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The Role of Mental Rehearsal in Spatial and Object Imagery during Mental Rotation

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Abstract

Mental imagery has long been a topic of interest in cognitive psychology, with researchers exploring the relationship between spatial abilities, visual processing, and mental rotation. This study aims to investigate the impact of mental rehearsal on mental rotation, specifically examining whether spatial imagery or object imagery is the more dominant mechanism. The experiment involved 54 participants divided into three groups. The first group (18 participants) practiced mental rehearsal based on mental rotation, while the second group (18 participants) engaged in a task involving scoring tennis balls on different visual shapes (four large and four small). The third group performed mental rotation without any mental rehearsal or visual stimuli. Results show that mental rehearsal spun the mental rotation on vertical axis and right side of rotation, these results approve that mental imagery is not pictorial information, but also mainplanes the motor system, these findings have opened many questions for future studies about left- and right-hand tasks during rotation and mental imagery for motor system.

Keywords: Mental Imagery, Mental Rotation, Spatial Perception, Performance

Introduction

Motor performance can even be influenced by embodiment, ideomotor, and mental representations, (Wilson, 2002; Knuf et al.,2001; Henning, 2017; Jansen & Doren., 2012; Jaquess et al., 2021) but mental imagery could be key role to spin perception and action (Monaco et al., 2020; Toth et all., 2020). In this study we try to investigate, that mental rotation and spatial perception are spined by mental imagery during motor task or performance.

Mental imagery is clearly important for motor task and mental processing. The two sides of mental imagery, explicit and implicit motor images, such as explicit is conscious representation of an action see (Jeaenrod & Frank, 1999; Jeanerod & Jacob., 2005; Cole et al., 2022; Suggate & Lenhard, 2022)

Several studies have confirmed that mental imagery guided to more successful performance (for review see Toth et al., 2020) and still central concern of cognitive science (Cole & Eacoll, 2022). The studies of Titchener circles or the Ebbinghaus illusion have confirmed improving of sport performance (Chauvel & Wulf, 2014; Wood et al., 2013; Witt et al., 2012)

Vision and action are important for motor task or sport performance, mental imagery is like perception and is link between perception and action (Dieter at al., 2014; Beilock & Gonso, 2008; Tatler & Land, 2011). The mental representations play crucial role in action or performance. We see is not the same thing as the allocentric and egocentric model and nor same embodied of things. Most of things which around us have mental representations are not the same level of effect size. So, one of these keys are mental imagery and the Visual illusions in motor system. The most Ebbinghaus illusion findings, that visual illusion improves sport performance. For instance, Witt and Proffitt (2013) used the Titchener circles (visual illusion) two task first one (11) small circle (3.8 cm diameter) surround the golf hole (10.16 cm diameter) and second task (5) large (28 cm diameter) circles around the golf hole to create the Titchener circles or visual illusion. The study findings that golf was enhanced when the hole surround by the little circles. see (Chauvel & Wulf., 2014; Witt & Proffitt., 2014; Wood et al., 2013).

However visual imagery and mental rotation task are still debated (Zhao et al., 2019; Jost & Jansen, 2021) Mental imagery has several kinds of representations, the most important: Spatial imagery, object imagery and rotated imagery, (Blajenkova et al., 2006; Burton & Fogarty, 2003; ;Khalaf, 2014;Penez-Febello., 2019). The spatial imagery refers to object in movement or in space, in this investigate was used rotated object imagery that refers to

different sizes and shapes. however, mental rotation is linked spatial task (Campos-Juanatey & Campos., 2019)

The aim of this study is to investigate that mental imagery spins visual illusion and mental rotation together during motor task whether spatial imagery or object imagery. To investigate this question, we used three conditions, first one is mental rotation with numbers only, and second condition is visual illusion with four big balls and four small balls, third condition similar second condition, but with practice (mental imagery) see Figure (1). All three-groups did mental rotation, but second group used visual illusion addition to rotation, also third group used mental imagery based on visual illusion addition to rotation. So, if mental imagery will spin mental rotation and visual illusion, mental imagery will be doing more scores and few errors than mental rotation and visual illusion, also try to recognize about spatial image and object image of mental rotation during motor task.

Method

Participant

Fifty-four students (24 years men: *mean* age, *SD=2.6*) participated in this experiment. They satisfied all requirements for volunteer gave informed consent approved by Education College, Ethics Committee at Mastansiriyah University. All participants considered themselves to be in good health, had no history of disease, and were not undergoing any medical treatment that might influence motor or vision-motor functions. The final sample size of 18 provides 80% power to detect effects with $d > 0.695$.

