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Gender difference does not mean genetic difference: Externalizing improves performance in mental rotation

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ABSTRACT

The fear of underperforming owing to stereotype threat affects women's performance in tasks such as mathematics, chess, and spatial reasoning. The present research considered mental rotation and explored effects on performance and on regulatory focus of instructions pointing to different explanations for gender differences. Two hundred and one participants were asked to perform the Mental Rotation Test (MRT) and were told that men perform better than women. Then they were divided into four sub-groups and provided with no additional information (control condition) or one of three explanations: (a) genetic factors, (b) widely-held stereotype, or (c) time limit. A decrease in performance was predicted for the genetic instruction and an increase for the two alternative explanations based on externalizing. Results showed that both women and men are harmed by the genetic explanation and relieved by both the stereotype and the time limit explanations. Explanations stressing genetics and time limit as factors affecting performance favor prevention focus.

1. Introduction

Individual differences based on gender or gender roles have been often studied. Many researchers have studied the differences between the performances of men and women in completing various cognitive tasks. Their results confirmed that there are many gender-related stereotypes or beliefs and few true differences. One difference did show up in a test of mental rotation, the ability to rotate mental representations of two- and three-dimensional objects, a task that men perform better than women due to a wide range of factors. Research has demonstrated that one's performance is not dependent on ability alone but on situational factors, such as gender role beliefs and test instructions.

Imagine that in the instructions you are told that there is a gender difference for a task you are asked to perform. What would you think? You may consider genetic factors to be the reason for the difference. Indeed, there is a tendency to attribute differences in ascribed identities (e.g., gender or ethnicity) to biologically-rooted reasons (Prentice & Miller, 2006).

Research, however, has widely demonstrated that many other explanations may be valid. One is based on the fear of confirming a widely-held stereotype (Aronson, Quinn, & Spencer, 1998), known as stereotype threat. Reminding a common-held stereotype causes performance decrements in minority members (e.g., women told that men perform better in math, elderly told having poor memory). Common ways to raise stereotype threat are priming gender in some preliminary questions (Steele & Aronson, 1995) or instructing that gender differences occur in the test at hand (Moè, 2009).

Effects due to stereotype threat activation have been documented with mental rotation, an ability in which men have been shown to score up to one standard deviation higher than women (Voyer, Voyer, & Bryden, 1995), due to genetic explanations, such as hemispheric specialization (e.g., Jordan, Wuestenberg, Heinze, Peters, & Jaencke, 2002), and prenatal brain organization (e.g. Burton, Henninger, & Hafetz, 2005), and also to strategic, motivational, experiential, and culture-based factors, including stereotype activation (Moè & Pazzaglia, 2006).

Men prefer holistic strategies (e.g., Hugdahl, Thomsen, & Ersland, 2006) that are more effective than analytic (Linn & Petersen, 1985), and they have more functional motivational beliefs than women, for example that men have a higher spatial perception ability (Moè & Pazzaglia, 2006). Due to cultural factors, people consider spatial ability as a predominantly masculine characteristic (Devlin, 2001), and beginning in childhood, boys are encouraged more strongly than girls to engage in activities that promote the development of spatial skills, such as computer games, math and science courses, participating in basket-ball, volleyball or being music performance majors and this experience with spatial activities increases performance in mental rotation (Cherney & Neff, 2004; Ginn & Pickens, 2005). Flaberty (2005) found a positive correlation between the number of masculine activities performed (e.g., carpentry, making objects, building train/car set) and mental rotation scores, irrespective of gender. Terlecki and Newcombe (2005) found that men use computers and videogames more than women and that this kind of spatial experience mediates the gender difference in mental

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rotation performance. Mental rotation performance can be improved in both genders through experience and practice with spatial tasks and through videogame training and repeated testing (Newcombe, Mathason, & Terlecki, 2002; Terlecki, Newcombe, & Little, 2008). People with low baseline spatial abilities need longer interventions and may take some time to begin to show spatial gains, but there is evidence of transfer and long-term maintenance for both genders.

This suggests the opportunity to encourage women to acquire spatial experience through appropriate training in order to better perform spatial tasks. In addition, experience aids in developing a higher self-perception of one's ability, which is harmed due to stereotypical threats or having no practice performing a task.

Many methods have been proposed for alleviating the stereotype threat effects: priming a positive stereotype (Marx & Roman, 2002), self-affirming (Martens, Johns, Greenberg, & Schimel, 2006), teaching (Aronson, Fried, & Good, 2002) or having (Moè, Meneghetti, & Cadinu, 2009) an incremental theory, remembering positive ascribed identities (McGlone & Aronson, 2006), giving reminders of individuals who have succeeded in the stereotyped task (e.g., women who excelled in masculine professions: McIntyre, Paulson, & Lord, 2003), and explaining that performance depends on effort (Moè & Pazzaglia, 2010) or that the gender gap is due to a stereotype and not to lack of ability (Johns, Schmader, & Martens, 2005).

