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Sex differences in egocentric spatial ability and the effects of priming

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ABSTRACT

It is widely accepted that there are gender differences within visual-spatial abilities. The gender difference debate regarding social and biological factors has been ongoing. The aim of this study was to investigate the controversy surrounding gender differences within spatial ability. Generally there is a perception that men tend to perform better than women on several spatial tasks, particularly tests involving mentally rotating an image. Women tend to perform better than men in tasks that require object location. The foremost objective of the present study was to investigate whether priming half of the participants to the opposite perceptions would diminish the effect of gender. Forty University students (20 males, 20 females equal numbers in each group) participated in an experiment that comprised two computerized spatial recognition tasks that were presented through Super Lab. Participants completed a 20 item mental rotation and object location task, which measured correct responses and reaction times. Participants were treated in accordance to the ethical code of conduct. The results revealed that priming improved the performance of females in terms to reaction time and accuracy in the mental rotation task. Without priming female performance was poorer. Males had the greatest performance rate overall. Priming was less effective for males and females in the object location task. This research has shown that performance expectations can be positively influenced by priming.

KEY WORDS:	GENDER DIFFERENCES	SPATIAL ABILITY	MENTAL ROTATION	OBJECT LOCATION	PRIMING

Introduction

Visual-Spatial Ability

Spatial ability has an essential role within the environment as a salient feature of recognizing objects, navigation and recollecting locations (Gardner, 1993; Delgado & Prieto, 2004; Webb et al, 2007). Spatial ability is complex, and evidently not a single entity amongst the sexes. Two types of spatial abilities are object location memory and mental rotation, Coluccia and Louse (2004) made a distinction between the two in that object location memory is an aspect of spatial memory that is involved with remembering the precise location of objects relative to each other and mental rotation; is the ability to mentally rotate a two or three-dimensional image within ones imagination by creating a mental picture within egocentric space. The focus here will be on object location and mental rotation as there is a great deal of evidence that gender differences exist and are extensively documented (Voyer & Bryden, 1995; Levine et al, 2005; Terlecki & Newcombe, 2005; Halpern, 2007; Tzuriel & Egozi, 2010).

Mental Rotation

Early and resent studies have found that males tend to surpass females on mental rotation tasks (Maccoby & Jacklin, 1974; Duff & Hampson, 2001a). One example from a wide range of empirical support comes from Shepard & Metzler (1971) who described the mental rotation paradigm as the most robust gender difference in cognitive science. A mental rotation experiment was conducted by Hochberg & Gellman (1977). Male and female participants were presented with a pair of two-dimensional images. The participant had to decide as quickly as possible whether the images were in an identical orientation or a mirror image version. Males consistently showed better accuracy and faster reaction time than females. There is a suggestion from Levin et al, (2005) that modern males may be similar to their prehistoric ancestors. Brains may have evolved individually to meet environmental demands (Mc Burney et al, 1997). Early on in evolutionary terms larger selection pressure was put on men to develop tools and navigational skills (Ecuyer-Dab & Robert, 2003). Men appeared to be more involved in hunting that would possible have taken them further away from their home within an unknown territory thus enabling mental rotation (Gaulin & FitzGerald 1989; James & Kimura, 1997). Recently Kimura (2002) asserts that, males are able to learn routes and recall more particulars about directions of a map in lesser trials then females.

Object Location

In terms of object location, Levine et al (2005) assert that there is a notion that females tend to outperform males. One example comes from Silvermen and Eals (1992). Male and female participants were presented with an array of images, and then shown a second different array whereby some of the images were in exchanged locations. Females located far more images than males. Moreover, McBurney et al (1997) showed performance of females on a memory game task. Pairs of cards were positioned face down. Participants turned over the cards until they found the matched pairs. Women took less time and found pairs in fewer trials than men. Duff and Hampson, (2001a) find that females tend to recall more landmarks and road names which suggest a tendency to spatial memory and may be associated to their higher scores on object location tasks. Research by, Gaulin (1995) suggests that within evolutionary terms women tended to stay at home and

care for children and spent time near to their home searching for food and may have needed to rely upon landmarks. Women also developed the ability to detect minor changes such as displacements in their home that may have signalled a trespasser (Wynn et al, 1996).

Hemispheric Mechanisms

Gender differences within neuropsychological functioning have been examined extensively. (Weiss et al, 2003). The debate has intensified following new imaging techniques such as functional magnetic resonance imaging (fMRI) (Kimura, 2002). One neuropsychological approach in particular, that of Roberts and Bell (2003) has clearly shown that there are differences in terms of cognitive functioning. Within mental rotation tasks, males show predominantly more left parietal activation and females show more right parietal activation. However in contrast, imaging studies including that of Levine et al (2005) have also shown cognitive differences. Male and female participants took part in a computerized mental rotation and object location task whilst carrying out an fMRI scan. Males surpassed females on the mental rotation task, and showed predominantly more activation in left parahippocampal gyrus, inferior parietal lobe, right medial frontal gyrus and inferior frontal gyrus. Whereas females, only showed activation in the left parahippocampal gyrus. No differences were found in the object location task, males showed activation in the left inferior parietal and medial frontal regions, while females activated left inferior frontal gyrus.

However according to Weiss et al., (2003) gender difference research should be approached with caution, variables such as hormones and handedness tend to have an overriding influence within the reported results. Kimura (1999) investigated the influence of hormones and found that there are peak periods when the level of testosterone is much greater in males then in females. Men with lower testosterone levels tend to perform better at spatial tasks. However women with higher testosterone levels tend to perform better at spatial tasks. Testosterone levels in males may vary throughout the time of day and seasons in a year (*higher levels early in the morning, evening and in autumn*). Male spatial ability is enhanced in spring and during the day. The female menstrual cycle produces high and low estrogen phases. During the high estrogen phase females tend to perform better in location recognition tasks. However females perform mental rotation tasks better when at the lower estrogen phase (Levine et al, 2005). The combined evidence of Levy (1969) and Decety & Sommerville (2003) proposed that there are also differences in terms to handedness. Within the WAIS performance test, the extent of handedness was assessed with the Edinburgh Handedness Inventory (Oldfield, 1971) the findings suggest that right handed people were far better at visual spatial ability than left handed people and there was no preference to gender (Rizzolatti & Craighero, 2004).