Material and apparatus

There were two dart board rings each one is attached at a wall at the height of 173cm. size of diameter is 80 cm, inside a board ring there are eight circles, each circle has diameter: 12 cm. The distance between the starting line, where the participant was instructed to stand, and board was 350 cm. The two board rings one board numbers ring and second one with eights shapes, four big balls, (football, handball, basketball, volleyball) and four little billiard balls, see figure (1)

Procedures and design

In the present study, three participant groups (rotation task, mental rehearsal and visual shapes {each group *n*=18}) The first group task is mental rehearsal and mental rotation addition to visual objects board which included eight shapes, four big balls and four little balls, see the right side of figure (1). Participant was informed to throw the ball's tennis according examiner's order, e.g., examiner says to participant please imagine yourself to throw the ball on the football circle for a few second, after that participant throws the ball tennis to football circle, also billiard ball number nine and until finish eight trails doing randomly. The second group same task, but without mental rehearsal, examiner gives the order to participant to start throwing the ball tennis on the target. Examiner selects the eight trails randomly. the third group task was rotation based on circle inside a board (figure one) with numbers, the participants preformed the task spontaneously. Participant starts the task via signal from examiner, this task takes a few seconds. Participant throws the tennis ball according to examiner's signal, this task is the eight trails doing randomly, for instance participant throws the tennis ball to any number in circle, based on examiner's order and number to complete eight trails for each participant.

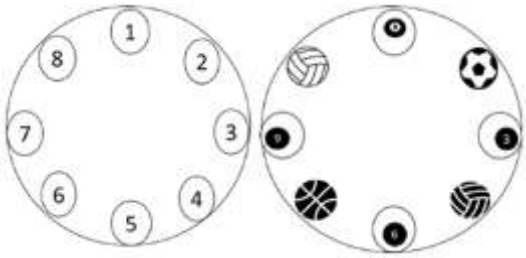

Figure (1)(2)Two dart board rings (mental rotation, visual shapes)

Note: The shaps are the same scale,but the right dartborad looks bigger than the left dartborad. This phenomenon is called Ebbinghaus illusion.

Results

The first group, the mental rotation with mental rehearsal, $t(17) = -2.718$, $p<0.015$, $d = -0.641$, high significant data, the participants made more successful trails, during execution of performance, also second group, mental rotation task with Visual objects for big and little Object t (17) = 2.482, $p<$ 0.024, d=-0.585, while mental rotation without Visual objects and mental rehearsal the result is insignificant t (17) = 0.356, p=0.726, d=0.084. In

General, there is a marginal significant among the three groups (mental rotation without visual objects and mental rehearsal, one- way anova F (18) = 2.777, p= 0.072, η^2=0.098.

These results of the circles of rotation, which was divided into two sides right side, that is consisted of numbers 2,3, and 4 while, the left side is consisted of numbers: 8,7, and 6) addition to vertical column number 1 and 5. The vertical column finding: F(18)= 6.250, p<0.017, η^2= 0.079 Mental imagery in the vertical column was significant and better than rotation task and visual illusion, while rotation and visual shapes was on the right side: F(18) = 1.830, p=0.185, η^2 = 0.028. On the right side of the board rotation: Numbers 2,3, and 4 between mental rehearsal and visual objects F (18) = 4.219, p<0.020, η^2 = 0.069, also mental rotation and mental rehearsal there was insignificant. But the interesting thing happened on the left side of the number 8,7, and 6 that reveal visual objects was better than mental rotation task. F (18) = 4.749, p< 0.03, η^2= 0.036. see Figure (2) and (3)

