who are motivated to disconfirm the female-mathematics stereotype are particularly vulnerable to stereotype threat performance effects, the study presented in Chapter 3 found that stereotype threat can itself lead to reductions in motivation, particularly in the presence of negative feedback.

Theoretical Implications

As stated in the introduction to this thesis, a central theoretical assertion of STT is that the effects of stereotype threat on performance are not the result of simply internalizing the relevant stereotype (Steele, 1997; Steele & Aronson, 1995). Further, Steele and his colleagues (2002) suggested that the more someone has internalized a self-relevant stereotype, the *less* vulnerable they may be to the effects of stereotype threat. The first two studies of the present thesis provide

evidence that is highly consistent with this assertion. Women with low levels of confidence in their own mathematical ability, and those exposed to information that men are considerably mathematically superior, were particularly likely to accept the mathematical superiority of men. However, they were also buffered from the effects of stereotype threat on performance. Conversely, women high in self-perceived mathematical ability, and those who were informed that there were only slight gender differences in performance, were less likely to expect significant gender differences, but particularly vulnerable to stereotype threat. If stereotype targets performed worse simply because they internalized their group's inferiority, this could not account for why women in the present research performed better in circumstances in which they accepted the mathematical inferiority of women.

STT instead asserts that stereotype threat interferes with performance by inducing a motivational pressure to disconfirm the relevant stereotype (Steele, 1997; Steele & Aronson, 1995; Steele et al., 2002). If the pressure to disconfirm one's stereotyped inferiority is central to stereotype threat, it would be expected that when stereotype targets were more likely to aspire to perform as well as the out-group, they would be particularly vulnerable to performance decrements. This was consistent with the findings presented in Chapter 2. Women high in self-perceived ability and those informed of slight gender differences, were not only less likely to accept the mathematical superiority of men, but were also more likely to aspire to a level of performance equivalent to that of men. However, they were more susceptible to stereotype threat than women who acquiesced to the stereotype. Although these findings do not, in and of themselves, provide definitive evidence that a motivational pressure directly interfered with performance, they support the assertion that when individuals are motivated to disconfirm their stereotyped inferiority, they are particularly vulnerable to stereotype threat (Steele, 1997; Steele & Aronson, 1995). By demonstrating across two experiments that women who were more likely to aspire to disconfirm their stereotyped inferiority were also more vulnerable to stereotype

threat, these results provide a complement to research which suggests that stereotype threat interferes with performance by inducing an increased motivational pressure (Jamieson & Harkins, 2007, 2009; Johns, Inzlicht, & Schmader, 2008; Schmader & Johns, 2003). Further, these results are convergent with evidence that stereotype threat can be ameliorated by removing a burden of proof (Brown, R. P., & Josephs, 1999).

Although there is evidence that stereotype threat can lead to increased motivational pressure, STT also suggests that this pressure can ultimately lead to reduced identification, persistence and motivation in the relevant performance domain (Steele, 1997). This assertion is another key theoretical pillar of STT, but has been relatively neglected in the literature. By demonstrating the effect of stereotype threat on intentions to improve mathematical ability, the present thesis contributes to the small but growing literature on the effects of stereotype threat on interest and motivation in the relevant performance domain (Davies, Spencer, Quinn, & Gerhardstein, 2002; Davies, Spencer, & Steele, 2005; Gupta & Bhawe, 2007). Furthermore, the present research contributes to this literature by suggesting that the effects of stereotype threat on motivation might be particularly profound among women who receive personal performance feedback that is consistent with their group's stereotyped inferiority. Such feedback potentially reduces women's belief that they can disconfirm their stereotyped inferiority and reduces their motivation to improve in the relevant domain. This is consistent with the assertion that pressures towards disidentification with a domain are greater when individuals experience frustrations and setbacks (Crocker et al., 1998).

The present thesis also highlights the theoretical significance of social identity theory (Tajfel & Turner, 1979; Turner, 1975) to the phenomenon of stereotype threat. Social identity theory's relevance to stereotype threat has been identified by a number of STT researchers (Gresky, Ten Eyck, Lord, & McIntyre, 2005; Logel et al., 2009; Rosenthal & Crisp, 2006; Rydell & Boucher, 2010; Rydell, McConnell, & Beilock, 2009; Wout, Danso, Jackson, & Spencer,

2008). The current thesis extends these theoretical connections by drawing upon the principles of social identity theory to predict the circumstances under which stereotype threat is most likely to occur. Specifically, Tajfel and Turner suggested that if members of low status groups acquiesce to the superiority of the out-group, they should be less motivated to engage in inter-group conflict and competition (see also, Haslam, Salvatore, Kessler, & Reichler, 2008). In the context of intellectual performance, such acquiescence will potentially reduce the motivational pressure of stereotype targets and buffer them from the effect of stereotype threat on performance, which is consistent with the results presented in the first chapter of this thesis. According to social identity theory, if individuals do accept their group's stereotyped inferiority, they will engage in other strategies to maintain positive social identity (e.g. Tajfel & Turner, 1979). This suggests an exciting avenue for further research, to determine whether individuals who acquiesce to a self-relevant stereotype are more likely to engage in other social identity strategies, such as reducing their identification with their social group and instead identifying with another group, or devaluing the relevant performance domain.

Practical and Applied Implications

The results of the present thesis highlight the potentially pervasive effects of stereotype threat on women's outcomes in math-related fields. The effect of stereotype threat on women's mathematical performance was replicated across the three experiments in this thesis, and it was also found that stereotype threat led to lower motivation among women who received negative feedback. By demonstrating the effect of stereotype threat on both performance and motivation, these results not only support the theoretical tenets of STT (e.g. Steele, 1997; Steele et al., 2002), but also suggest that the female-mathematics stereotype can lead to gender differences in math-related fields through a range of means. Specifically, stereotype threat can potentially lead to poorer outcomes for women by directly interfering with performance, and also indirectly, by reducing the likelihood that women will take measures to improve their mathematical ability. The

capacity for stereotype threat to reduce motivation is of particular importance given the finding that women continue to be underrepresented in math-intensive fields and that their intentions and choices appear to play a significant part in this difference (Ceci & Williams, 2010; Ceci, Williams, & Barnett, 2009).