All these results stress the role played by instructions. Among them research has outlined the importance of those priming what the test measures (spatial ability or empathy) in conjunction with gender-role beliefs. Women perform better when instructed that the test (actually a spatial one) measures empathy and they perceive themselves as a feminine person or measure spatial ability and they perceive themselves as a masculine person (Massa, Mayer, & Bohon, 2005). In this study instructions presenting the test as a measure of spatial abilities were provided.

Previous research has found that both men and women are affected by instructions stressing that one gender performs better/worse than the other on the task at hand (Moè, 2009; Moè & Pazzaglia, 2006). Unfortunately, nothing was said in the instructions about the reasons for this gender difference, while previous research has shown that the participant's knowledge or the pre-existent causal belief about the reason for underperforming plays a crucial role regarding performance, at least for women.

When prevented from believing that what matters are genetic factors, women have been shown not to be affected by the stereotype activation (Dar-Nimrod & Heine, 2006). This is a very intriguing result found only with studies involving mathematics, and it should be confirmed with mental rotation and deserves deeper understanding of the underlying mechanisms. One possibility is facilitating by externalization the reason for underperforming, i.e. by suggesting an external (e.g., stereotypes held by others, situational constraints) rather than internal (e.g., lack of ability) causal attribution for a poor performance. If this is true, alternative instructions favoring externalization should produce the same effects on performance. Among them, those based on commonly-held stereotypes and on time limits were examined.

The first aim of this research was to test the hypothesis that an instruction priming a participant that a stereotype is the source of underperformance helps women to increase mental rotation performance. Effects of this instruction were compared with instructions based on genetics. The prediction was that women instructed that men have an advantage that is dependent on a commonly-held stereotype perform better than women instructed that genetic factors are the main source of the observed gender differences in performance.

The second aim was to examine whether the advantage for women instructed on stereotype effects depend on providing an external reason (stereotypes does this) for their underperformance. To this end, a third instruction based on externalizing the reason for underperforming was provided. Participants were told that a time restriction negatively affects women's performance. Indeed, this is a true explanation. The gender gap in performance increases with a time restriction (Scali, Brownlow, & Hicks, 2000). The prediction was that this instruction would lead to the same increased performance effect caused by the stereotype instruction.

The third aim was to examine effects of instructions on the regulatory focus. Higgins (1999) distinguished between two regulatory focuses or modalities of approaching a test: prevention versus promotion. Prevention is characterized by the fear of failing and it leads to avoiding risks, or being cautious. Persons characterized by a preventive focus tend to provide no answer when they are uncertain. Promotion sustains hope to succeed and it leads to approaching the task even with the risk of making mistakes or not to provide the right answer. It is expected that thinking that genetic factors affect performance can create apprehension and favor a greater prevention focus. Believing that time restriction affects performance can increase a feeling of pressure that could result in a more prevention-oriented focus. The stereotype threat explanation of gender differences should favor a promotion focus because it alleviates the fear of inability.

Effects of the three instructions about genetics, stereotype and, the time limit were compared with a control condition in which participants are told that men perform better on the test at hand. This instruction was preferred to one in which nothing is said about gender differences, because it is more explicit. Not all the participants would recognize and endorse the stereotype about women underscoring on the test to the same extent and this differential level of endorsement could cause differential performance within the control group.

The fourth aim was to explore effects for men, not considered by the research of Dar-Nimrod and Heine (2006). In previous research considering mental rotation (Moè, 2009; Moè & Pazzaglia, 2006), the fact that the instructions included the words 'men perform better' caused men to perform better due to an effect called 'stereotype lift' (Walton & Cohen, 2003). However no additional information was provided about the causes for men's higher performance in mental rotation compared to women. It could be expected that stressing genetic causes could cause decreased performance due to the apprehension not to be able to confirm the stereotype suggested by the instructions, an effect called "choking under pressure" (Beilock & Carr, 2001).

Effects on performance and on the regulatory focus of the four instructions on genetics, stereotype effects, time limit and control were then compared in order to assess these hypotheses and to confirm that, in women, attributing gender differences to factors different from genetics cause increased performance and, for the stereotype threat explanation, a more promotion-oriented focus.

2. Method

2.1. Participants

Ninety-five female and one hundred and six male high school students participated in the research on a voluntary basis. Their mean age was 15.50 years ($SD = 0.92$, range 14–18 years old). They were divided into four groups, each following different instructions: genetic ($n = 56$, 26 females and 30 males), stereotype ($n = 48$, 23 females and 25 males), time limit ($n = 51$, 20 females and 31 males), and control ($n = 46$, 26 females and 20 males).

Data collection was done in Italy considering students attending different high schools, namely professional ($n = 52$), technical ($n = 93$), and liceo ($n = 56$). None stressed topics such as geometry, technical drawing, or spatial reasoning that previous research has shown enhanced mental rotation performance (e.g., Baenninger & Newcombe, 1995; Kirby & Boulter, 1999).

2.2. Materials

Mental rotation ability was assessed by using a modified version (Moè & Pazzaglia, 2006) of the Mental Rotation Test (MRT) originally