Interventions

In contrast to a vast literature that exists on gender differences there is a new field of neuroscience that is developing interest around a training paradigm, to establish whether these differences may be eliminated or reduced (Newcombe, 2007; Iachini, 2009). Importantly, the effects of training have proved to be highly significant and provide superior spatial skills essential within engineering, maths and science. (Sternberg & Grigorenko, 2002). A resent idea within this literature finds that predominantly some girls may not engage with sports at school, in particular football;

which requires knowledge of spatial location and rotational ability (Haywood & Lidz, 2007).

Moreover, Feng et al (2007) findings are of great importance as they speculate whether or not gender differences exist in spatial ability and whether any differences can be modified. Male and female participants were trained to play an action video game and practiced object location and mental rotation. Mental rotation improvements were especially pronounced in females, and males were slightly better than females within an object location task. A highly similar study by Lidz & Elliott (2000) used the same paradigm and found that although males and females used different cognitive strategies; they were as capable as each other in task performance. Similarly in the Field, Tzuriel & Egozi (2010) support this notion and conducted a study that trained girls in mental rotation tasks and found that eventually girls performed better than boys. These results seem to be the accepted wisdom now and are consistent with recent studies that have found females advantaged more than males in mental rotation tasks (Coluccia & Louse, 2004; Delgado & Prieto, 2004).

With extensive evidence it is widely accepted that the gender difference debate into social and biological factors is continually ongoing (Linn & Peterson, 1985; Baenninger & Newcombe, 1989; Lawton, 1994; Gittler & Vitouch, 1994; Sutton, 2010). Recent research has reopened the debate and taken an extreme social and deterministic viewpoint of cognitive differences. Fine (2010) claims that there are no sex differences and that humanity is not based on the premise of what a women or men scores in a spatial test. As long as there are equal opportunities for males and females within society, studies that disprove the notion assist in bridging the gap (Levine et al, 1999). Sutton (2010) finds that Baron-Cohan, endeavours to dismantle this finding by demonstrating that fundamentally there are differences between male and female cognitions that are empirically established.

From a scientific perspective, sex differences are an outcome of both biological and social influences. The principal value of analysing sex differences provides awareness of learning disabilities such as autism which seems to affect more boys than girls (Baron-Cohan et al, 2005). Despite this finding there are reasons to be optimistic (Sutton 2010). Gender differences can be scientifically appealing, and researches are often expected to declare the gender of participants. If a difference is established then it is reported (Kimura, 1999). Very often studies claim that sex differences are hard wired but in actual fact the sample sizes are small (Hamilton, 1995; Silverman et al, 2000; Schmader, 2002). Furthermore research from; Iachini (2009) highlights that, several studies show no difference and others show only a male or female advantage; which underlie small effect sizes. Women may have less opportunity than men to practice visual spatial tasks and tend to rate their spatial abilities as more inferior to males (Sherman, 1967).

Resent evidence supports the notion of Foss (1969) that gender is stereotypically an ideology that is primed within the mind and interferes with one's ability and level of interest in the commission of a task. Sharps et al., (1994) find that when participants are not informed that spatial tasks favour males or females, there are no sex differences. Hyde, (2005) asserts that as a consequence of gender roles there is an emergent body of research within the priming phenomenon which demonstrates that by eliminating the treat of stereotype, potentially is released that is usually suppressed. Fine (2010) demonstrates that this outcome is a result of educational, socio-cultural factors and that equal social support and empowerment are vital in constituting positive self belief.

The evidence that is presented is unclear, thus not a precise dichotomy of females being better at object location or males being better at mental rotation. However this may be mediated by social pressures. In light of the preliminary findings of Tzuriel and Egozi (2010) and Fine (2010); an experiment will be conducted to compare the performance of males and females on a mental rotation and object location task, however half of the participants will be primed by the suggestion that the opposite sex are better, to test whether there will be an impact on their performance. Methodology will differ from that of Tzuriel et al (2010) in that the spatial stimuli will be presented in two computerized tasks, thus participants will be directly tested on reaction time and accuracy. The scenes will either be, identical or different. The hypothesis becomes directional in that it will be expected that there will be a selective gender difference in spatial abilities as a result of priming. Prior to this investigation and to the knowledge of the researcher there is no existing research into the effect of priming in both of these tasks together.

Hypothesis

For the mental rotation task it is hypothesised that,

H1: There will be a difference between males and females on the mental rotation task.

H1: There will be a difference depending upon the priming condition on the mental rotation task.

H1: There will be an interaction between priming and males and females on the mental rotation task

For the object location task it is hypothesised that,

H1: There will be a difference between males and females on the object location task.

H1: There will be a difference depending upon the priming condition on the object location task.

H1: There will be an interaction between priming and males and females on the object location task.

Method

Ethical Approval

Ethical approval for this study was obtained from the Department of Ethics Committee of the Faculty of Health and Human Sciences, University of West London as according to guidelines by the British Psychological Society (BPS).

Design

The first task was mental rotation and used a, 2x2x2 mixed experimental design. The task was analysed by using a split plot ANOVA. The between subjects factors were gender (males vs females). Another between subject factor of two types of prime (primed vs not primed). The within subjects factors, were the image orientation (identical vs mirror image). The dependant variable was a measure of the participants reaction time (in milliseconds) and the number of correct responses out of 20 trials per task. The second task was object location, and used a 2x2x2 mixed

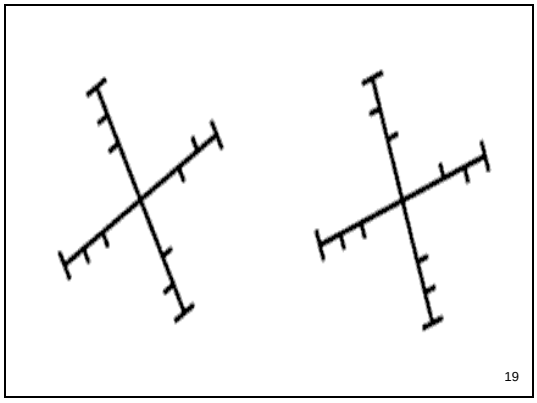
experimental design. The task was analysed by using a split plot ANOVA. The between subjects factors were gender (males vs females). Another between subject factor of two types of prime (primed vs not primed). The within subjects factors, were the tasks (identical vs different). The dependant variable was a measure of the participants reaction time (in milliseconds) and the number of correct responses out of 20 trials per task.

