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Implicit gender–math stereotype and women's susceptibility to stereotype threat and stereotype lift

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ABSTRACT

This study explored the effects of implicit gender–math stereotyping on women's math self-efficacy and mathematics performance under stereotype threat and stereotype lift conditions. It was conducted with a sample of female undergraduate students enrolled in an introductory statistics course. Results showed that girls with implicit gender–math stereotype were sensitive to a stereotype threat-lift manipulation, whereas girls with weak implicit stereotype were not. Data suggest that implicit gender–math stereotyping acts as a critical variable in determining women's math self-efficacy and performance. These findings give some suggestions about the improvement of the teaching of math and related disciplines to female students.

1. Introduction

Although participation of girls and women in advanced mathematics studies, as well as in math-related activities and careers, has increased over the last decades (Hyde, Lindberg, Linn, Ellis, & Williams, 2008), the gender gap is still present. Cheryan (2012) argued that male and female gender roles can help in understanding why women choose not to enter math related careers. Indeed, math-related careers, especially in engineering and computer science, are stereotyped as masculine and are viewed as incongruent with female gender roles (e.g., Diekman, Brown, Johnston, & Clark, 2010) that traditionally include being socially skilled, helping others, having a family and raising children. Thus, among several explanations on which factors might contribute to gender differences in mathematics domain, the *Stereotype Threat* theory (Steele, 1997; Steele & Aronson, 1995) offers a perspective rooted in the power of social stereotype to influence thought and behavior.

The stereotype threat is one of the most heavily studied topics in social psychology over the past decade and refers to the concern that is experienced when one feels at risk of confirming, as self-characteristic, a negative stereotype about one's group (Steele & Aronson, 1995). The stereotype threat has been applied to the underperformance of African–Americans (e.g., on standardized tests: Steele & Aronson, 1995), white males (e.g., on athletic performances: Stone, 2002), Latinos (e.g., on difficult math tests: Gonzales, Blanton, & Williams, 2002), and a variety of other minority groups. In each case, the threat of confirming the stereotype undermines the performance of stigmatized individuals in the specific domain in which the stereotype applies.

Stereotypes concerning gender and mathematics ability propose that women have less mathematical aptitude than men. A growing body of research evidence indicates that these gender–mathematics stereotypes influence women's interest and performance in the mathematics domain (Davies, Spencer, Quinn, & Gerhardstein, 2002; Jacobs & Eccles, 1992; Quinn & Spencer, 2001; Sekaquaptewa & Thompson, 2003; Shih, Pittinsky, & Ambady, 1999; Spencer, Steele, & Quinn, 1999). Experimental studies suggest that gender differences in mathematics performance occur in environments evoking the gender stereotypes (Beilock, 2008), and that making participants' gender identity salient can be sufficient to create a threatening environment in which females' performance on demanding mathematics tasks drop to a lower-than-optimal level (Shih et al., 1999). This effect is especially impressive since it might apply in educational contexts. For example, Shapiro and Williams (2012), discussing how teachers' mathematics confidence might impact students' mathematics performance, illustrated the complexity of the mechanisms through which adults' mathematics attitudes can affect children. In the same way parental attitudes, and endorsement of gender stereotypes about mathematics, seem to be important for the development of girls' expectations of their own mathematics performance (Eccles, 2006). For example, Tomasetto, Alparone, and Cadinu (2011) found the moderating role of mother's gender stereotypes on girls' vulnerability to stereotype threat.

Along with the effects on performance, the stereotype threat theory (Aronson & Steele, 2005; Steele & Aronson, 1995) has been proposed to explain also gender differences in mathematics self-efficacy, defined as the self perception about one's capabilities to successfully perform a

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mathematics task and obtain a satisfactory mathematics performance (Hackett & Betz, 1989; Pajares & Miller, 1994). Mathematics self efficacy – including students' belief about their own capabilities to successfully accomplish the subject in general, the specific tasks, and the ability to managing and monitoring their own learning – acts on performance in mathematics (Alenezi, 2008; Ayotola & Adedeji, 2009; Skaalvik & Skaalvik, 2004). While several evidences that stereotype threat interferes with mathematics performance have been provided, little research has explored the changes that this threat induces in mathematics self-efficacy. To the best of our knowledge, only Good, Aronson, and Harder (2008) have found that when the stereotype threat is nullified (i.e., when women were told that past results did not confirm the stereotype), women tend to perceive themselves more efficacious in solving mathematics problems than those ones in the stereotype threat condition (i.e., women who were told that past results confirmed the stereotype).

In the same way, despite the large body of literature examining the effects of stereotype threat on women's mathematics performance, little research has been done to examine the effects of *stereotype lift*. Traditionally the stereotype lift referred to members of groups favored by societal positive stereotype (e.g., men or Asian people in mathematics) but, alternatively, it refers to the boosting of performance in a given domain that occurs when an outgroup is negatively stereotyped or labeled (Walton & Cohen, 2003). Indeed, when cognizant of the weaknesses of an outgroup, an individual may approach the task more highly endorsing the assumption that he or she can succeed (Chalabaev, Stone, Sarrazin, & Croizet, 2008). Concerning gender–mathematics stereotype, Johnson, Bernard-Brak, Saxon, and Johnson (2012) adopted this alternative definition and compared three different conditions: threat, lift, and no threat/lift. They found that women perform better under no threat/lift or stereotype lift conditions than under stereotype threat, confirming that there is a detrimental effect on performance when the outgroup's superiority is stressed. Inversely, they did not find any difference between stereotype lift and no threat/lift conditions, suggesting that information about the outgroup's inferiority did not produce a boosting effect on women' mathematics performance.