Further, this research highlights some of the circumstances under which individuals are particularly vulnerable to the effects of stereotype threat on performance, offering suggestions as to where, when and for whom interventions to alleviate stereotype threat are most needed. In the first study in Chapter 2, women were more likely to experience stereotype-related performance decrements if they believed that they were mathematically proficient. This finding is in line with Steele's (1997) 'vanguard hypothesis', which states that it is stereotype targets with the skills and self-confidence to succeed who will be the most vulnerable to stereotype threat. The vulnerability of such women to stereotype threat suggests that interventions are particularly important for mathematically proficient women, such as those enrolled in mathematics courses at selective tertiary institutions, and those at high levels of mathematical careers. Although these women might appear to be those least in need of remediation, the results of this thesis suggest that their performance is potentially the most affected by stereotype threat.

Interestingly, the results of the second study of Chapter 2 also suggest that stereotype targets might be particularly vulnerable to stereotype threat when the difference between their own group and an out-group is perceived as small and contestable. This is particularly pertinent in the case of mathematical ability, in which gender differences appear to be small, (e.g. Hyde, 2005; Hyde, Fennema, & Lamon, 1990; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Lindberg, Hyde, Petersen, & Linn, 2010). Although the relative parity in the mathematical outcomes of men and women is encouraging, and perhaps at first glance suggests that stereotype threat may not generally interfere with women's performance in real-world settings, gender differences favoring men do emerge on complex tasks and at higher levels of performance (e.g.

Ceci et al., 2009; Hyde et al., 2008; Lindberg et al., 2010). In an intriguing parallel, stereotype threat has been shown to interfere with task performance primarily on difficult tasks (e.g. Spencer, Steele, & Quinn, 1999) and among women who at least perceive themselves as mathematically proficient (e.g. Chapter 2, Study 1 of the present thesis). Thus, when mathematically proficient women perform difficult tasks, it is possible that the very ambiguity regarding the female-mathematics stereotype, and its self-relevance, interferes with their performance and contributes to poorer outcomes for women in high-level mathematical careers. This highlights the need for interventions that ameliorate the effects of stereotype threat on women's mathematical performance, even though the overall extent of gender differences in mathematics is small (e.g. Hyde et al., 2008).

The results of the present thesis also support the assertion that targets of stereotype threat are unlikely to improve simply by exerting more effort to disprove the relevant stereotype (Roberson & Kulik, 2008; Steele, 2010). Indeed, in the first two studies of this thesis, women high in self-perceived ability and those informed of minor gender differences generally did aspire to perform as well as men, but were particularly vulnerable to stereotype threat. This is consistent with Steele and Aronson's (1995) assertion that stereotype threat may produce a motivational pressure that leads to increased effort but reduced efficiency on complex cognitive tasks (see also, Jamieson & Harkins, 2007, 2009). Instead, the results of this thesis suggest that interventions that aim to remove a motivational pressure might be particularly effective in ameliorating stereotype threat. Consistent with such an assertion, interventions designed to remove such a pressure by framing a test as non-diagnostic of an innate ability (Dar-Nimrod & Heine, 2006; Steele & Aronson, 1995; Thoman, White, Yamawaki, & Koishi, 2008), or as measuring a non-stereotyped ability (Huguet & Regner, 2007; Schmader & Johns, 2003), or by providing a re-attribution for feelings of arousal (Ben-Zeev, Fein, & Inzlicht, 2005; Johns,

Inzlicht, & Schmader, 2008), have reduced or removed the effects of stereotype threat on performance.

The results presented in Chapter 3 also highlight the need for interventions that help sustain women's interest and motivation in stereotype-relevant careers. The capacity of stereotype threat to interfere with motivation has been identified by STT researchers (e.g. Crocker et al., 1998; Davies et al., 2002, 2005; Murphy, Steele, & Gross, 2007 Steele, 1997; Steele et al., 2002). These studies have also identified possible remedies to these effects. For example, Davies and colleagues (2002) found that women's interest in mathematical careers was higher if they were exposed to gender-neutral commercials than if exposed to gender-stereotypic commercials. Further, Murphy and colleagues (2007) found that when women observed videotapes of a discussion that ostensibly took place at a mathematics and science conference; those who observed discussions with equal numbers of each gender reported a greater likelihood of attending future versions of the conference than did those who observed discussions with a majority of males. These findings demonstrate that the effects of stereotype threat can be reduced in the context of 'identity-safe' environments (Davies et al., 2002), in which cues to the relevant stereotype are minimized. The results of this thesis suggest that identity-safe environments are particularly important for the motivation of stereotype targets who have received negative feedback in the relevant domain.

Strengths of Research

A key strength of this research is that it provides unique support for the assertion that the effects of stereotype threat on performance are not the result of an internalization of a self-relevant stereotype, and are particularly likely among those who do not accept, and are motivated to disconfirm, their stereotyped inferiority (Steele, 1997; Steele et al., 2002). In particular, the findings of the second study in Chapter 2 are the first to demonstrate that when stereotype targets are informed that their group is considerably inferior to an out-group, they are more likely to

acquiesce to their group's stereotyped inferiority than when told that the difference between groups is small, but are paradoxically protected from stereotype threat performance effects. This finding, while counter-intuitive, supports the assertion of STT that it is the pressure to *disconfirm* the relevant stereotype, rather than an internalization of the stereotype, which interferes with performance (Steele, 1997). As stated earlier, these results also provide a complement to a growing body of research that stereotype threat interferes with the performance of its targets by inducing a motivational pressure (e.g. Jamieson & Harkins, 2007, 2009; Schmader & Johns, 2003). Further research is required to delineate the circumstances under which stereotype threat is mediated either by merely increased effort (Jamieson & Harkins, 2007, 2009), or decreased working memory (Schmader & Johns, 2003). However, the results of the present study are consistent with both of these accounts in suggesting that stereotype threat will have its greatest effects when there is a motivational pressure to disconfirm the relevant stereotype.

Another strength of this thesis, and specifically the study presented in Chapter 3, is that it adds to a relatively small body of research on the effect of stereotype threat on motivation. This study also makes two unique contributions to this research. First, it suggests that a combination of stereotype threat and negative feedback can be particularly pernicious in its effects on women's motivation. Second, it demonstrates the capacity for stereotype threat to affect the intentions to engage in a specific behavior in the short term. Such intentions are particularly predictive of actual behavior (e.g. Azjen, 2005; Fishbein & Azjen, 2010), suggesting the potential real-world implications of this study's findings. To further illustrate this point, it is worth considering the implications for the academic performance of women who participated in this study, had they not been adequately debriefed at the end of the experimental session. Given that they rated themselves as significantly less likely to attend mathematics tutorials, it is entirely feasible that this would have impacted upon their actual likelihood of attendance. In turn, this

could have had profound implications for the grades of women exposed to stereotype threat in this experiment.

