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Sex differences and the Factor of different fields of study in Mental Rotation test

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ABSTRACT
Different tasks are often used to assess spatial ability in humans. we used than mental rotation test of Shepard and Metzler (1978) to test 60 men (mean age = 17.38 years, SD = 0.6) and 73 female (mean age = 17.46 years, SD = 0.5) high school students from different fields of study which included Mathematics, Humanities and Experimental sciences. Multivariate analysis of variance (MANOVA) was performed to compare MRT scores. The results show that a significant Fields of study effect in favor of Mathematics students (p = 0.0001), and a significant gender effect in favor of boys when comparing MRT scores (p = 0.01), but results show that no significant interactive effects between Fields of study and gender (p = 0.13). Moreover Mathematics students had better scores than two other groups. This suggests that women are underrepresented in these areas and Spatial abilities are associated with success in mathematics and science courses, performance on standardized tests and the choice of mathematics and science in school.
Keywords: *mental rotation, gender differences, fields of study , spatial abilities*

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INTRODUCTION

Researchers divided Spatial abilities into three categories: 1. Mental Rotation 2. Spatial perception and 3.Spatial visualization. Mental Rotation (MR) is the ability to make the mental image of a given 2D or 3D object turning in space [1]. The term of MR was first used by Shepard and Metzler [2].
Marmor (1975), reported that 4- and 5-year-old children are able to use MR to solve a task similar to the Shepard and Metzler paradigm, albeit with 2D figures of Panda bears instead of multiarmed [2]. Quinn and Liben (2008), and Moore and Johnson (2008), reported some MR ability in 4-month-old infants. But there is accumulated evidence of gender differences in adult MR ability, with men systematically outperforming women [3]. Different ages have been reported in the literature regarding the emergence of this gender difference: in infancy [4 and 5], at the age of 4 to 5 years [6], and between 9 and 10 years [7 and 8]. Titze *et al* [7], investigated whether the age of 10 was the crucial time slot for the appearance of gender difference. They compared 9- to 10-year-old children's performance on the MRT and reported large gender differences only in older children, whereas at the age of 9, girls and boys had similar performance.
It is commonly accepted that the human brain is functionally asymmetrical, with the left hemisphere supporting verbal functions, and the right hemisphere supporting nonverbal functions, including spatial ability. Men, on the other hand, may have more specialized hemispheric lateralization. Mental rotation certainly involves spatial ability, and it has often been shown to be a task dependent on the right [9].
Two main causes might contribute to explain this gender [7]: the "psychosocial" variety (stereotype threat, sex-role identification, or differential experience and socialization) and the "biological" variety (genetic complement, sex hormone level, or cerebral lateralization). From a biological viewpoint, differences in cortical activation patterns – and most especially hemispheric lateralization of brain activity – was consistently reported . Concentration of sexual hormones was also reported as a possible cause of this gender difference. A number of studies have shown that females differ in the performance of spatial tasks during phases of the menstrual cycle. In interpreting this effect, effects of testosterone on parts of the brain that are involved in spatial activities is emphasized [10].

Titze et al (2010a), considered both the psychosocial and biological causes to explain these differences in children, they studied more deeply the psychosocial theory by investigating the influence of gender beliefs in 10- to 11-year-old children. They examined this phenomenon using the VMRT (see Vandenberg & Kuse, 1978) while experimentally manipulating children's beliefs about spatial ability (instructions given: boys are better, girls are better, or independent of gender). Surprisingly, they did not find any changes in performance as a function of the instruction. This result shows that the psychosocial explanation is neither systematic nor the only one possible. Hahn *et al* (2010), examined this gender difference in children from a biological point of view and found a hemispheric asymmetry as being a function of gender. Boys revealed a more bilateral pattern of brain activity, while girls' brain activity was clearly lateralized toward the left hemisphere. In sum, whether sex differences in hemispheric lateralization are caused by biological (genetic, hormonal) or environmental (spatial activities, socialization) factors remains to be answered [6]. With regard to Foreign investigations in relation to gender differences in Mental Rotation ability, Unfortunately, very little research related to Mental Rotation ability of gender in different cultures of my Country, Between different fields of study and at different ages done. The aim of this study was to evaluate the ability of Mental Rotation in male and female high school students in Sofian in the fields of study included of Experimental sciences, Mathematics and Humanities courses are done.

