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Impossible “mental rotation” problems A mismeasure of women’s spatial abilities?

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Abstract

Current textbooks report that men’s visual–spatial skills are superior to women’s. However, the research is not consistent with this sweeping generalization. We hypothesized that sex differences would be more pronounced on “impossible problems” (mirror images) than possible rotations. We also hypothesized that males’ performance would be adversely affected by visual interference, whereas females’ performance would be adversely affected by auditory interference. Ninety-five college students (25 males, 70 females) viewed images of a train station from various perspectives, including some that were impossible rotations of the original image. There were no sex differences in accuracy or response time on the possible rotation problems, but males were more accurate than females on impossible problems. Neither auditory nor visual interference affected accuracy. The alleged sex difference in mental rotation problems is largely due to the use of problems that are not actually mental rotation problems. © 2001 Elsevier Science Inc. All rights reserved.

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1. Introduction

In this experiment, we examined sex differences in a visual–spatial skill: the ability to mentally rotate images of objects (see Fig. 1). Many current textbooks report that men are superior to women in visual–spatial skills. A number make fairly broad generalizations:

Boys outperform girls on tests of visual–spatial abilities — that is, the ability to draw inferences about or otherwise manipulate pictorial information. . . (Shaffer, 1999, p. 476)

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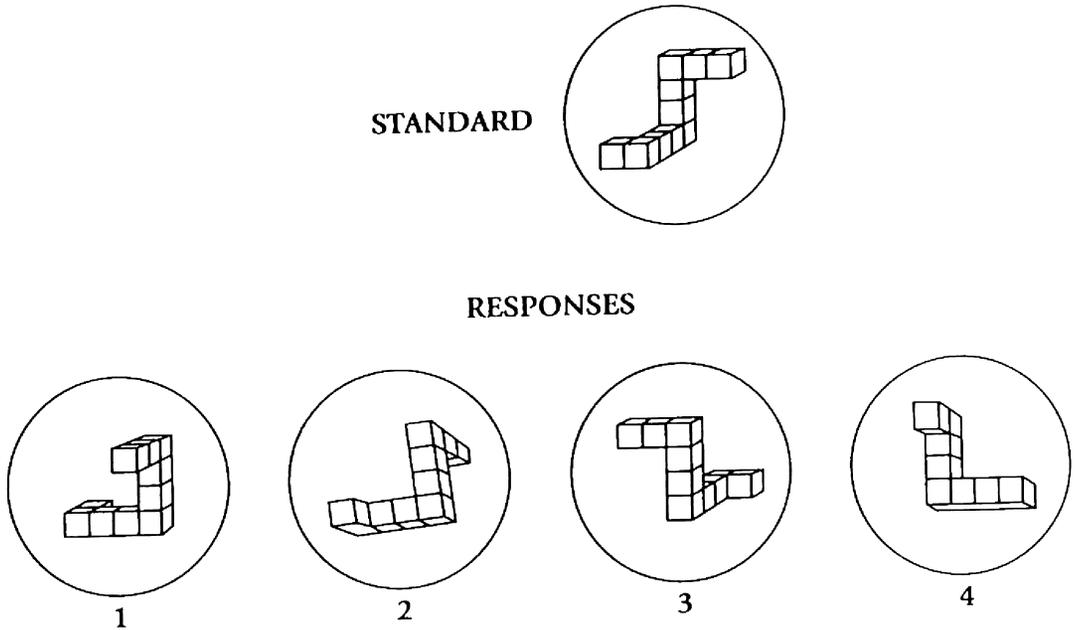


Fig. 1. A sample item from Vandenberg and Kuse's (1978) mental rotation test (adapted from Linn & Petersen, 1985, Copyright 1985, Society for Research in Child Development, adapted with permission).

On tests of mental rotation. . . the sex difference is substantial and becomes larger with age. . . the difference is quite large (Eagley, 1995; Voyer, Voyer, & Bryden, 1995). The fact that girls score lower on such tests does not mean that no women are qualified for occupations that demand such skill, such as architecture or some kinds of engineering; it does mean that fewer girls and young women will be able to meet the training requirements for such jobs (Bee, 2000, pp. 220–221).

Spatial skills such as mental rotation are clearly important for a number of high-paying professional careers such as dentistry, medicine, architecture, engineering, navigation, and others. Standardized tests of spatial skills are used for educational and personnel selection in many of these fields (e.g., Dental Admissions Exam, see Reed, 2000, p. 176). It is essential to distinguish actual sex differences in mental rotation from *apparent* sex differences that show up on a test of mental rotation because of some other confounding variable, such as differential demand characteristics (Orne, 1962) on male and female research participants.

We briefly review some of the major studies on sex differences in spatial skills, with special attention to the ability to mentally rotate images of objects. We then examine the measures used in these studies to identify sources of inconsistency in the research. One critical variable emerges: Some mental rotation tests require the respondent to discriminate which *direction* an image would have to be rotated in order to match the standard, whereas many tests require the respondent to discriminate which images represent *possible rotations* of the standard from images which are *not possible rotations* of the standard — they are

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