This thesis also demonstrates the multiple effects of stereotype threat on their targets, something which has been called for by Major and O'Brien (2005) in terms of stigma in general, and Shapiro and Neuberg (2007) and Smith (2004), specifically in the context of stereotype threat. By demonstrating that the same stereotype can affect performance and motivation, this thesis demonstrates the potentially pervasive sequelae of stereotype threat on the outcomes of its targets.

Finally, although a number of stereotype threat studies have been conducted in an Australian context (e.g. Henry, von Hippel, C., & Shapiro, 2010; von Hippel, C., Issa, Ma, & Stokes, 2011; von Hippel, C., Wiryakusuma, Bowden, & Shochet, 2011; Yeung & von Hippel, C., 2008), the studies in the present thesis are the first of which the authors are aware, that have been conducted specifically on the effects of stereotype threat on Australian women's mathematical performance and motivation. Thus, this thesis helps to further demonstrate the generalizability of stereotype threat, not only across a range of stereotyped groups and to a number of performance domains, but also across a variety of cultural contexts.

Limitations and Future Research

Although this thesis has presented some important and unique findings, it is not without its limitations. Each of the experiments employed a blatant manipulation of stereotype threat, in which participants were provided with explicit information regarding gender differences. Of course, such manipulations are not without precedent in the STT literature. For example, previous STT studies have informed participants that group differences exist, without specifying which group is better (O'Brien & Crandall, 2003; Spencer et al., 1999), while others have explicitly informed participants that a particular group is superior to the other (Keller, 2002; Smith & Johnson, 2006; Smith & White, 2002; Yeung & von Hippel, C., 2008). Further, Cadinu and

colleagues (2003) told participants the average score that men and women obtained, as was the case in the present research. However, the use of blatant manipulations in each of the studies of this does limit the generalizability of its findings, particularly given evidence that subtle and blatant manipulations of stereotype threat might affect their targets in different ways (Stone & McWhinnie, 2008). Thus, it is important to replicate the findings of this thesis in experimental designs that do not use explicit manipulations of threat.

It is also worth noting that the same stereotype threat manipulation was used in the first study in Chapter 2 and the study presented in Chapter 3, but a main effect of stereotype threat condition emerged only in the latter experiment. A possible explanation for this difference comes from the inclusion of only women in the first study, but both men and women in the study in Chapter 3. In the first study, it was found that women were only vulnerable to the stereotype threat manipulation if they were high in self-perceived ability. The lack of male participants may have allowed women low in self-perceived ability to ignore men as a relevant comparative group (whereas those high in self-perceived ability aspired to disconfirm the stereotype). However, in the experiment presented in Chapter 3, the presence of men potentially made the comparison between genders salient for *all* women, thus producing a main effect of stereotype condition. Such an assertion is supported by evidence that stereotype targets perform worse in the presence of out-group members (Inzlicht & Ben-Zeev, 2000; Sekaquaptewa & Thompson, 2003). Interestingly, this suggests that across these two studies, the physical presence of men (Study 1) and a level of mathematical confidence that led women to aspire to perform as well as men (Study 2), were each sufficient in their own right to lead to stereotype threat.

Another limitation of the present research is that although it was found that women who were more likely to acquiesce to the female-mathematics stereotype were also buffered from stereotype threat in both studies of Chapter 2, the design of these studies precludes the ability to directly test whether stereotype acquiescence moderated the effect of stereotype threat on

performance. This is because participants' expectancies for each gender, and their aspirations for their own performance, were measured after the stereotype manipulation in each study. Such a design allowed a test of the circumstances in which women were more likely to acquiesce to the female-mathematics stereotype, which was one of the key aims of the present research. However, because these measures followed the stereotype threat manipulations in each study and were themselves influenced by stereotype condition, this ruled out their use as valid moderators of the effect of stereotype condition on performance.

Future research could address this limitation by measuring women's acceptance of the female-mathematics stereotype and motivation to disconfirm the stereotype, prior to allocation to experimental condition. Although Schmader, Johns and Barquissau (2004) conducted such an experiment and found that women who endorsed the stereotype were more vulnerable to stereotype threat, women in the study who were classified as 'high' in stereotype endorsement in fact only provided moderate levels of endorsement of the possibility that the stereotype is true, as discussed in Chapter 2. Thus, future research could explore whether women who have genuinely high levels of belief in the female-mathematics stereotype are less vulnerable to stereotype threat. Further, it would be worth exploring whether women who, prior to experimental allocation, do not aspire to disconfirm the female-mathematics stereotype, are less vulnerable to stereotype threat manipulations. Such research would allow a clear delineation of whether an acceptance of the mathematical superiority of men, or a failure to aspire to perform as well as the out-group, are necessary or sufficient to protect women from stereotype threat. It would also provide a valuable complement to the present research, which identified conditions that led women to acquiesce to the female-mathematics stereotype, and found that the same conditions also buffered the effect of stereotype threat on performance.

Moreover, an important next step of research into the acquiescence hypothesis would be to identify the mechanisms through which stereotype acquiescence protects targets of negative

stereotypes from threat-related performance decrements. Recent mediational evidence is consistent with the idea that acquiescent individuals should be protected from stereotype threat. For example, individuals who acquiesce to the relevant stereotype should be less concerned about performing as well as men and consequently exert less effort. As demonstrated by Jamieson and Harkins (2007, 2009), this might paradoxically protect their performance on complex cognitive tasks. Furthermore, Schmader and colleagues' (2008) integrated process model suggests that uncertainty about the veracity of the stereotype, as well as a tendency to suppress thoughts related to the stereotype, are two of the processes through which stereotype threat interferes with performance. Individuals who simply accept the veracity of the relevant stereotype should be relatively free from each of these effects. Thus, there are a number of theorized mechanisms of stereotype threat that could potentially lead individuals who acquiesce to the relevant stereotype to be protected from performance decrements.

Finally, it is important for future research to examine both the moderators and mediators of the effect of stereotype threat on *motivation* following negative performance feedback. It is possible, for example, that women who acquiesce to the mathematical superiority of men might be protected from the effect of stereotype threat on performance, but also less motivated to improve their ability in instances when they do receive negative feedback. Moreover, as discussed earlier, there are a range of potential mechanisms through which stereotype threat interferes with motivation, including a desire to avoid the relevant domain (Steele, 1997) and a decreased belief in the capacity to improve. Identifying the mechanisms through which stereotype threat reduces women's motivation will help in the development of interventions that sustain the motivation of women who have received negative feedback in stereotype-relevant domains.