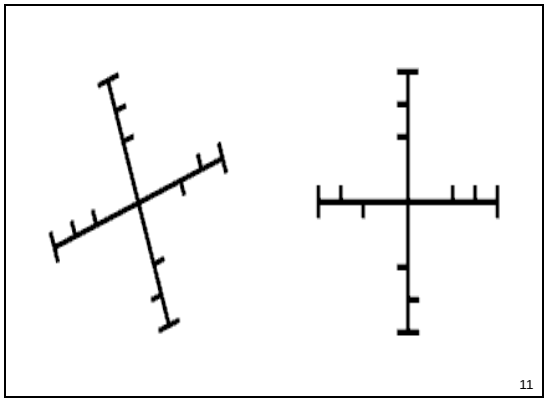
Participants

The participants are male and female undergraduate students from, The University of West London, aged 18 years and over. There were 40 participants in total. Right-handed participants were chosen based on research that showed different hemispheric functioning amongst individuals that were left and right handed (Kim et al., 1993). Kramer et al., 1996 suggested that this variable needs to be controlled when investigating gender differences in spatial ability. Female n1= 20 (range 21-37, mean age 29) Male n2= 20 (range 23- 40, mean age 32). Participants were recruited by the researcher. They were approached after lectures, and asked if they would like to volunteer to take part in a cognitive research project. All participants had no previous knowledge of the items in the computerized stimuli. They participated in an experiment that comprised two cognitive behavioural tasks.

Materials

Stimuli were presented using *Super Lab* version 4.5 (computer experiment generator) which also controlled the timing of each trial in milliseconds. The experiment was run on a laptop. The *mental rotation task* followed the procedure by (Hochberg & Gellman, 1977). Stimuli were designed using Microsoft PowerPoint 2007. Stimuli for the mental rotation task comprised 20 pairs of two-dimensional images that were rotated from 0° to 180° degree angles. The images were 8cm in length, consisted of black cross with small bars on a white background. Each trial began with a pair of Images presented at the same time in the middle of a computer screen in either an identical orientation or a mirror image version. The participant mentally rotated the right image until it was viewed from the same perspective as the reference image on the left. Figure 1, is an example of stimuli used; **a,** and **b** feature some of the mental rotation images used. The images in **a,** are both identical, and **b** differs in the form of the reference image. Participants immediately indicated using one of two keyboard keys (I key, for identical orientation and M key, mirror image version). Then a black fixation cross (4 ° x 4 ° cm) appeared in the centre of the screen for 500 milliseconds to refocus the participants attention onto the next trial. There were 20 trials in total. Upon analysis, the recognition response is tested for speed and accuracy.





A **B**

Figure 1: Examples of experimental stimuli used for mental rotation phase of experiment. A, identical images presented in different *angles*. B, features 2 mirror image versions. Sitting comfortable in front of the computer allowed the participants to view the imagery, visualise and mentally rotate a comparison in depth.

Following Silverman and Earls (1994) paper and pencil version of an object location task, a computerized version was designed in PowerPoint. On the Super lab program, an array of 13 familiar images with a black outline (see figure 2) were presented on a white background and appeared in the middle of the screen for 1200 milliseconds. The participant analysed the array then a fixation point emerged for 500 milliseconds to refocus the participants attention. Then a second array of images appeared, one of the images may have been transposed. The participant pressed the, I key if both arrays were identical or the; D key if they were different. There were 20 trials in total. Upon analysis, the recognition response is tested for speed and accuracy.

A B

Figure 2: Stimuli examples, (a) presentation of an array of familiar line drawings (left) differ from (b) response array (right).

Ethical Considerations

BPS code of ethics and conduct were carefully revised (www.bps.org.uk & Bersoff, 2008). The participants were presented with an outline in advance, detailing the purpose of the study and ethical guidelines. The experimental procedure was explained to the participants so that they were made aware of what was expected of them. Participants were given the opportunity to remain anonymous they were not linked with any research materials. They were informed that their participation was completely voluntary and their data will be used to examine differences in male and female cognitions which were assessed by The University of West London for dissertation purposes only. The participants were advised that there was no risk of physical or psychological distress. The participants were given the opportunity to ask questions regarding the procedure. They were informed of their right to withdraw from the research at any stage and for any reason, without negative consequences. Written consent was obtained for their participation. All data was treated with full confidentiality. Participants were debriefed at the end of the study.

Procedure

The goal of the study was to compare gender within two cognitive behavioural tasks (mental rotation and object location). Every effort was made to produce clear experimental instructions and create stimuli that were easy to view. A pilot study was carried out on (n = 10) university colleagues in order to investigate an accurate development of each task. The preliminary results showed that the length of milliseconds necessary for the participants to view the fixation point was adjusted to less. All trials for both tasks were randomised per participant to prevent floor and ceiling effects. The numbers of images in the location task stimuli were decreased from twenty to thirteen. Images for both tasks were adjusted and enlarged in size.

Main Experiment

The experiment began at The University of West London. Potential participants were asked questions from the Edinburgh Handedness Inventory (Oldfield, 1971) to determine full right handedness. One participant took part at a time. Informed consent and demographic information were obtained. The participant was lead to the computer and the mental rotation task was administered. Instructions on screen informed the participant to press one of two keys to indicate whether the image was a correct orientation or a mirror image version. Once completed, the object location task was administered. The instructions informed participants to use the computer keys in accordance to indicate whether any item from an array of 13 images were transposed from the previous presentation location. The entire experiment took approximately five minutes. Upon analysis the recognition responses of both tasks were tested for accuracy and reaction time out of twenty trials. Trials were randomized for each participant. The presentation of these tasks, were counterbalanced across participants, half of the male and female participants performed the rotation task first then the location task to avoid any order or practice effects.

Priming

Following the study by Steele et al (2002), half of the participants were randomly primed on both tasks. Ten male participants were informed that males perform better than females on *object location tasks* and females perform better on mental rotation tasks. Ten female participants were informed that males perform better on object

location tasks and they perform better than males on *mental rotation tasks.*These were standardised tasks which are not known to have any significant psychological effects. If any of the participants appeared to feeling anxious they were approached by, the experimenter and asked if they wished to continue. Their participation and data were kept confidential.

Results

Mental Rotation Task

The data was entered into SPSS and descriptive statistics of the mean correct responces can be found in the table below.