MATERIALS AND METHODS

60 men high school students (from the 3nd grade, Humanities; 15, Experimental sciences; 24 and Mathematics; 21, mean age = 17.38 years, *SD* = 0.6) and 73 female high school students (from the 3nd grade, Humanities; 17, Experimental sciences; 29 and Mathematics; 27, mean age = 17.46 years, *SD* = 0.5) took part in the experiment. The experimental procedures were first approved by the local research ethics board and then by the parents. The MR ability was assessed using by "SM" MRT test, that composed of the figures provided by Shepard and Metzler (1978). The MRT consists of 24 items of 3D-objects, with one reference figure on the left and four target figures on the right. The participants have to mentally rotate the target figures in space to find the two correct items that match the reference, while two cannot be made to match, regardless of how they are rotated. There are two ways of scoring the test. The first method gives a point for each correct answer, so that the theoretical maximum for a 24 problem set is 48 points. here a scoring method was used that discourages guessing, where a single point is given if and only if both correct stimuli are identified, Therefore, the score for each individual thus ranged from 0 to 24. After having done two practice problems for which solutions were provided, subjects commenced with the test. The test was presented in two sets of 12 questions, with 6 min for each set, separated by a rest pause of 4 min. Sample test item from test is illustrated in Figure 1. The test was completed in the classroom, during the morning session at 9 am.

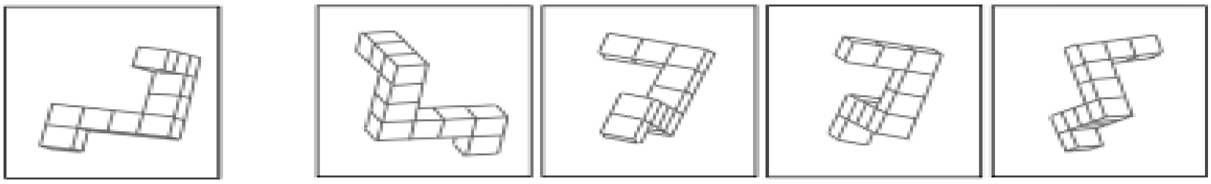

Figure 1. Sample items from the MRT test. The reference is on the left, while the four alternatives appear on the right. Among them, only two match the reference and must be recognized.

Multivariate analysis of variance (MANOVA) was performed to compare MRT scores, as well as to test the effect of gender and three different educational courses in the groups. The results are presented as mean (*SD*) with a level of $p < .05$ being considered critical for assigning statistical significance.

RESULTS

Descriptive Statistics revealed that boys had a mean score of 4.80 (*SD* = 3.86) in the MRT test while girls' mean scores were 3.43 (*SD* = 2.39), as can be seen in Fig. 2. Results at the Fields of study effect in each group separately showed that Mathematics students had better scores than two other groups. Mathematics male students had a mean score of 6.19 (*SD* = 3.48), Experimental sciences male students had a mean score of 5.75 (*SD* = 4.05) and Humanities male students had a mean score of 1.33 (*SD* = 1.17). while girls' mean scores were 4.11 (*SD* = 2.54), 3.86 (*SD* = 2.32) and 1.64 (*SD* = 1.11) respectively in Mathematics, Experimental sciences and Humanities. If we look at the gender effect in each group separately, results showed that boys outperformed girls in the Fields of Mathematics and Experimental sciences but girls were better in the Fields of Humanities than boys. All Descriptive statistics data are summarized in Table 1.