Summary and Conclusions

Although gender differences in mathematical performance are small and appear to have diminished over the past few decades, some differences, favoring men, do emerge at higher levels of performance. Furthermore, women continue to be underrepresented in mathematical careers. The present thesis found that stereotype threat potentially contributes to these differences by impairing women's mathematical performance and reducing their motivation to improve. Moreover, this research made some important findings regarding the circumstances under which women are particularly vulnerable to the effect of stereotype threat on performance and motivation. Specifically, when women had positive perceptions of their own ability and were led to believe that the gender differences were minimal, they did not accept the female-mathematics stereotype, but were particularly vulnerable to the effect of stereotype threat on performance. Further, stereotype threat had its greatest effect on the motivation of women who had received negative feedback. By identifying the various factors that influence when stereotype threat is most likely to affect performance and motivation, this research contributes to the extant stereotype threat literature. In turn, this research can help tailor interventions to reduce the varied and pernicious effects of stereotype threat, and further redress the imbalance between genders in outcomes in mathematical and scientific fields.

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Appendices

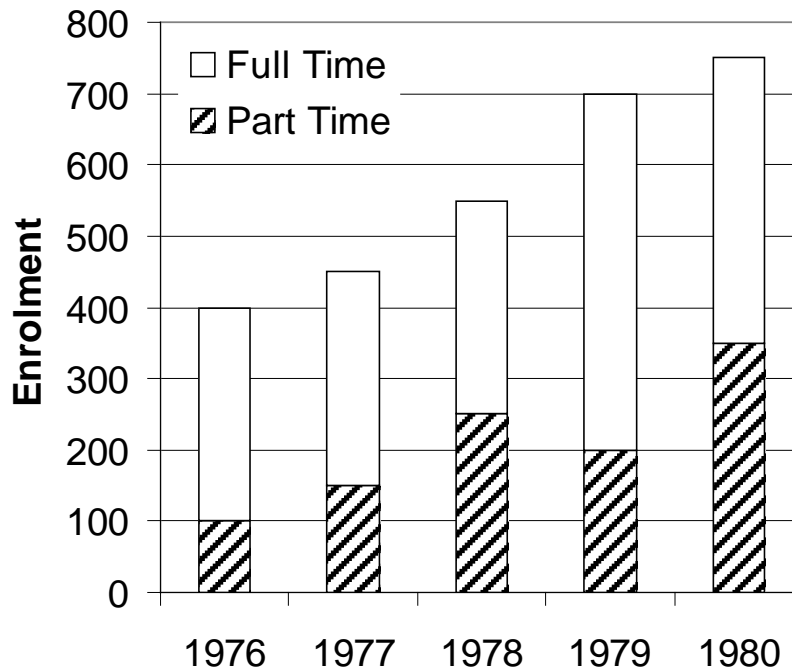
Appendix A

Examples of Mathematics Test Items

Note: The following items were used in the test described in Chapter 2, Study 1. The tests used in the other studies were comprised of primarily the same items, with some slight variations.

Test Question

Total Student Enrolment at University R

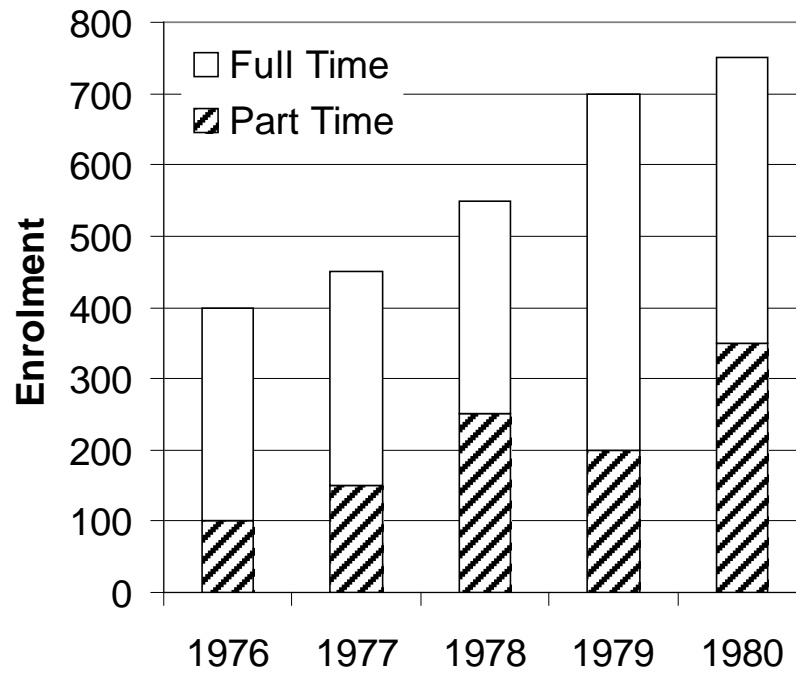


In which year was the *total* student enrolment the highest?

- a: 1976
- b: 1977
- c: 1978
- d: 1979
- e: 1980

Question 1

Total Student Enrolment at University R

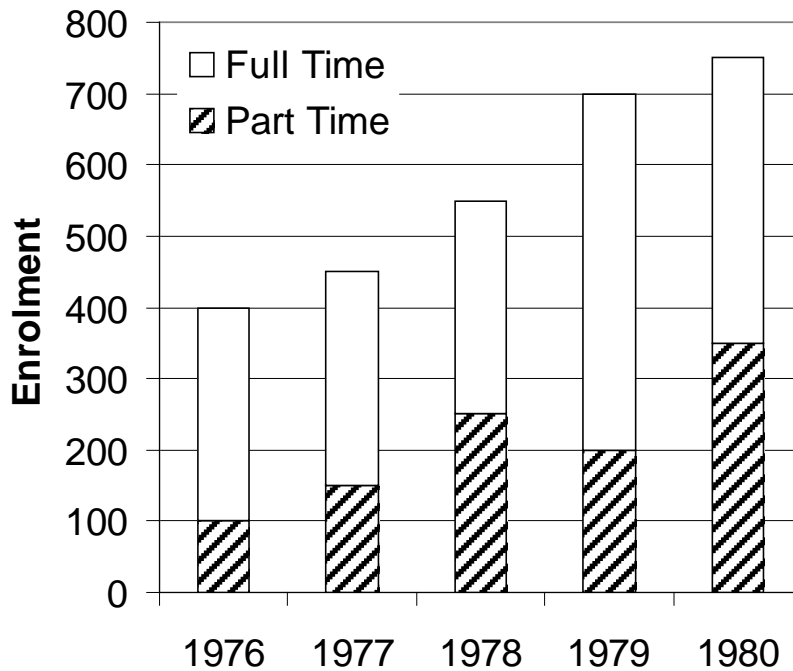


What was the total number of students enrolled at University R in 1979?