Table 1
Means and standard deviations for correct responses for the mental rotation task

	Identical Prime		No Prime		Mirror Image Prime		No Prime	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Male	7.00	1.41	8.30	1.34	7.50	1.43	6.50	1.84
Female	6.90	1.59	4.90	1.37	6.90	1.29	5.90	1.20

Table 1, shows the mean correct responses of primed and non-primed participants. Primed males obtained lower mean scores to identical images, conversely non-primed males showed a higher mean score. Primed females showed a high mean score. In contrast non-primed females show the lowest mean scores and prominently to identical images. Mirror image stimuli had no effect on primed males, mean scores were higher than non-primed males and primed females. Overall the mean scores suggest that males performed better than females. Females performed better once primed.

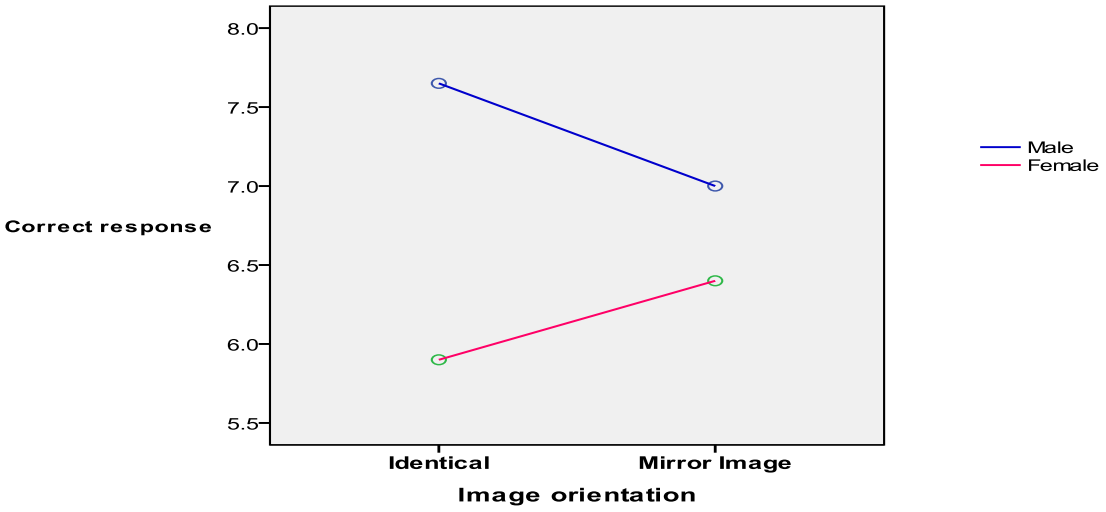


Figure 3: Plots illustrating correct responses out of 20 trials on the mental rotation task for gender

Figure 3, shows mean correct responses of participants. A 2x2x2 split plot ANOVA was conducted. The between subjects factors were gender (males vs females). Another between subject factor of two types of prime (females perform best vs males do not perform best). The within subjects factors, were the task (identical images and mirror images). On analysing, gender and mental rotation task there was an interaction effect, F= (1, 38) 4.031; P<.05 an inspection of the means indicated that males performed better than females. There was a main effect for gender F= (1, 38) 10.84; P<.002. There was no main effect for mental rotation task F= (1, 38) .069 P = .795ns.

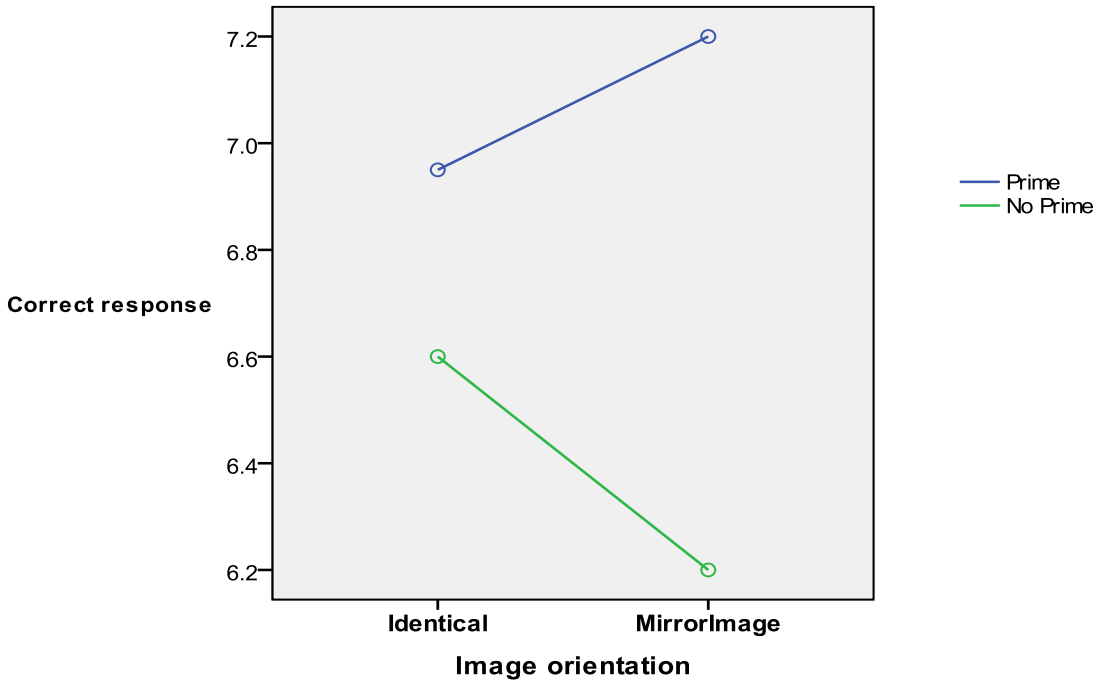


Figure 4: Plots illustrating correct responses out of 20 trials on the mental rotation task for prime

Figure 4, shows mean correct responses of primed and non-primed participants. A 2x2x2 split plot ANOVA was conducted. The between subjects factors were gender (males vs females). Another between subject factor of two types of prime (females perform best vs males do not perform best). The within subjects factors, were the task (identical images and mirror images). Upon analysis, gender; prime and task showed an interaction effect F= (1, 38) = 8.299; P<.007 an inspection of the means indicated that primed females improved in both stimuli, primed males scored less with identical stimuli. Gender and prime showed a main effect F= (1, 38) 13.61; P<.027. There was no main effect for prime and mental rotation task. F= (1, 38) 1.28; P =.264ns. There was no main effect for prime F= (1, 38) 3.57; P =.067ns an inspection of the means revealed an opposing effect.

