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Girls *can* play ball: Stereotype threat reduces variability in a motor skill

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ABSTRACT

The majority of research on stereotype threat shows what is expected: threat debilitates performance. However, facilitation is also possible, although seldom reported. This study investigated how stereotype threat influences novice females when performing the sensorimotor task of bouncing a ball to a target. We tested the predictions of two prevailing accounts for debilitation and facilitation due to sterotype threat effects: working memory and mere effort. Experimental results showed that variability in performance decreased more in stigmatized females than in control females, consistent with the prediction of the mere effort account, but inconsistent with the working memory account. These findings suggest that stereotype threat effects may be predicated upon the correctness of the dominant motor behavior, rather than on a novice-expert distinction or task difficulty. Further, a comprehensive understanding should incorporate the fact that stereotype threat can facilitate, as well as debilitate, performance.

1. Introduction

Twenty years ago, Steele and Aronson (1995) coined the term Stereotype Threat (ST) to describe the concern that arises when one feels at risk of confirming a negative stereotype about one's group. Subsequent research has focused on how this concern debilitates the performance of stigmatized groups. For example, when examining gender stereotypes, the typical question has been, "Why do women underperform under stereotype threat?" (Cadinu, Maass, Rosabianca, & Kiesner, 2005). Consistent with the premise of this question, research has shown debilitation in a variety of cognitive and sensorimotor tasks. However, could the expectation that women underperform under ST be just another stereotype?

The focus on the debilitating effects of ST may stem from its potential negative societal implications. For example, lower ability in science and math is one of the most prominent stereotypes of females that may account for the underrepresentation of females in these fields (Eccles, Jacobs, & Harold, 1990; Nosek et al., 2009). Furthermore, Spencer, Steele, and Quinn (1999) demonstrated that women with a strong mathematical training performed worse than men with average training on the advanced GRE exam in mathematics; they performed only equally well on a comparable GRE exam of average difficulty. Critically, when women were told that the difficult exam did not produce gender differences, they performed as well as men, suggesting that stereotypes about math ability had influenced their performance. Thus, a better understanding of ST effects may prevent the failure of young women and encourage and enable them to pursue careers in STEM fields (e.g., 28% of STEM tenure-track faculty in the US were female in 2013: National Science Foundation, National Center for Science and Engineering Statistics, 2013).

In fact, the current accounts of ST effects flow directly from this emphasis on debilitation in the cognitive domain. The prevailing perspective argues that concern over confirming the stereotype produces disrupting thoughts that utilize cognitive resources, which could be otherwise devoted to task performance. It is this reduction in working memory capacity that causes the debilitation so often reported on cognitive tasks (Schmader, Hall, & Croft, 2015; Schmader, Johns, & Forbes, 2008).

The effects of ST on motor performance have also been studied, although much less extensively than on cognitive tasks. Again, most research regarding the effect of ST on sensorimotor performance has observed debilitating effects. Studies have reported debilitation from ST in a variety of sensorimotor tasks such as golf putting (Beilock, Jellison, Rydell, McConnell, & Carr, 2006; Stone, Lynch, Sjomeling, & Darley, 1999; Stone & McWhinnie, 2008), soccer dribbling (Chalabaev, Sarrazin, Stone, & Cury, 2008; Heidrich & Chiviacowsky, 2015), simulated driving (Yeung & von Hippel, 2008), tennis serving (Hively & El-Alayli, 2014), and basketball free throw shooting (Hively & El-Alayli,

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2014; Krendl, Gainsburg, & Ambady, 2012). The majority of these studies examined the effects of a gender-related ST, reporting that female performance is debilitated when exposed to the stereotype that females perform worse than males either in athletic performance or in that specific motor task (Chalabaev et al., 2008; Heidrich & Chiviacowsky, 2015; Hively & El-Alayli, 2014; Stone & McWhinnie, 2008; Yeung & von Hippel, 2008). While less commonly studied, it has also been shown that male performance in golf putting can be debilitated when instructed that females perform this task better than males (Beilock et al., 2006). In addition, evoking race-related stereotypes has led to debilitated sensorimotor performance in the stigmatized group (Krendl et al., 2012; Stone et al., 1999). These reports are consistent with the pervasive stereotype that males are more competent in athletics (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002) and show higher levels of daily physical activity (Knisel, Opitz, Wossmann, & Keteihuf, 2009).