- a: 200
- b: 250
- c: 500
- d: 650
- e: 700

Question 2

Total Student Enrolment at University R

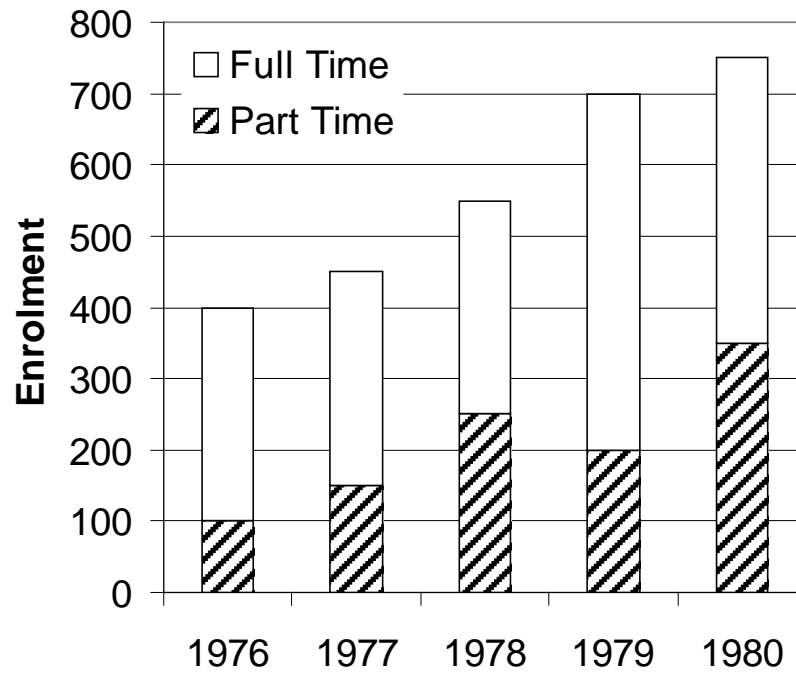


By what percent did the number of part-time students increase from 1979 to 1980?

- a: 7%
- b: 42%
- c: $66\frac{2}{3}\%$
- d: 75%
- e: 80%

Question 3

Total Student Enrolment at University R

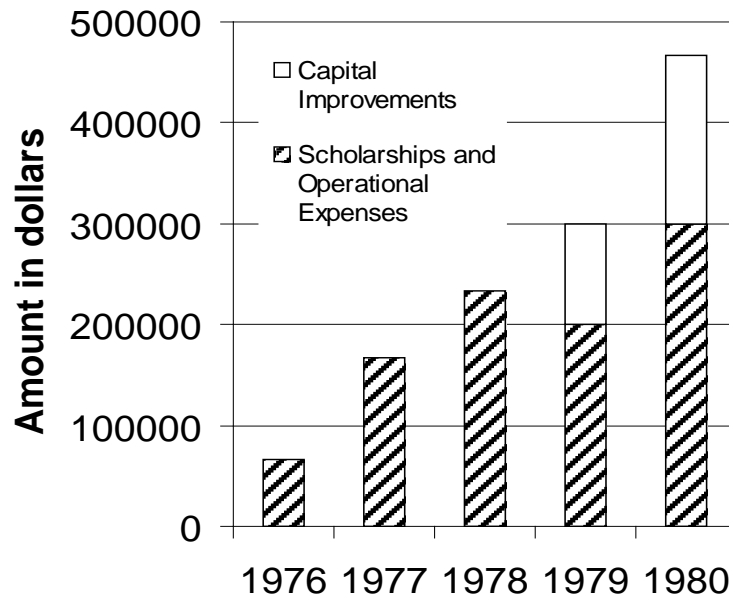


What was the increase, if any, in the number of full-time students enrolled at University R from 1976 to 1977?

- a: 0
- b: 50
- c: 100
- d: 150
- e: 200

Question 4

Allocation of all Contributions at University R

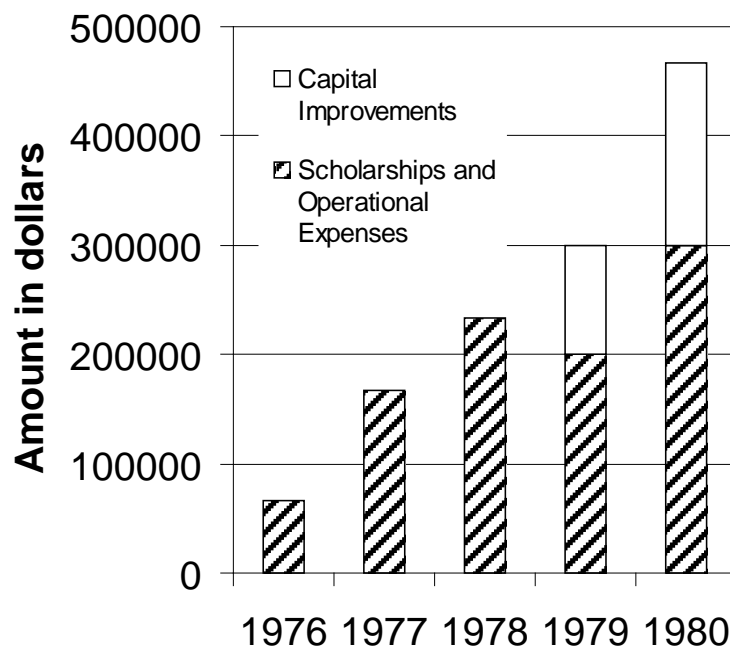


By 1978, if 12% of the amount of contributions allocated to scholarships and operational expenses was allocated to heating costs, approximately how much was NOT allocated to heating costs?

- a: \$2,000
- b: \$25,000
- c: \$176,000
- d: \$205,000
- e: \$250,000

Question 5

Allocation of all Contributions at University R



Approximately what was the total amount of contributions to University R from 1978 through 1980 inclusive?