Table 2

Means and standard deviations for reaction time out of 20 trials on the mental rotation task

	Identical Prime		No Prime		Mirror Image Prime		No Prime	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Male	3277	.57	4861	.86	2584	.06	3615	.20
Female	4600	.90	9089	.62	2913	.57	8177	.34

Table two, shows mean reaction times in milliseconds for both sets of stimuli. Priming showed an effect on females; mean reaction times were faster to mirror images. In comparison without priming, females showed a slower mean reaction time and less accuracy. However, primed males showed slightly faster mean reaction times than non-primed males and females in general. Conversely, both males and females showed faster mean reaction times and more accuracy with mirror images.

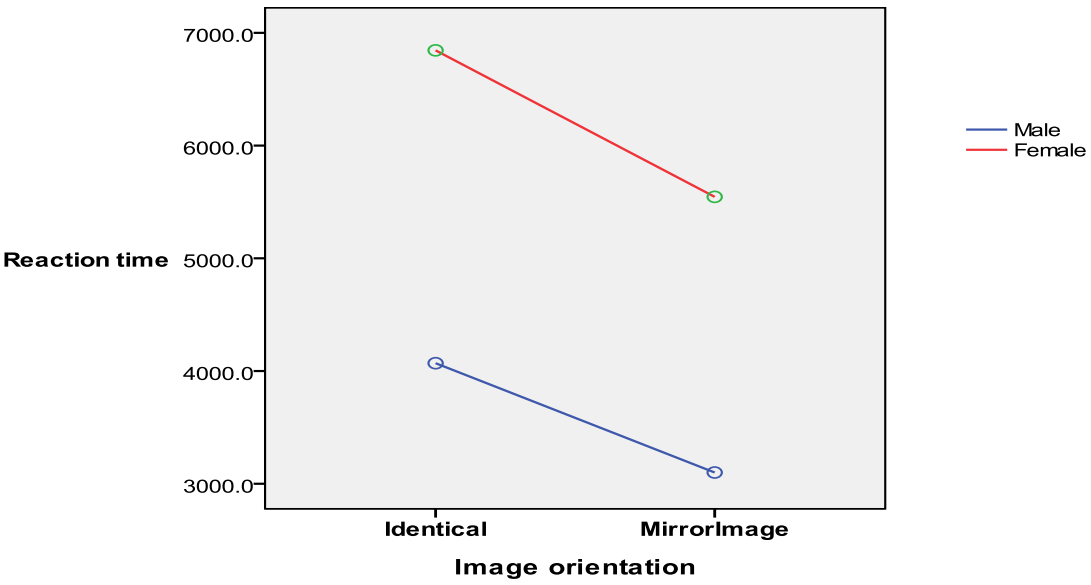


Figure 5: Plots illustrating mean reaction times on mental rotation task for gender

Figure 5, shows the participants mean reaction times in milliseconds. A 2x2x2 split plot ANOVA was conducted. The between subjects factors were gender (males vs females). Another between subject factor of two types of prime (females perform best vs males do not perform best). The within subjects factors, were the task (identical images and mirror images). Upon analysing the data, there was a main effect for reaction time and mental rotation task F= (1, 38) = 37.5; P<.00. Gender showed a main effect F= (1, 38) 21.10; P<.00 an inspection of the means indicated that, males reacted faster than females. There was no main effect for reaction time, mental rotation task and gender F= (1, 38) .792 = .379 ns.

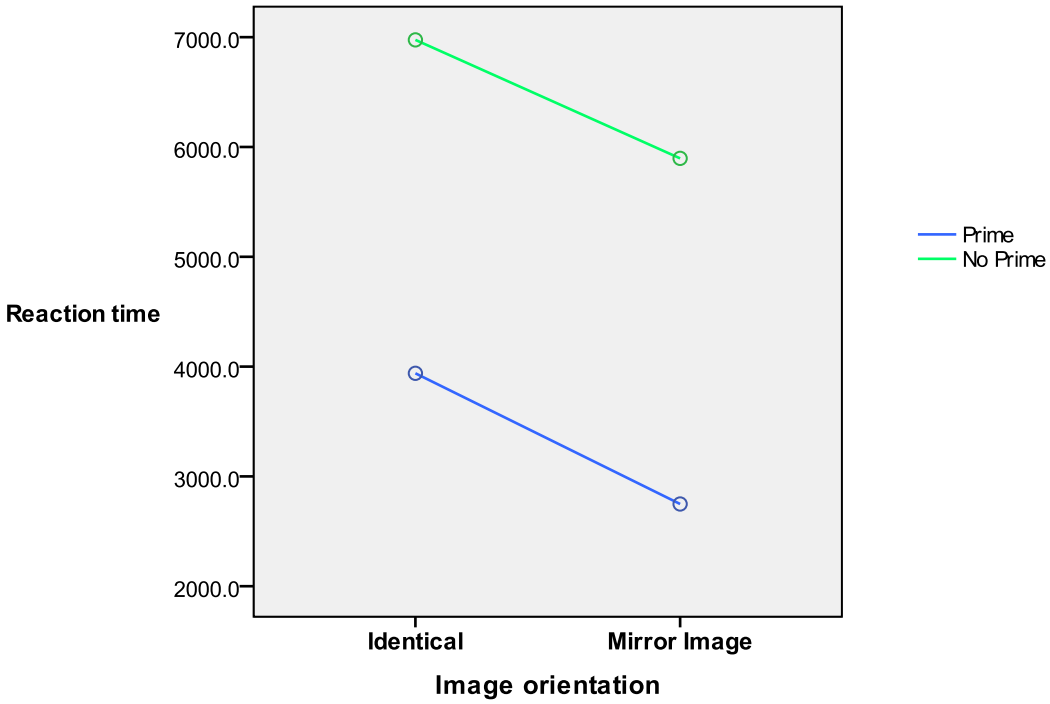


Figure 6: Plots illustrating mean reaction times on mental rotation task for prime

Figure 6, shows the participants mean reaction time in milliseconds. A 2x2x2 split plot ANOVA was conducted. The between subjects factors were gender (males vs females). Another between subject factor of two types of prime (females perform best vs males do not perform best). The within subjects factors, were the task (identical images and mirror images). On analysing, prime there was a main effect F= (1, 38) 29.60; P<.00. There was a main effect for gender and prime F= (1, 38) 21.10; P<.00 an inspection of the means signified that priming had a significant effect on reaction times for males and females. There was no main effect for reaction time, task and prime F= (1, 38) .090; = .766 ns. There was no main effect for reaction time, mental rotation task, prime and gender F= (1, 38) .090; = .082 ns.