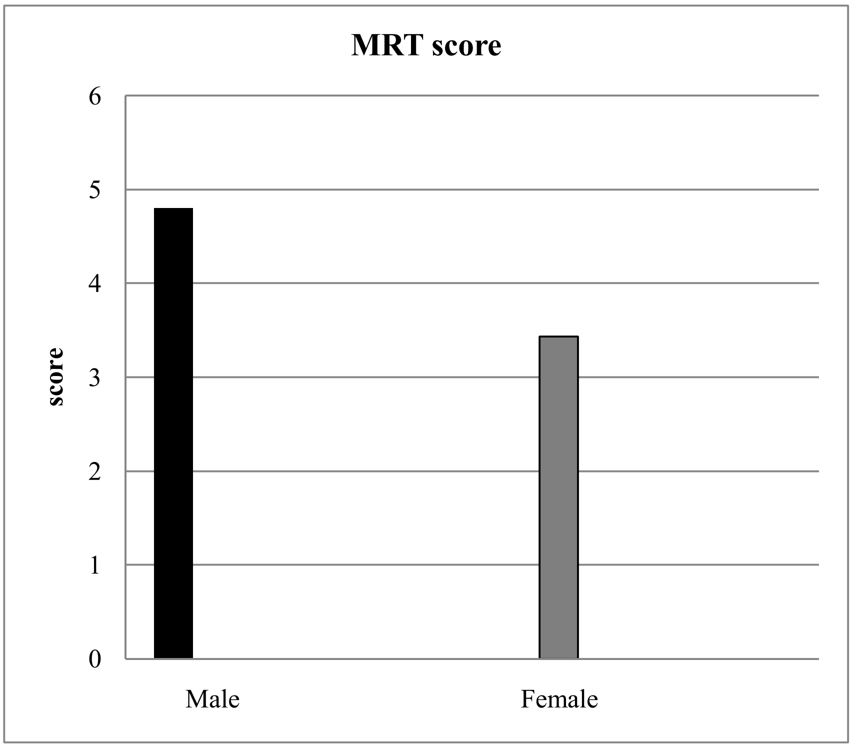

Fig. 2. Mental rotation score for males and females. Males score significantly better than females on mental rotation (P = 0.01).

Table1. Descriptive statistics

students	gender	Mean	Std. Deviation	upper	lower	number
Humanities	male	1.33	1.17	4	0	15
	Female	1.64	1.11	4	0	17
Experimental sciences	male	5.75	4.05	18	1	24
	Female	3.86	2.32	11	1	29
Mathematics	male	6.19	3.48	16	1	21
	Female	4.11	2.54	12	1	27
Total	male	4.80	3.86	18	0	60
	Female	3.43	2.39	12	0	73
Total		4.05	3.20	18	0	133

The MANOVA revealed a significant Fields of study effect in favor of Mathematics students (F= 19.11; p = 0.0001) and a significant gender effect in favor of boys when comparing MRT (F= 6.03; p = 0.01). but results show that no significant interactive effects between Fields of study and gender (F= 2.06; p = 0.13). Additional information provided at the table 2.

Table 2 . Results from the (MANOVA) for comparisons Fields of study and gender

variable	Mean Square	df	F	P	Partial Eta
Fields of study	147.68	2	19.11	0.0001	0.23
Gender	46.62	1	6.03	0.01	0.04
Fields of study * Gender	15.98	2	2.06	0.13	0.03

DISCUSSION

The results from the mental rotation task show that males are better at mental rotation than females, and this is consistent with past [2 and 11]. Our results confirm that Mathematics students in groups have higher MRT abilities than Experimental sciences and Humanities students, probably because of their life experience, and school programs including mathematic courses (especially geometry), which may substantially contribute to improve their visuo-spatial ability. In fact, some evidence suggests that males generally tend to use more holistic strategies that are more efficient in MR performance [12]. males tended to use a direct strategy, while females preferred strategies that were non spatial or unclassifiable

during the probe trial. Moreover, there are a variety of other factors that may contribute to these performance differences. For example, Quaiser-Pohl and Lehmann (2002), have shown that sex differences in mental rotation are of a greater magnitude in students studying arts, humanities, and social sciences, and smallest for those students majoring in computational visualistics. Additionally, it has been shown that females perform better on the mental rotation task during menstruation (when estrogen was lowest) as opposed to during their luteal phase (when estrogen is highest). Hence, each of these factors, alone or in combination, probably contribute to strategy preferences and abilities in mental rotation, and future experimentation is necessary to disambiguate the role of these factors in sex differences and performance [13]. under standard conditions, females do tackle fewer questions than males, because under the time limits imposed, they do not get as far in the series of problems as males. This supports the idea that females are slower in solving the problems. slower performance of women on the MRT may reflect a tendency to double check answers by rotating them more than once. They also point out that when using a "part-by-part" rotational strategy, women may be more inclined to rotate additional parts of the block objects before deciding on an answer, thus utilizing a less efficient strategy [14]. No doubt, this plays a role in the overall sex differences in the number of solutions. if females are slower overall in performing mental rotations, time pressures might be different for the sexes even for the problems that were attempted. Females performance suffers more from time constraints than that of males, but it does not allow the conclusion that speed of mental rotation is the sole factor accounting for sex differences. When double time was given to females, they solved significantly more problems, but because males also benefited from additional time, there was no significant interaction between time available and the magnitude of sex differences. higher recognition performance in men, despite the fact that participants were given unlimited time to respond, is consistent with previous reports in mental rotation tasks [15]. These results indicate that, in this task, the differential performance between men and women is due to perceptual processes,. Instead, findings indicated that in this task, the differential performance of men and women was a result of differential visual sensitivity. According to these authors, one strategy would be based on rotation of mental representations around canonical axes while the second one would rely on mental representations encoding spatial relationships between objects. Accordingly, the first strategy is not invariant with respect to the object's orientation and position and thus involves the use of mental rotation to solve the task. By contrast, the second strategy would offer the advantage of being invariant with respect to the object's orientation and position and thus allowing comparison or recognition without any mental rotation. women rely on the first strategy of mentally rotating the displayed stimulus toward the canonical references of the memorized target until the two angles coincide. in general, men lend more attention to the geometry of the environment whereas women lend more attention to environmental landmarks.. This suggestion is supported by an elegant study showing that when geometric cues (the page frame geometry) were eliminated, differences in performance between women and men [16].
Terlecki et al (2008), show that performance of female participants who had received video game training came close to that of male participants who had received no training, Terlecki et al (2008), speculated that, given enough training, the performance of the female participants might converge to that of the male participants. Training methods that develop an individual's ability to maintain, select, and exchange items in spatial working memory may be essential to provide a basis for equalization on complex spatial tasks. In sum Spatial abilities are associated with success in mathematics and science courses, performance on standardized tests and the choice of mathematics and science in college. Early individual differences in abilities influence confidence, self efficacy, and attitudes, and thus inferior spatial skills lead to avoidance of learning situations that require spatial cognition [17]. These lost opportunities for learning have an effect on subsequent participation in science, technology, engineering, and mathematics.