- a: \$967,000
- b: \$1,000,000
- c: \$9,000,000
- d: \$9,667,000
- e: \$10,000,000

Question 6

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Column A

Column B

$$(40\% \text{ of } 50) + 60$$

$$(60\% \text{ of } 50) + 40$$

Question 7

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Column A

Column B

$\frac{1}{12}$ of 17

$\frac{1}{17}$ of 12

Question 8

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.

$$x + y = -1$$

Column A

Column B

x

y

Question 9

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Column A

Column B

23(784)

24(783)

Question 10

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.

$$0 < r < t$$

Column A

$$\frac{r}{t}$$

Column B

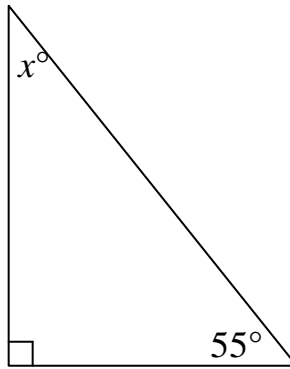
$$\frac{t}{r}$$

Question 11

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.



Column A

x

Column B

35

Question 12

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.

For each home in town x , the amount of property tax is p percent of the value of the home. The property tax on a home whose value is \$45,000 is \$1,200.

Column A

Column B

The property tax on
a home in Town x
whose value is \$54,000

\$1,300

Question 13

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.

The area of square region S is 36.

Column A

Column B

The perimeter of S

24

Question 14

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.

A printer numbered consecutively the pages of a book, beginning with 1 on the first page. In numbering the pages, he printed a total of 189 digits.

Column A

Column B

The number of
pages in the book

100

Question 15

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.

The average (arithmetic mean) of x , y , and 6 is 3.

Column A

Column B

$$\frac{x + y}{2}$$

$$\frac{3}{2}$$

Question 16

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.

Triangular regions T_1 and T_2 have equal areas and have heights h_1 and h_2 , respectively.

Column A

Column B

The area of T_1

The area of T_2

h_1

h_2

Question 17

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Column A

$$\frac{3 \times 3 \times 3}{6 \times 6 \times 6}$$

Column B

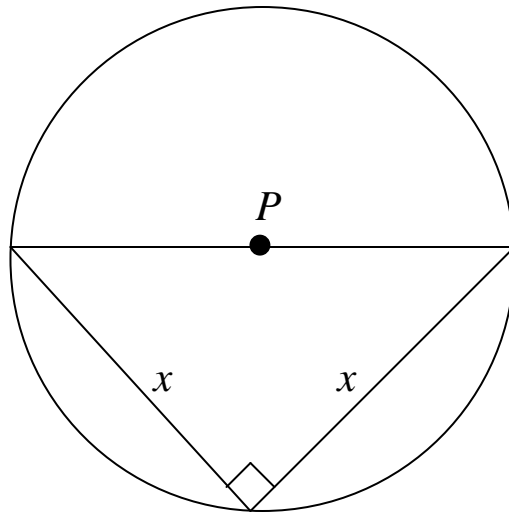
$$\left(\frac{1}{2}\right)^3$$

Question 18

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.



The area of the circular region with centre P is 16π

Column A

x

Column B

4

Question 19

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.

m , p , and x are positive integers and $mp = x$

Column A

Column B

m

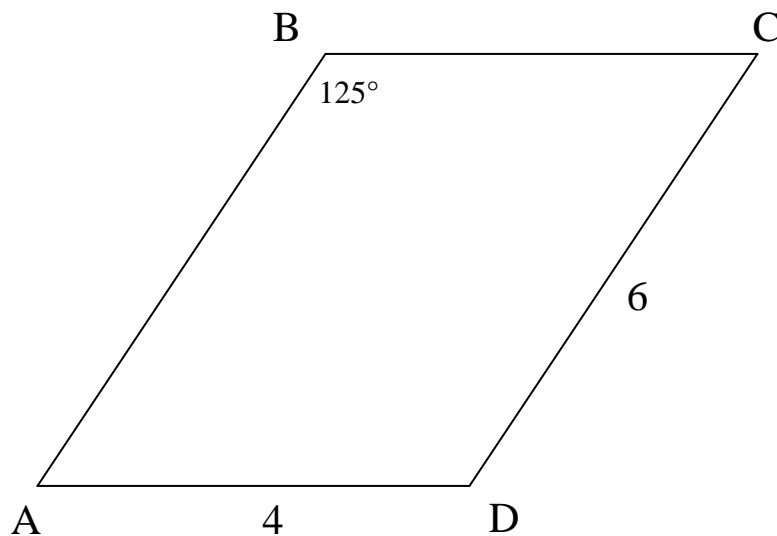
x

Question 20

This question consists of two quantities, one in Column A and one in Column B. You are to compare the two quantities and use the mouse to click on one of the letters a, b, c or d on the screen to indicate your answer:

- a if the quantity in Column A is greater;*
- b if the quantity in Column B is greater;*
- c if the two quantities are equal;*
- d if the relationship cannot be determined from the information given*

Please note: Information concerning both quantities to be compared is centred above the two columns.



ABCD is a parallelogram

Column A

The area of region ABCD

Column B

24

Question 21

When walking, a certain person takes 16 complete steps in 10 seconds. At this rate, how many complete steps does the person take in 72 seconds?

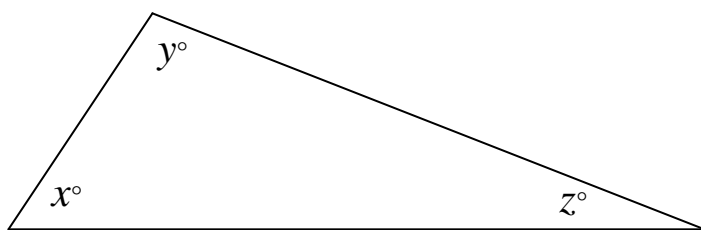
To indicate your response, use the mouse to click on the letter corresponding to your answer

- a: 45
- b: 78
- c: 86
- d: 99
- e: 115

Question 22

In the figure below, what is the value of $x + y + z$?

45



To indicate your response, use the mouse to click on the letter corresponding to your answer

a: 2

b: 3

c: 4

d: 5

e: 6

Question 23

$$52.68 \times \frac{1}{100} =$$

To indicate your response, use the mouse to click on the letter corresponding to your answer

a: 0.05268

b: 0.5268

c: 5.268

d: 526.8

e: 52,680

Question 24

If $b - c = 3$, and $a + c = 32$, then $a + b =$

To indicate your response, use the mouse to click on the letter corresponding to your answer

a: 30

b: 35

c: 40

d: 42

e: 50

Question 25

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

To indicate your response, use the mouse to click on the letter corresponding to your answer

a: abc

b: $a + b + c$

c: $a + bc$

d: $a(b + c)$

e: $(a + b)(b + c)$

Question 26

If $x \neq 0$, then $\frac{x(x^2)^3}{x^2} =$

To indicate your response, use the mouse to click on the letter corresponding to your answer

a: x^2

b: x^3

c: x^4

d: x^5

e: x^6

Question 27

Seven is equal to how many thirds of seven?