Object Location Task

The data was entered into SPSS and descriptive statistics of the mean correct responce can be found in the table below.

Table 3

Means and standard deviations for correct responses out of 20 trials on the object location task

	Identical				**Mirror Image**			
	Prime		**No Prime**		**Prime**		**No Prime**	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Male	5.30	1.95	6.30	1.49	6.00	1.88	4.60	1.35
Female	6.50	1.84	8.30	1.57	6.30	2.75	8.00	1.49

Table 3, shows the mean correct responses for primed and unprimed participants. Primed males showed a low mean scores to identical images, compared to non primed males and females. Primed males showed a higher mean score to different images. In contrast, non-primed males acquired the lowest mean score to different images. Primed females showed lower mean scores compared to non-primed females. Conversely, females had the highest mean scores suggesting that performance stayed consistent across both sets of images.

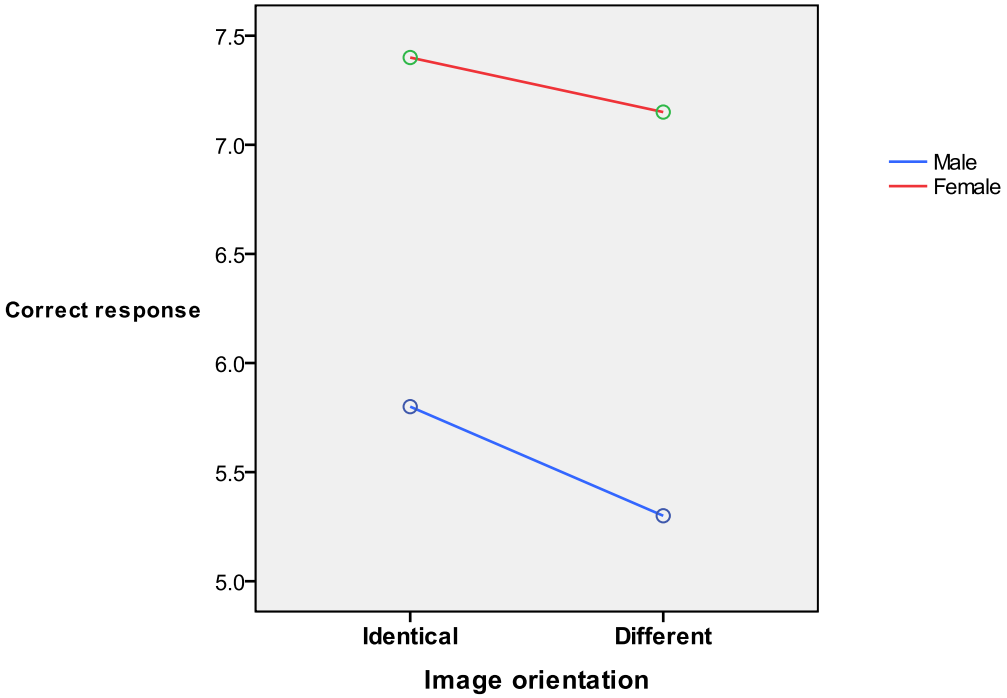


Figure 7: Plots illustrating mean correct responses on the object location task for gender

Figure 7, shows the mean correct responses of participants. A 2x2x2 split plot ANOVA was conducted. The between subjects factors were gender (males vs females). Another between subject factor of two types of prime (males perform best vs females do not perform best). The within subjects factors, were the task (identical images and different images). On analysing, gender there was a main effect F= (1, 38) 12.80; P<.001. There was no main effect for object location task F= (1, 38) 1.333; P = .256ns. There was no main effect for task and gender, F= (1, 38) 1.333; P = .703 ns.

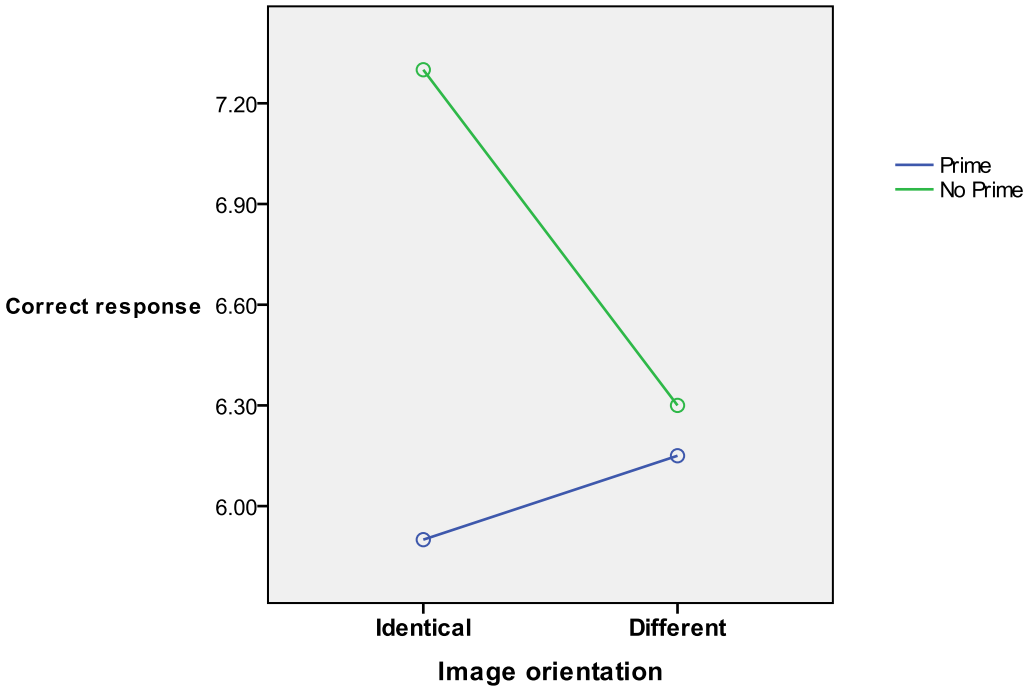


Figure 8: Plots illustrating mean correct responses on the object location task for prime