To explain the debilitating effects in motor performance, Schmader et al. (2015) suggest that ST increases performance monitoring, which in turn reduces working memory and disrupts task execution. This is particularly noticeable in well-learned, proceduralized tasks such as golf putting. However, a recent study by Huber, Seitchik, Brown, Sternad, and Harkins (2015) found that the same ST manipulation could be used to debilitate and facilitate motor performance under different circumstances. While any observation of facilitated performance under ST is incongruent with the predictions of the working memory account, the findings of Huber et al. (2015) were consistent with an alternative account developed by Jamieson and Harkins (2007). This account, referred to as "mere effort," argues that individuals faced with ST are motivated to disprove the negative stereotype about their group, leading to the potentiation of the dominant, or prepotent, response. For sensorimotor tasks, the prepotent response is considered the dominant motor behavior, which can either be correct or incorrect, depending on whether or not the dominant motor behavior leads to the desired performance of the task. Huber et al. (2015) reported that ST affected performance in a rhythmic ball bouncing task in opposite ways, depending on the correctness of the prepotent response. This response was determined by the skill level of the performer: In novices, the prepotent response was incorrect, and therefore ST debilitated their performance; for those experienced in the task, the prepotent response was correct, and ST therefore facilitated their performance. This latter finding highlighted a largely neglected fact: under certain conditions, women may actually rise to the challenge and improve their performance under ST (e.g. Jamieson & Harkins, 2007, 2009, 2011; O'Brien & Crandall, 2003). We believe that research on facilitation under ST is very relevant, since a better understanding of how and when ST facilitates performance can also help us better understand conditions under which ST debilitates performance.

In Huber et al. (2015), facilitation due to ST was only observed for performers experienced with the task. All prior work investigating the effect of ST on motor performance for novices has reported debilitation (Heidrich & Chiviacowsky, 2015; Krendl et al., 2012; Stone & McWhinnie, 2008). In the current work, we asked if ST could also facilitate the performance of *in*experienced performers on a novel sensorimotor task. Following our previous results that it is the dominant behavior that determines the effect of ST, we chose a task where this dominant behavior was correct. Unlike the distinction between novices and experts, the mere effort account grounds its predictions on the correctness of the dominant or prepotent behavior. Thus, in order to observe facilitation in novices, we first had to identify a motor task where the dominant behavior was correct in novice subjects. Given the correct dominant response, the mere effort account predicted that novice performance would be facilitated. In contrast, the working memory account predicted debilitation.

2. Baseline experiment

The purpose of the baseline experiment was to identify a task where the dominant behavior of novices was correct and quantify this behavior. The experiment introduced a discrete version of the ball bouncing task, where subjects hit a ball to a target line in a single bounce. This task resembled the golf putting accuracy task frequently used in prior ST research (Beilock et al., 2006; Stone & McWhinnie, 2008; Stone et al., 1999). In aiming tasks, errors in motor performance can be caused by a constant bias (e.g., tendency to under- or overshoot the target) and/or by variability around the desired solution (Schmidt & Lee, 2005). A constant offset would suggest that the prepotent response was incorrect, whereas the absence of a bias (i.e. variability is clustered evenly around the target) would suggest that the prepotent response was correct.

It is important to note that while the experimental setup of the discrete ball bouncing task was similar to the rhythmic ball bouncing task used in our previous experiments (de Rugy, Wei, Müller, & Sternad, 2003; Dijkstra, Katsumata, de Rugy, & Sternad, 2004; Ehrlenspiel, Wei, & Sternad, 2010; Huber et al., 2015), the motor control demands were very different as different motor strategies are used in discrete versus continuous rhythmic performance (Hogan & Sternad, 2007).

2.1. Method

2.1.1. Participants

25 undergraduate students (13 males and 12 females) from Northeastern University participated in the experiment in exchange for partial fulfillment of a course requirement. None had any prior experience with the specific task. Prior to the experiment, participants read and signed the consent form as approved by the Institutional Review Board of Northeastern University. We planned to recruit an equal number of males and females, however data collection had to be terminated at the end of the semester, leading to the slightly uneven numbers.

2.1.2. Task

In the experimental task, the participants used a real racket to bounce a virtual ball to a target line (for a detailed description of the experimental setup, see Wei, Dijkstra, & Sternad, 2007). The participants stood in front of a projection screen holding a real table tennis racket in his or her dominant hand (Fig. 1). The screen displayed a virtual scene consisting of a ball, a racket, a target line positioned 1.0 m above the racket, and a number score. The vertical displacements of the real racket controlled the vertical position of the virtual racket.

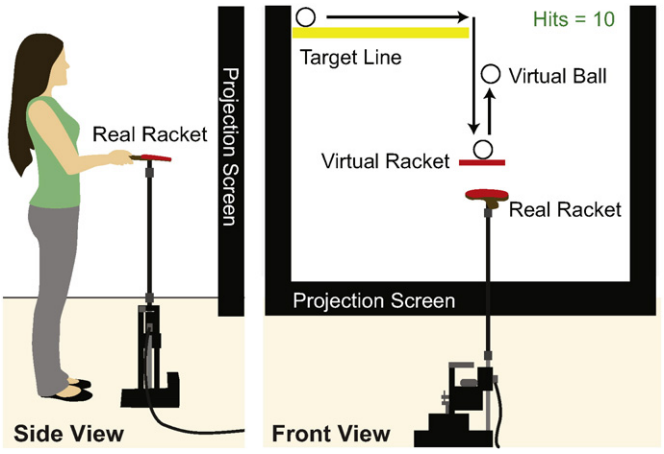

Fig. 1. Side and front view of the virtual experimental setup for discrete ball bouncing. Participants were positioned in front of a screen and manipulated a real table tennis racket to bounce a virtual ball to a target height in a 2D virtual environment.