REFERENCES

1. Pohl C , Lehman W, (2002). Girl's spatial abilities: charting the contributions of experiences and attitudes in different accademic groups. British Journal of Educational Psychology, 72, 245-260.
2. Nady Hoyek, Christian Collet, Patrick Fargier, and Aymeric Guillot, (2012). The Use of the Vandenberg and Kuse Mental Rotation Test in Children, Journal of Individual Differences 2012; Vol. 33(1):62–67.
3. Hoyek N, Collet C, Rastello O, Fargier P, Thiriet P, Guillot A, (2009). Enhancement of mental rotation abilities and its effect on anatomy learning. Teaching and Learning in Medicine, 21, 201–206.
4. Moore D, Johnson S,(2008). Mental rotation in human infants: A sex difference. Psychological Science,19,1063–1066.
5. Quinn P , Liben L, (2008). A sex difference in mental rotation in young infants. Psychological Science, 19, 1067–1070.
6. Hahn N , Heil M, Jansen P,(2010). Preschoolers' mental rotation: Sex differences in hemispheric asymmetry. Journal of Cognitive Neuroscience, 22, 1244–1250.

7. Titze C , Jansen P , Heil M, (2010a). Mental rotation performance and the effect of gender in fourth graders and adults. European Journal of Developmental Psychology, 7, 432–444.
8. Titze C , Jansen P, Heil M, (2010b) . Mental rotation performance in fourth graders: No effects of gender beliefs (yet?). Learning and Individual Differences, 20, 459–463.
9. Ditunno P L, Mann V A, (1990). Right hemisphere specialization for mental rotation in normals and brain damaged subjects. Cortex, 26, 177–188.
10. Seurinck R , Vingerhoets G , de Lange F, Achten E,(2004). Does egocentric mental rotation elicit sex differences? Neuroimage, 23, 1440–1449.
11. Michael Peters,(2005). Sex differences and the factor of time in solving Vandenberg and Kuse mental rotation problems, Brain and Cognition 57 (2005) 176–184.
12. Heil M, Jansen-Osmann P, (2008). Sex differences in mental rotation with polygons of different complexity: Do men utilize holistic processes whereas women prefer piecemeal ones? Quarterly Journal of Experimental Psychology, 61, 683–689.
13. Quaiser-Pohl C, Lehmann W, (2002). Girls' spatial abilities: charting the contributions of experiences and attitudes in different academic groups. Brit J Educ Psychol;72:245–60.
14. Thomas , Parsons , Peter Larson , Kris Kratz , Marcus Thiebaux , Brendon Bluestein, Galen Buckwalter, Albert , Rizzo, (2004). Sex differences in mental rotation and spatial rotation in a virtual environment, Neuropsychologia 42 (2004) 555–562.
15. Coluccia E , Louse G, (2004). Gender differences in spatial orientation: A review. Journal of Environmental Psychology, 24(3), 329-340. doi:10.1016/j.jenvp.2004.08.006.
16. Collaer M L, Nelson J D, (2002). Large visuospatial sex difference in line judgment: Possible role of attentional factors. Brain and Cognition, 49(1), 1-12. doi:10.1006/brcg.2001.1321.
17. Terlecki M , Newcombe N , Little M, (2008). Durable and generalized effects of spatial experience on mental rotation: Gender differences in growth patterns. Applied Cognitive Psychology, 22, 996–1013.

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