Figure 8, shows mean scores of prime. A 2x2x2 split plot ANOVA was conducted. The between subjects factors were gender (males vs females). Another between subject factor of two types of prime (males perform best vs females do not perform best). The within subjects factors, were the task (identical images and different images). On analysing, prime there was no main effect, F= (1, 38) 2.58; P = .117ns. There was no main effect for object location task and prime at the p < 0.05 level, F= (1, 38) 3.703; P = .062ns. There was no main effect for task, gender and prime F= (1, 38) 3.134; P = .085ns. An interaction effect occurred between gender and prime F= (1, 38) 4.09; P<.05 an inspection of the means identified that females obtained the most correct responses, non-primed males showed some improvement in performance.

Table 4
Means and standard deviations for reaction time on the object location task

	Identical				**Mirror Image**			
	Prime		**No Prime**		**Prime**		**No Prime**	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Male	3346	.85	3371	.94	3791	.07	5238	.69
Female	2544	.57	2536	.23	2538	.90	3089	.50

Table 4, shows, the participants reaction times in milliseconds to both sets if stimuli. Priming showed no effect on male mean reaction times to identical images. However, non-primed males showed a slower mean reaction time to different images. Priming had less effect on female's their mean reaction times were faster and more accurate constantly across the trials.

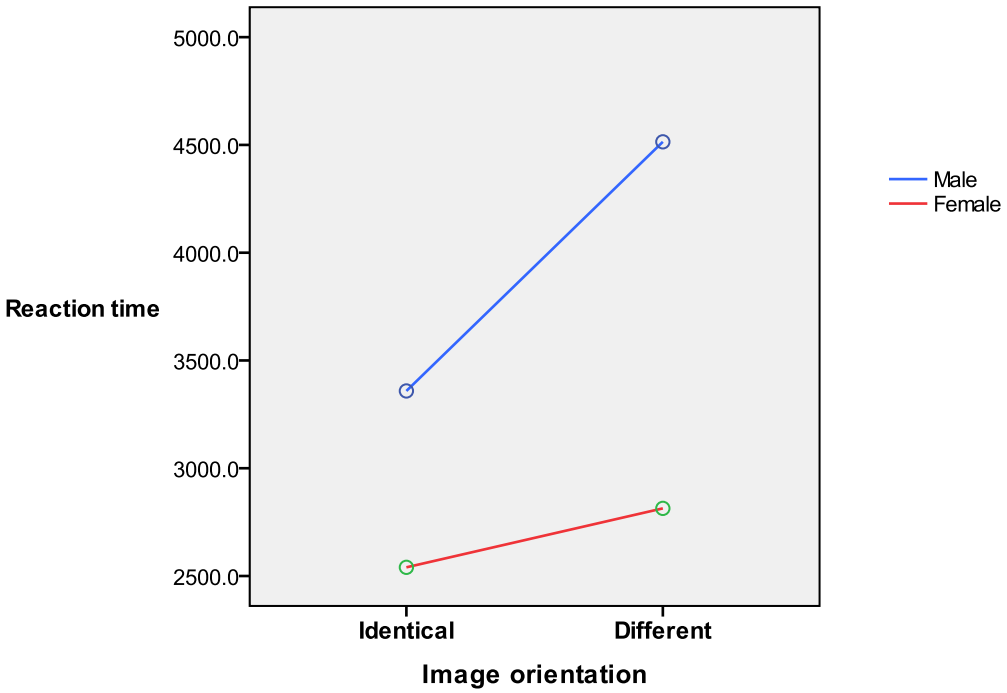


Figure 9: Plots illustrating mean reaction times on object location task for gender

Figure 9, shows mean reaction times in milliseconds for gender. A 2x2x2 split plot ANOVA was conducted. The between subjects factors were gender (males vs females). Another between subject factor of two types of prime (males perform best vs females do not perform best). The within subjects factors, were the task (identical images and different images). The analysis revealed, there was a main effect for gender F = (1, 38) 6.60; P<. 014. an inspection of the means signified that females reacted faster than males. There was no main effect for object location task F= (1, 38) 2.979; P = .093 ns. There was no main effect for task and gender F= (1, 38) 1.431; P = .239 ns.

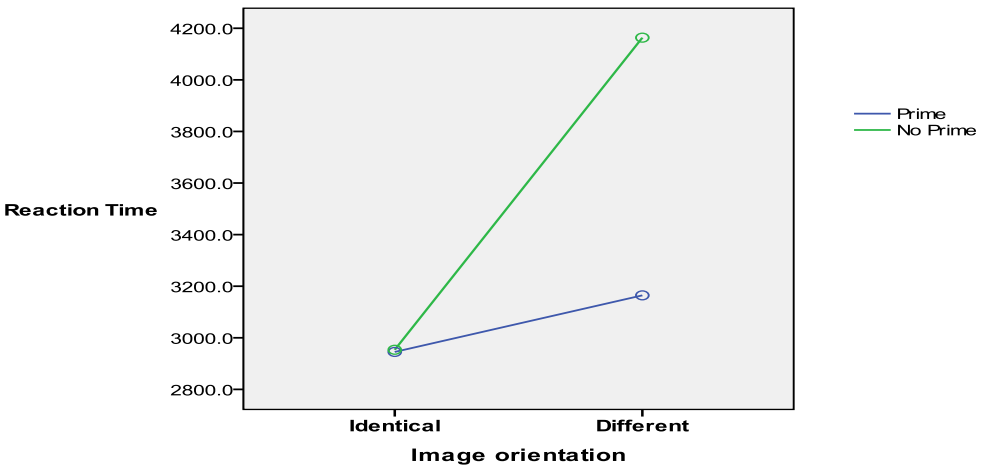


Figure 10: Plots illustrating mean reaction times on object location task for prime

Figure 10, shows mean reaction in milliseconds for prime. A 2x2x2 split plot ANOVA was conducted. The between subjects factors were gender (males vs females). Another between subject factor of two types of prime (males perform best vs females do not perform best). The within subjects factors, were the task (identical images and different images). On analysing, prime there was no main effect F= (1, 38) 1.057; P = .311ns. There was no main effect for prime and gender F= (1, 38) .226; P = .638ns. There was no main effect for object location task and prime F= (1, 38) 1.431; P = .239ns. There was no main effect for task, prime and gender F= (1, 38) .271; P = .606ns.