To indicate your response, use the mouse to click on the letter corresponding to your answer

a: $\frac{1}{3}$

b: 1

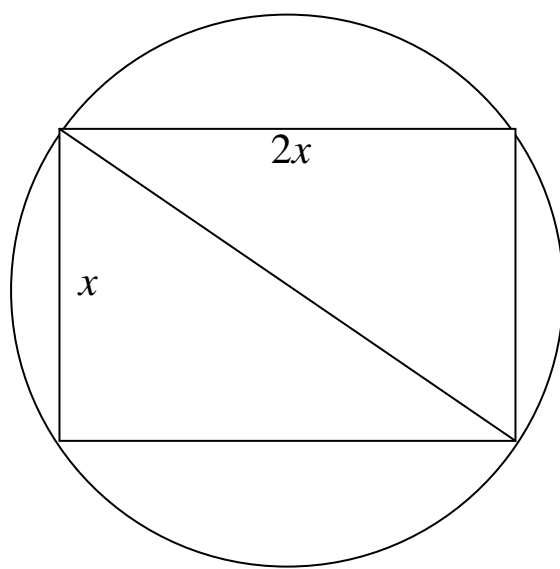
c: 3

d: 7

e: 21

Question 28

In the figure below, if the area of the inscribed rectangular region is 32, then the circumference of the circle is:



To indicate your response, use the mouse to click on the letter corresponding to your answer

a: 20π

b: $4\pi\sqrt{5}$

c: $4\pi\sqrt{3}$

d: $2\pi\sqrt{5}$

e: $2\pi\sqrt{3}$

Question 29

Which of the following equals the reciprocal of $x - \frac{1}{y}$,

where $x - \frac{1}{y} \neq 0$

To indicate your response, use the mouse to click on the letter corresponding to your answer

a: $\frac{1}{x} - y$

b: $-\frac{y}{x}$

c: $\frac{y}{x - 1}$

d: $\frac{x}{xy - 1}$

e: $\frac{y}{xy - 1}$

Question 30

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

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

To indicate your response, use the mouse to click on the letter corresponding to your answer

- a: III only
- b: I and II only
- c: I and III only
- d: II and III only
- e: I, II, and III

Appendix B

Items from Measures Used in Chapter 2 (Studies 1 and 2)

NB: Measures in *italics* were not retained for the final manuscript.

1. Pre-experimental questionnaire used in Study 1

1. Demographic questions

a) Age: _____

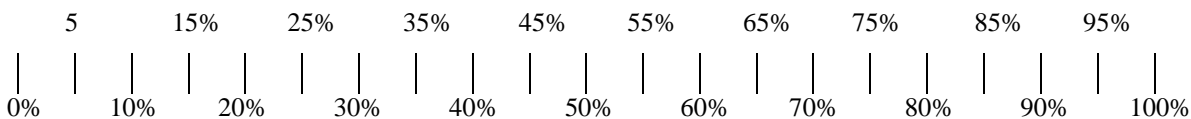
b) Ethnicity: _____

c) Gender: _____

2. Self-perceived mathematical ability

On the scale below, please indicate how you rate your own mathematical **ability**, relative to other University students. For example, if you think that you are better at mathematics than all other University students, you would circle the point corresponding to 100%. If you think that you are not better at mathematics than any other University students, you would circle the point corresponding to 0%. If you think that you are better at mathematics than 50% of other University students, you would circle the point corresponding to 50%.

“I AM better at mathematics than ____% of other students”



3. Mathematical attitudes

The following is Aiken's (1974) Revised Mathematical Attitudes Scale.

Please indicate your level of agreement with the following statements:

a) *I enjoy going beyond the assigned work and trying to solve new problems in mathematics*

Completely disagree Completely agree
1 2 3 4 5 6 7

b) *Mathematics is enjoyable and stimulating to me*

Completely disagree Completely agree
1 2 3 4 5 6 7

c) *Mathematics makes me feel uneasy and confused*

Completely disagree Completely agree
1 2 3 4 5 6 7

d) *I am interested and willing to use mathematics outside University*

Completely disagree Completely agree
1 2 3 4 5 6 7

e) *I have never liked mathematics, and it is my most dreaded subject*

Completely disagree Completely agree
1 2 3 4 5 6 7

f) *I have always enjoyed studying mathematics in school and University*

Completely disagree Completely agree
1 2 3 4 5 6 7

g) *I would like to develop my mathematical skills and study this subject more*

Completely disagree Completely agree
1 2 3 4 5 6 7

h) Mathematics makes me feel uncomfortable and nervous

Completely disagree *Completely agree*

1 2 3 4 5 6 7

i) *I am interested and willing to acquire further knowledge in mathematics*

Completely disagree *Completely agree*

1 2 3 4 5 6 7

j) *Mathematics is dull and boring because it leaves no room for personal opinion*

Completely disagree *Completely agree*

1 2 3 4 5 6 7

k) *Mathematics is very interesting, and I have usually enjoyed courses in this subject*

Completely disagree *Completely agree*

1 2 3 4 5 6 7

1) *Mathematics has contributed greatly to science and other fields of knowledge*

Completely disagree *Completely agree*

1 2 3 4 5 6 7

m) *Mathematics is less important to people than art or literature*

Completely disagree *Completely agree*

1 2 3 4 5 6 7

n) *Mathematics is not important for the advance of civilization and society*

Completely disagree *Completely agree*

1 2 3 4 5 6 7

o) Mathematics is a very worthwhile and necessary subject

Completely disagree *Completely agree*

1 2 3 4 5 6 7

p) An understanding of mathematics is needed by artists and writers as well as scientists

Completely disagree Completely agree
 1 2 3 4 5 6 7

q) Mathematics helps develop a person's mind and teaches them to think

Completely disagree Completely agree
 1 2 3 4 5 6 7

r) Mathematics is not important in everyday life

Completely disagree Completely agree
 1 2 3 4 5 6 7

s) Mathematics is needed in designing practically everything

Completely disagree Completely agree
 1 2 3 4 5 6 7

t) Mathematics is needed in order to keep the world running

Completely disagree Completely agree
 1 2 3 4 5 6 7

u) There is nothing creative about mathematics; it's just memorising formulas and things

Completely disagree Completely agree
 1 2 3 4 5 6 7

2. Expectancies items

As you may recall, the mean on this test is 100. The following questions ask you to predict your own scaled score and also the mean scaled score for various groups.

