

Converging Evidence That Stereotype Threat Reduces Working Memory Capacity

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Although research has shown that priming negative stereotypes leads to lower performance among stigmatized individuals, little is understood about the cognitive mechanism that accounts for these effects. Three experiments tested the hypothesis that stereotype threat interferes with test performance because it reduces individuals' working memory capacity. Results show that priming self-relevant negative stereotypes reduces women's (Experiment 1) and Latinos' (Experiment 2) working memory capacity. The final study revealed that a reduction in working memory capacity mediates the effect of stereotype threat on women's math performance (Experiment 3). Implications for future research on stereotype threat and working memory are discussed.

One of our brightest and most motivated undergraduate research assistants was recently lamenting her upcoming date with the Graduate Record Examination (GRE). In describing her past struggles with these sorts of standardized tests, she stated that as soon as she sees the math problems, she becomes intensely fascinated by the physical details of her pencil or any other proximal stimulus, so long as it is not the actual math problem she is meant to solve. Although her experience could represent nothing more than active avoidance of an aversive stimulus, we wondered if it might also illustrate one of the ways that stereotype threat interferes with performance on complex tests of cognitive abilities. Cognitive psychology has identified working memory capacity as the ability to focus one's attention on a given task while keeping task-irrelevant thoughts at bay (Engle, 2001). Thus, one explanation for our research assistant's frustration with standardized math tests is that she experiences lower levels of working memory capacity in these testing situations, perhaps because gender stereotypes place an extra burden on her cognitive resources. In the research presented here, we set out to test the hypothesis that stereotype threat interferes with performance on complex cognitive tasks by reducing individuals' working memory capacity. In this article, we

integrate existing research on stereotype threat with what is known about working memory capacity. We then present the results of three experiments that examine whether manipulations of stereotype threat reduce working memory capacity.

Stereotype Threat and Performance

Stereotype threat refers to the phenomenon whereby individuals perform more poorly on a task when a relevant stereotype or stigmatized social identity is made salient in the performance situation. Steele and his colleagues (Steele, 1997; Steele & Aronson, 1995; Steele, Spencer, & Aronson, 2002) maintained that this reduced performance results from an added pressure or concern that a poor performance could be seen as confirming a negative social stereotype about their ingroup. Thus, in sharp contrast to socialization theories, inherent ability theories, or even educational resource theories for why men outperform women on math tests or why European Americans outperform African Americans on standardized tests, stereotype threat offers a uniquely situational explanation for these group-performance differences (see Steele, 1997, for review).

In support of the stereotype threat explanation, research shows that group-performance differences can be eliminated when the same test is given in a stereotype-free context (see Steele et al., 2002, for a review). For example, African Americans show increased stereotype activation and perform worse than their White peers when the task they are performing is described as diagnostic of intellectual ability (Steele & Aronson, 1995). However, when the same task is framed as unrelated to intelligence, levels of stereotype activation are much lower and African American students perform equally to White students. Similarly, women perform worse than men on a math test when they are told that the test has revealed gender differences in the past, but they perform equally to men when they are told that the test is "gender fair" (Spencer, Steele, & Quinn, 1999). The ease with which stereotype threat can be created in testing situations is demonstrated further by evidence that White men, a group that is not traditionally thought of as being negatively stereotyped as being poor at math, perform more poorly on a math test when they believe they will be compared with Asian men (Aronson et al., 1999).

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Taken together, these findings suggest that activating negative stereotypes about a social identity that one possesses can create an extra situational burden that interferes with the ability to perform as well at a mental task as might otherwise be possible. Although the body of research establishing the existence of these effects is ever expanding, the processes by which performance is reduced have remained elusive in most studies. The assertion that reduced performance results from an added pressure or concern (Steele, 1997; Steele & Aronson, 1995) has led many researchers to examine the role of several affective mechanisms, such as anxiety, evaluation apprehension, or physiological arousal, in producing stereotype threat. For example, several studies have demonstrated that stereotype threat conditions lead to higher levels of anxiety that parallel performance decrements on complex tasks (Aronson et al., 1999; Spencer et al., 1999; Stone, Lynch, Sjomeling, & Darley, 1999). In addition, Spencer et al. (1999) found evidence that self-reported anxiety partially mediated the effects of a stereotype threat manipulation on women's math performance. However, many other stereotype threat studies have reported no differences in self-reported anxiety between stereotype threat conditions (Gonzales, Blanton, & Williams, 2002; Schmader, 2002; Schmader & Johns, 2003; Steele & Aronson, 1995).