Discussion

The aim of this study was to investigate whether there are sex differences in egocentric spatial ability and whether priming can eradicate any differences. For the mental rotation task, it was hypothesised that; there will be a difference between males and females on the mental rotation task. There will be a difference depending upon the priming condition on the mental rotation task. There will be an interaction between priming and males and females on the mental rotation task. For the object location task, it was hypothesised that; there will be a difference between males and females on the object location task. There will be a difference depending upon the priming condition on the object location task. There will be an interaction between priming and males and females on the object location task.

The data supports the hypothesis for the mental rotation task. This task was invariably concerned with reaction time and accuracy and able to detect differences that went undetected in previous studies. The results suggest that by priming half of the male participants to the perception that females perform better there was an effect on there perfomance. When presented with identical images their reactions were slower with fewer correct responses. This is not consistent with other literature, thus the assumption is raised as to whether a decline in performance underlies a lack of confidence. Weiss et al, (2003) assert that results are inconsistent throughout studies due to stringency and methodological problems and that sex differences will not endure the test of time, within better methodologies and larger samples. Consequently, without priming males still reacted slower to identical images but in contrast had the highest correct responses overall. Interestingly primed males were the most accurate and fastest to mirror images.

Priming half of the female participants to the notion that they perform better than males, proved to be effective. They improved to the perfromance of males and were equally accurate in both sets of stimuli and exhibited an expectionally fast reaction to mirrior images. In this light this research has shown similar findings to, Steele et al (2002) and Schmader (2002) in that priming remarkably reduces stereotype threat when males and females are advised that a task is in favour of their gender they perform better, whereas when participants were told the opposite they perform significantly worse. Although these studies varied from the experimental paradigm used within this task and was interested in mathematical abilities as opposed to visual spatial abilities, it still points to the fact that females are more prone to make errors due to irrational beliefs. Ortner & Sieverding (2008) assert that striking results are found when the threat of stereotype disappears thus females perform considerably better than they expected. Furthermore results support the notion of Hyde (2005) that across a range of tasks males and females are more similar then different.

The present study found that without priming, male performance improves and female performance was considerably poorer and predominantly to identical images. Similarly, Webb et al; (2007) have shown that males show better accuracy and faster reaction time than females on mental rotation tasks. This task has revealed that there are gender difference as males are performing better than females in general. However priming appears to have provided an effective positive reinforcement for females. They improved considerably in speed and accuracy. This result was able to replicate previous findings. Sharps et al (1994) examined effects of priming performance in spatial tasks and found a significant main effect of priming on a mental rotation task for females.

Overall the results are in accordance with the prediction that by notifying males that their performce is inferior, and notifying women that their performance is superoir, performance differences disappear. Males begin with the confidence that their performance is better whereas females appear to lack in confidence. This could in part explain Weiss et al's (2003) findings, that males rate their spatial abilities superior to females, whilst females scarcely rate their spatial abilities superior to males.

The data was also able to support the hypothesis for the object location task. The results reveal that by priming half of the male participants to the presumption that they perform better than females showed a diverse effect in performance and confidence as they actually performed worse with identical arrays, they obtained fewer correct responses but reaction time was fast. Results here suggest that the rather small sample of (10) participants in the priming condition poses a need for caution. Despite this, with different arrays they were slightly more accurate. Whereas in contrast males that were not primed were the slowest and least accurate to different arrays. This further highlights the profound effectiveness of the experiment in being able to detect subtle differences.

Furthermore, results support the notion of Sommer et al, (2004) among others (Coluccia & Louse, 2004; Delgado & Prieto, 2004) that the role of social and psychological variables prompts how males and females perform. Consequently by priming half of the female participants to the opposite perception, it is interesting then that performance hardly differed between primed and non primed females on either image of the task. It is highly unlikely that this result is due to a ceiling effect as trials were randomized within the Super Lab software and tasks were counterbalanced. Priming females had very little effect to their confidence and performance, they remained faster and more accurate and constantly across the trials. It is established by Duff and Hampson (2001a) that females do show better accuracy and faster reaction time than males on object location tasks.

This investigation and that of Tzuriel & Egozi 2010 have provided robust behavioural evidence and a vital starting point for further neuropsychological studies to draw a close to gender differences. This finding supports the more defined perception of Fine, (2010) that fundamentally there is no sex difference unfortunately the difference lies in the way that society threats gender a perception that is primed within the mind. Once the perception is changed performance differences diminish. Baron-Cohan (2005) asserts that an influence of social factors can change behaviour, and despite the elegance of these findings this is a sterile pursuit that does not prove priming has caused a spontaneous gender difference to occur in the first place. This influence has been suggested to be a form of intervention assuming that an absence of gender stereotype may be the cause of change. Good (2008) argues that essentially if females are frequently remained that males posses superior

spatial skills then they may be of that belief. In general females are encountering more limitations in their socio-cultural experience and expectations than males; such as equal education and opportunity. The contribution of this research embraces the fact that social factors are significant and play a vital role in shaping ones behaviour. When people feel encourage and hence more confident, they are more incline to perform better on tasks.

Conclusion

Ultimately the sex differences that are derived from spatial abilities are complex and not as straightforward as some research asserts. When differences are found they are actually rather small and across a range of tasks there are more similarities than differences not this precise dichotomy that some evidence asserts. Both males and females have individual strengths and limitations. The experiment examined whether priming might have an effect on performance. With the use of two innovative computerized tasks that were designed to measure reaction times and accuracy, this study was able to highlight differences that were too subtle to be captured by standard paper and pencil test. The experiment indicated that males and females differed in their spatial ability and performance as expected. Consistent with the priming literature the results suggest that priming enables an improved holistic spatial awareness amongst females and reduced initial sex differences in task performance whether the differences were attributed to environmental or biological factors. Once the perception is adapted female performance shows an improvement. Participants that were not primed showed gender expected performances. Future developments to neuroimaging technology may be able to shed further light on any sex differences. This research has revealed that performance expectations are influenced within priming and presents an interesting prospect for further neuropsychological study.

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