- a) *Self-expectancy: What scaled score do you expect to attain?*
- b) Expectancy for women: What scaled score do you expect the average woman to attain?
- c) Expectancy for men: What scaled score do you expect the average man to attain?

3. Aspirations scale

The following statements ask you to indicate the SCALED SCORE you would need to get to think or feel a certain way (e.g. to feel happy about your performance, or to think that you have done well).

- a) I would IDEALLY like to get a scaled score of _____
- b) I AIM to receive a scaled score of _____
- c) I OUGHT to be able to get a scaled score of _____
- d) I would need to get a scaled score of _____ to feel EXTREMELY PLEASED with my performance
- e) I would need to get a scaled score of _____ to feel QUITE PLEASED with my performance
- f) I will be SATISFIED if I receive a scaled score of _____
- g) I would need to get a scaled score of _____ to meet my own performance STANDARDS
- h) I would need to get a scaled score of _____ in order not to feel EMBARRASSED about my performance
- i) I would need to get a scaled score of _____ in order to feel I have a VERY GOOD abstract reasoning ability

4. Feedback validity scale used in Study 2

- a) My feedback on this test will provide a true reflection of my mathematical ability.
- b) This test is not likely to be a valid measure of my mathematical ability
- c) My performance today will be an accurate reflection of my mathematical ability
- d) This test will NOT provide a good indication of my mathematical ability

Appendix C

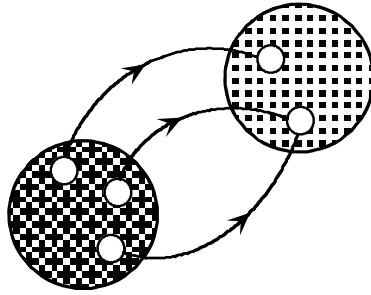
Items from Measures Used in Chapter 3

1. Rosenberg Self-esteem Inventory (Rosenberg, 1965)

NB: Words in bold represent additions to the original scale. Words in parentheses represent removal from the original scale.

- a) On the whole, I am satisfied with myself **right now**.
- b) **Right now**, I think I am no good at all
- c) **Right now**, I feel that I have a number of good qualities
- d) **Right now**, I am able to do things as well as most other people
- e) **Right now**, I feel I do not have much to be proud of
- f) **Right now**, I certainly feel useless (at times)
- g) **Right now**, I feel that I am a person of worth, at least on an equal plane with others
- h) **Right now**, I wish I could have more respect for myself
- i) **Right now**, all in all, I (am inclined to) feel that I am a failure
- j) **Right now**, I take a positive attitude toward myself

2. Numeracy Centre Advertisement



Numeracy Centre

***[BUILDING NUMBER
DELETED]***

[Telephone Number Deleted]

WHAT'S ON OFFER AT THE NUMERACY CENTRE ?

The Numeracy Centre, located in [Building Number Deleted], provides individual and small-group assistance to those students who need learning support in numeracy-related areas such as introductory mathematics and statistics units. If you are studying mathematics, computing, electronics, economics, statistics, psychology, physics, chemistry or biology and you find that you need extra help, particularly with the underlying mathematical concepts, the Numeracy Centre staff can help you. The Centre operates on a free drop-in basis from Monday to Friday during the semester. Timetables may be obtained from the Centre or the Centre website at www.maths.mq.edu.au/numeracy. The Numeracy Centre also runs a wide variety of workshops during the semester to either refresh prerequisite knowledge or as additional classes for those who would like some extra tuition in various subjects. These workshops are currently run for STAT170, MATH123, MATH130, MATH135, MATH136 and PSY222. The days and times of the workshops will be advertised in your lectures and on the notice board outside the centre.

Enquiries: [Names deleted] on [Telephone number deleted].

Some comments made by past students:

"Extremely satisfied with the Numeracy Centre. They provided me with invaluable assistance to adjust to the high demand of study after a very long break."

"Numeracy Centre is fantastic! Staff are very helpful"

"Thanks so much for your wonderful workshops – and all other help – we wouldn't have made it without you."

"With many thanks for your help in assisting us all to have the confidence to have a go and truly believe that we could, and can do it."

In addition to the services listed above the Numeracy Centre runs a range of bridging courses. Although all of our bridging courses are run in February and many are repeated in August a number of our courses can be run on demand for a small number of students. These include:

- REVIEW SESSION – BASIC MATHEMATICS
- REVIEW SESSION – BASIC MATHEMATICS FOR STATISTICS
- REVIEW SESSION – ALGEBRA SKILLS
- MATHS ASSERTIVENESS COURSE

3. Numeracy Centre Questionnaire Items

Please read the attached advertisement for the Numeracy Centre. When you have read the advertisement, and reviewed the timetable for individual sessions and workshops, please fill out the following questionnaire.

- a) How likely do you think it is that, this semester, you will sign up to one of the workshops offered by the Numeracy Centre?
- b) How likely is it that, this semester, you will attend one of the “drop-in” sessions offered by the Numeracy Centre?

Appendix D

Means and Standard Errors for Chapters 2 and 3¹

¹ Note: This section only includes means tables that are not included in the body of the thesis

Table 1. *Mean (Standard Error) Mathematics Test Score by Gender and Stereotype Condition in Chapter 2, Study 2.*

	Stereotype condition			
	Control condition	No stereotype	Mild stereotype	Extreme stereotype
Female	6.77 ^a (0.63)	7.00 ^a (0.61)	4.72 ^b (0.54)	7.49 ^a (0.73)
Male	8.51 (0.78)	8.55 (1.06)	9.05 (0.99)	8.90 (1.25)

Note. Within each gender, figures with different superscripts were significantly different at $p < .05$.

Table 2. *Mean (Standard Error) Mathematics Test Score by Gender and Stereotype Condition in Chapter 3.*

	Stereotype condition	
	No stereotype	Stereotype
Female	10.00 ^a (0.78)	7.43 ^b (0.73)
Male	10.94 (1.24)	12.07 (0.91)

Note. Within each gender, figures with different superscripts were significantly different at $p < .05$.

Table 3. *Mean (Standard Error) Self-esteem by Gender, Stereotype Condition and Feedback Valence in Chapter 3.*

Feedback valence	Female		Male	
	No stereotype	Stereotype	No stereotype	Stereotype
Positive	5.56 (0.19)	5.12 (0.25)	5.74 (0.34)	5.28 (0.27)
Negative	5.59 (0.24)	5.28 (0.27)	4.76 (0.29)	4.83 (0.31)