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Following the instructions! Effects of gender beliefs in mental rotation

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Abstract

Research has widely demonstrated male superiority in the Mental Rotation Test (MRT). Various explanations have been put forward to account for these differences. We considered gender beliefs and argued that women may fare less well than men partly because they are considered unable to perform this kind of task. Beliefs about spatial ability were experimentally manipulated in samples of 107 female and of 90 male high-school students, divided into three groups, following the instructions: men are better, women are better, general (with no gender reference). Our data show that women who expect to be more able than men and men who expect to be more able than women outperformed their counterparts. MRT performance fell for those expecting to be less able. The effects of induced beliefs on cognitive performance are stressed, particularly in the educational context.

Keywords: Mental rotation test; Spatial abilities; Stereotype threat; Gender beliefs

In a socio-cognitive perspective of individual differences in intellectual performance, beliefs about one's abilities or task characteristics are supposed to affect cognitive performance (Dweck, 1999). Among these, beliefs about gender have begun to attract growing interest. Following the stereotype-threat theory of Steele and Aronson (1995), where a negative gender belief is aroused, subjects tend to under perform owing to fear of failure, anxiety or negative expectations. In other words, the fear (or the expectation) of confirming a negative stereotype about a group to which one belongs, might be responsible for decrements in performances of cognitive tasks (Steele, 1997).

These effects have been found with gender differences in mathematics (Cadinu, Maass, Frigerio, Impigliazzo, & Latinozzi, 2003), but the case of spatial ability may also be relevant. In spite of the common belief that men have stronger spatial ability than women, the only difference consistently found by research is in mental rotation tasks (Linn & Petersen, 1985; Masters & Sanders, 1993; Voyer, Voyer, & Bryden, 1995). The most widely used mental rotation task is the Mental Rotation Test (MRT; Vandenberg & Kuse, 1978). It consists of 20 items, each of them being the graphic representation of a target object followed by four similar objects. Among them, participants have to find the two which are identical to the target, except for their different rotations. Shepard and Metzler (1971) demonstrated that this task could be efficiently performed only by using a global mental rotation's strategy. Moreover, a large amount of

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evidence confirms that men have better performances than women in the MRT and that these differences emerge early, are stable and significant along the life span (Linn & Petersen, 1985; Peters, 2005).

Various explanations have been given for these gender differences. Some refer back to biological factors. Spatial tasks are performed through the right parietal regions (Allivatos & Petrides, 1997), and men have higher right hemispheric specialization. Women seem to use the left hemisphere for both verbal and non-verbal tasks, while men use the right hemisphere for spatial tasks. During prenatal life, the foetus is exposed to different kinds of hormone depending on gender, and these are known to affect brain development and organization (Grimshaw, Sitarenios, & Finengan, 1995).

Giving this male superiority in all research concerning mental rotation, the genetic explanation seems to be convincing. However, gender differences have also been considered a product of cultural influences. Spatial ability is conceived as a predominantly male characteristic (Devlin, 2001) and, consequently, men consider themselves competent in this arena and tend to perform well, whilst women consider themselves less able and/or interested in accurate performance of such tasks (Richardson, 1994). As a result, men perform more of these tasks and tend to choose toys and school curricula that stress spatial ability (Linn & Petersen, 1985). This in turn allows them to acquire greater expertise and develop strategies useful for accurate, fast and efficient solution of spatial tasks (Goldstein, Haldane, & Mitchell, 1990; Stumpf, 1993).

Moreover, strategic aspects can affect performance. Spatial tasks can be performed using either holistic or analytic strategies (Shepard & Cooper, 1982). Analytic strategies are sequential and involve breaking apart the stimulus object. Holistic strategies are more effective, involve parallel processes, and frequently occur with visualization (Cochran & Wheatley, 1989). Women prefer to use analytic and men holistic strategies (Blough & Slavin, 1987). For example, men reported using their hand and counting block less, but picturing the stimuli in their minds more, than did the women in performing the MRT (Freedman & Rovegno, 1981).

Finally, some motivational aspects can explain the gender differences. Women are more prudent in performing the MRT and think longer before answering, while men are faster than women in choosing items corresponding to a target (Shepard & Metzler, 1971). If enough time is provided, or participants' expectations of the task are experimentally manipulated (Sharps, Welton, & Price, 1993), they perform as accurately as men (Birenbaum, Kelley, & Levi-Keren, 1994). But if the level of difficulty of the task is increased (Collins & Kimura, 1997) or accuracy in performance is stressed (Scali, Brownlow, & Hicks, 2000) the difference between men and women performance increases.

Addressing mathematics, Steele and Aronson (1995) found that when the task is presented as diagnostic or when stereotypical information is activated – i.e. gender or race is requested – the subjects tend to feel themselves affected by common beliefs with consequent fall in performance, thus confirming the stereotype, a result of anxiety or evaluation stress. Following this theory, women can do worse than men in certain spatial tasks, such as the Mental Rotation Test (MRT) of Vandenberg and Kuse (1978), because they consider themselves less able to perform this kind of task, and are considered as such by other significant people.

The aim of our research is to demonstrate that even in tasks like mental rotation, where gender differences are found very early on in development, suggesting a genetic or biological explanation, motivational aspects such as beliefs can play an important role. In particular, we focused on beliefs about spatial abilities and about stereotype. Beliefs about spatial abilities were experimentally manipulated by feedback administration between first and second parts of the MRT presented. Participants were divided into three groups. The first was told that men are more able than women in the performance of the MRT, the second that women are more able than men, and the third received general instructions with no gender reference. Stereotype beliefs were measured through a self-evaluation questionnaire asking the subjects whether, for each of the tasks described, they considered men better, women better, or no difference.

We devised two different experiments, one with only women, and the other with men. We hypothesized an increase in performance after the manipulation stressing gender superiority, a drop in performance after manipulation stressing the contrary, and no change in performance for the group receiving general instructions. The minority group (women) was tested first, then we examined the case of the dominant (men) group.

1. Experiment 1

What would happen if women were considered more able than men in a mental rotation task? Would they perform better than when led to believe they are not capable of good performance? Experiment 1 aims to answer these questions.