Finally, another factor that we have to take into account is implicit processing. First, under stereotype threat, targets do not reliably report concerns about the stereotype when questioned directly (Steele & Aronson, 1995), and even when people report their explicit concerns about being stereotyped, the data does not reliably mediate stereotype threat effects (Bosson, Haymovitz, & Pinel, 2004; Johns, Schmader, & Martens, 2005; Wheeler & Petty, 2001). Thus, it is possible that stereotype threat effects occur, at least some of the time, without conscious awareness (Kiefer & Sekaquaptewa, 2007a). Second, a very recent study (Galdi, Cadinu, & Tomasetto, 2013) showed that girls make automatic associations consistent with the gender–mathematics stereotype from childhood, and it has been reported that women who possess implicit gender–mathematics stereotypes have less explicit mathematics identification and lower reported performance on mathematics-related achievement tests (Kiefer & Sekaquaptewa, 2007b; Nosek, Banaji, & Greenwald, 2002). Thus, if stereotype threat occurs through implicit processing of stereotype-relevant information, individual differences in the *implicit* gender–mathematics stereotyping, or in non-conscious cognitive associations of men with mathematics, may influence women's susceptibility to the stereotype threat. Kiefer and Sekaquaptewa (2007a) reported that when stereotype threat was reduced by describing the math test as non-diagnostic, the less women possessed implicit gender–math stereotypes, the better they performed. These findings were explained referring to the fact that women who possess strong implicit gender–math stereotypes have these stereotypes chronically accessible, and therefore may activate them even in the absence of stereotypic cues within the test-taking environment.

Starting from these premises, the present study aimed at investigating women mathematics self-efficacy and performance when exposed to stereotype threat and stereotype lift taking into account the role of *implicit* gender–mathematics stereotypes. That is, we examined how implicit gender–mathematics stereotyping might influence susceptibility to stereotype threat and lift referring both to performance and self-efficacy. In details, Kiefer and Sekaquaptewa (2007a, 2007b) manipulated the threat presenting a mathematics test as diagnostic or non-diagnostic. In the present study, to better understand if implicit gender–math stereotyping acts as a critical variable in determining women's math performance, we manipulated the threat *explicitly* referring to men and women's mathematical abilities (e.g., Good et al., 2008; McIntyre, Paulson, & Lord, 2003; Spencer et al., 1999). If women possess strong implicit gender–math stereotypes and have these stereotypes chronically accessible, this fact might make them especially sensitive to information related stereotype. Thus, in contrast with Kiefer and Sekaquaptewa (2007a), we hypothesized that girls who do not hold strong implicit stereotypes may be less sensitive to stereotype-related information, i.e., their math performance should be basically unaffected by those information. Vice versa, girls with strong implicit gender–mathematics stereotypes would be diminished under stereotype threat when explicitly told that woman perform worst. Additionally, always referring *explicitly* to men and women's mathematical abilities, we aim at exploring the potential boosting effect of counter-stereotypical information. Johnson et al. (2012) did not found any effect of stereotype lift on performance. However, they did not take into account the implicit mathematics–gender stereotype. In the present study, we aimed at better investigating the effect of informing about the outgroup's inferiority on both self-efficacy and performance of girls with a different level of implicit-stereotyping. Again, we hypothesized that who do not hold strong implicit stereotypes may be less sensitive to stereotype-related information, whereas a lift effect might be observed in girls who hold strong implicit stereotypes since these information are especially salient for them. This hypothesis is on line with studies that have demonstrated that counter-stereotypical information (e.g., informing women that they generally perform more reliably than men in a large array of tasks, or referring to women who have succeeded in several domains) alleviated the effects of stereotype threat on women's mathematics test performance (McIntyre et al., 2003).

2. Method

2.1. Participants

In line with previous investigations on the role of implicit stereotype on performance (Kiefer & Sekaquaptewa, 2007a, 2007b), the present study was conducted with a sample of female students. Participants were 78 female undergraduate students (mean age = 19.9, *DS* = 2.81) enrolled in an introductory statistics course at the University of Florence. Participants came from the following high schools: scientific lycée (23%), classic lycée (22%), linguistic lycée (10%), a teacher training school (32%), and industrial school (13%).

2.2. Measures and procedure

In order to measure mathematics skills and cognitive ability, participants received the *Prerequisiti di Matematica per la Psicometria* [Mathematics Prerequisites for Psychometrics] (PMP; Galli, Chiesi, & Primi, 2011) and the *Advanced Progressive Matrices—Short Form* (APM-SF; Arthur & Day, 1994). The PMP consists of 30 problems, and it has a multiple-choice format (one correct out of four alternatives). A single composite, based on the sum of correct responses, was calculated. The APM-SF is composed by 12 matrices derived from the APM, and its reliability and validity as a short-form of the Raven's Progressive Matrices has been tested (Chiesi, Ciancaleoni, Galli, Morsanyi, & Primi, 2012).

Additionally, participants completed individually the Implicit Association Test (IAT, Greenwald, McGhee, & Schwartz, 1998) administered on computers. The IAT assessed implicit gender–mathematics stereotyping