Although self-reported measures of anxiety show mixed results, there is some evidence to suggest that stereotype threat involves heightened levels of anxiety and arousal. For example, Blascovich, Spencer, Quinn, and Steele (2001) reported that African Americans show increases in blood pressure under conditions of stereotype threat, and in our previous research (Schmader & Johns, 2003), women who thought that their test performance would be used as an indicator of women's math ability, in general, felt that it was more important that they do well on the test. In addition, manipulations designed to reduce anxiety or arousal, such as engaging in self-affirmations or expressive writing (Martens, Johns, Greenberg, & Schimel, 2002), or providing a cue to misattribute arousal (Stone et al., 1999), seem to diffuse the effects of stereotype threat on performance.

The above findings provide converging evidence that stereotype threat involves affective experiences associated with increased anxiety and apprehension. However, these past studies also highlight the extent to which researchers interested in the underlying mechanism involved in stereotype threat have focused almost exclusively (with one notable exception, Quinn & Spencer, 2001, discussed below) on the affective side of the threat equation. In contrast, our goal in the present research was to examine how the fear of confirming a negative stereotype about a salient group identity disrupts cognitive processing. Because most stereotype threat studies involve evidence of reduced performance on a complex cognitive task, we were interested in understanding the nature of the cognitive disruption that stereotype threat causes. Specifically, we were interested in the effects of stereotype threat on working memory capacity.

Working Memory Capacity

The contemporary conceptualization of working memory capacity has its roots in theory and research on short-term memory, or the type of memory used to retain and manipulate information for immediate or near-immediate use. Baddeley and Hitch (1974) expanded earlier theory on short-term memory by proposing a

model of working memory that distinguished between three distinct but interactive cognitive functions: the phonological loop, the visuospatial sketchpad, and the central executive processor. The current concept of working memory capacity is an articulated version of the central executive processor (Engle, 2001), and refers to that type of memory that is used to focus attention on temporarily activated information of interest while inhibiting other information that is irrelevant to the task at hand. Thus, working memory capacity includes both the temporary storage of information as well as an attentional capability (Engle, Tuholski, Laughlin, & Conway, 1999). People with higher working memory capacity are better able to suppress task-irrelevant information (Rosen & Engle, 1998) as evidenced by their lower susceptibility to the cocktail party effect (Conway, Cowan, & Bunting, 2001).

Research on working memory has focused almost exclusively on assessing individual differences, the basic assumption being that interpersonal variation in working memory capacity is predictive, if not indicative, of variation in fluid intelligence (Engle et al., 1999). Thus, much of the research that has been conducted on working memory capacity has been aimed at developing construct valid measures that can predict performance on complex cognitive tasks (Engle et al., 1999; Klein & Fiss, 1999; Oberauer, Süß, Schulze, Wilhelm, & Wittman, 2000). This research indicates that individuals with higher levels of working memory capacity perform better on a variety of cognitive ability tests (e.g., La Pointe & Engle, 1990; Turner & Engle, 1989). Similarly, the measure of working memory capacity used in the present research has been shown to correlate significantly with both verbal ($r = .34$) and quantitative ($r = .33$) Scholastic Aptitude Test (SAT) scores (Turner & Engle, 1989).

The test of working memory capacity that we used in our research is the operation-span task developed by Turner and Engle (1989). The test consists of two separate tasks that are performed concurrently. One task is a processing task in which participants are presented with a mathematical equation [e.g., $(2 \times 3) - 5 = 1$] and must decide whether the answer given is correct or incorrect. The second task is a memory span task in which participants are given a word to recall at a later point. Each word is presented after an equation. Thus, participants might be presented with five equations and word pairings before being cued to recall the five words. Participants' ability to correctly recall the words provides an index of working memory capacity in that it reflects the ease with which they can both process the math problems while simultaneously holding the words in their mind.

Although working memory capacity research has not traditionally examined how situational manipulations can reduce working memory capacity temporarily, there is evidence to suggest that chronic levels of stress and anxiety might be associated with lower levels of working memory capacity (Eysenck & Calvo, 1992). For example, individuals who score high in trait anxiety or report experiencing more life stress perform worse than their less-stressed counterparts on measures of working memory capacity (e.g., Derakshan & Eysenck, 1998; Klein & Boals, 2001). Klein and Boals (2001) argued that life stress reduces working memory capacity because people under stress dedicate some of their mental resources to suppressing unwanted negative thoughts and feelings that intrude during other tasks. In addition to the direct relationship between general stress and working memory capacity, other research suggests that stressful performance situations reduce the