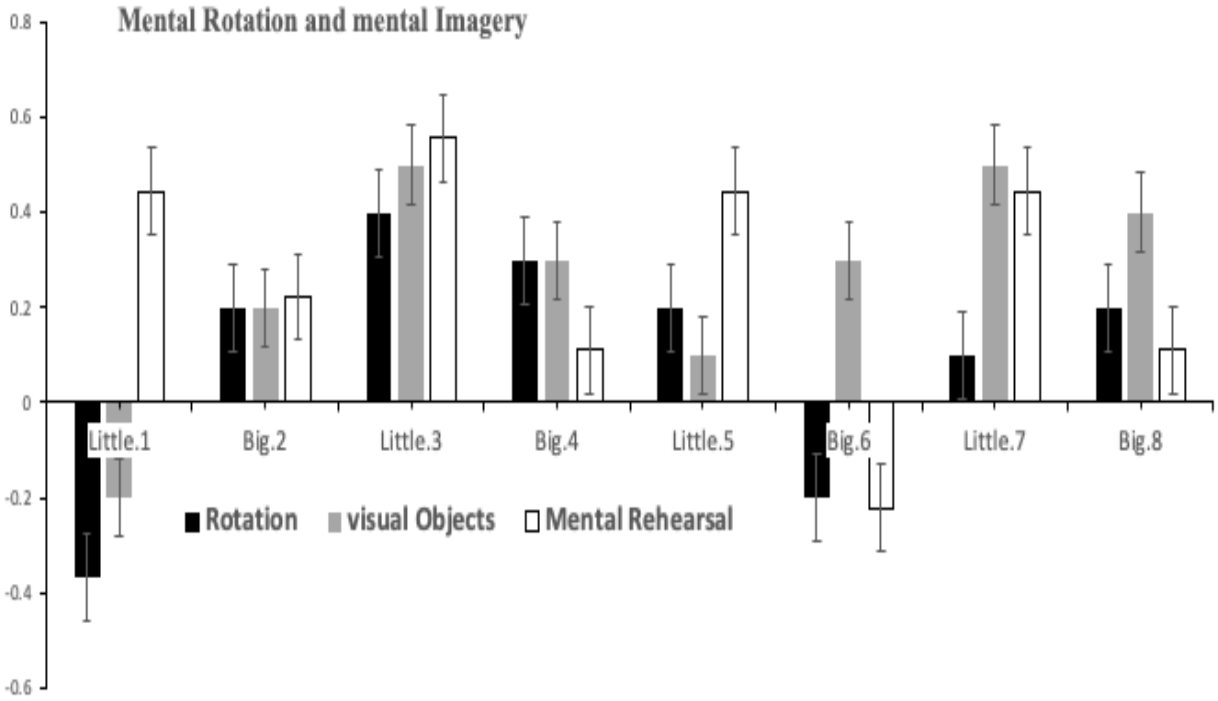

Figure (3) shows that mental rotation for eight numbers was positive accept number (1) and (6) were negative, also visual illusion at location number (1), while mental imagery is best of all accept at location number (6), this is interesting data. specific at location number (6) is big shape (basketball) this is data could be embodiment has robust role to influence to visual illusion more successful than others or could be rotation number (6) is confused location for mental imagery and rotation. This data will be discussed in general, there is different effect among three groups mental rotation without vision illusion that included (little & big) objects. Mental rotation with mental imagery is the best results than rotation with visual illusion see figure (4)

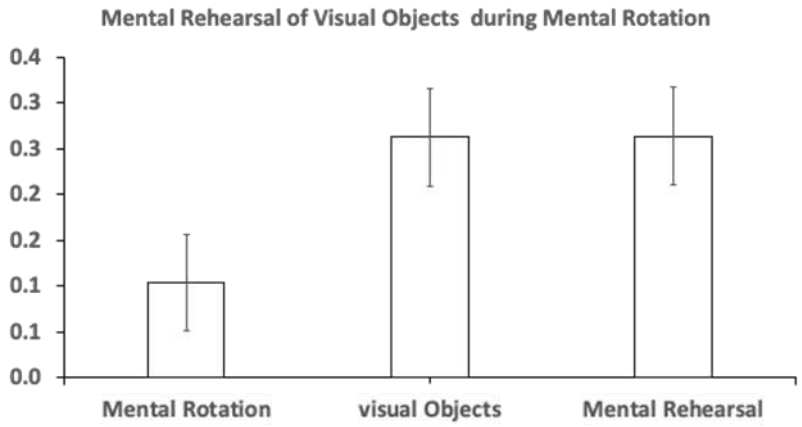

Figure (4) Descriptive statistics of three conditions (mental rotation, visual illusion and mental imager

*Note***:** Mental rehearsal with mental rotation and visual shape are better than mental rotation alone.

Discussion

Mental imagery plays a crucial role in the influence on direct mental rotation but not same level with visual illusion, also still debate if mental imagery is powerful for spatial imagery and shape, size imagery (Zhao et al., 2019; Jost & Jansen, 2021). In this study is used mental imagery to imagine the spatial and shapes image during mental rotation.

The results of different shape (big circles and little circles) revealed that mental imagery is spinning visual illusion and mental rotation but not all rotated locations and more specifically big shape number (6) circle and little shape number (1) circle. In vertical column number (1) mental rotation and visual

illusion did more error in negative side, while mental Imagery did more scores in the positive side, the reason of this different finding could be role of attention focus has enhanced the task or performance, while mental rotation and visual illusion could be influencing of many circles which surround of circle number (1). Also circle number (6) Visual illusion of basketball shape was much better than mental imagery and mental rotation, these findings could be influenced to embodied of object, basketball is so familiar object used by hands than others objects.

The brain is such as motherboard has two hemispheres and is divided into symmetrical left and right hemispheres. As known each half of brain is in charge of opposite side of the hands or the body, right brain controls left side of the body and the right hemisphere controls left side of the body. In these results the data revealed that right side of board number (2,3,4) was highly significant to mental imagery, also vertical column of board number (1,5) this is linked to conscious that is link between perception and action, while on left side of the board number (8,7,6) was highly significant of visual illusion and much better than rotation and mental imagery, see figure (2)

Ebbinghaus illusion is influenced to many components as emotion, embodiment, visual representation, and ideomotor... etc, and but mental imagery is stickier to attention and conscious during execution of task. (Elis & Tucker, 2000; Lee-kuen Chua et al., 2021; Razaghi et al., 2020; Wulf, 2013) Therefore mental imagery plays crucial role important between perception and action but not same space of mental rotation, right side of brain does more error during mental imagery in this study, while left side of brain is more powerful during mental imagery. Also, mental imagery with embodiment bigger shape in the right side was better than left side. mental imagery is spinning the mental rotation and visual illusion and more powerful in the left side of the brain and improve the focusing during the motor task. Also, in vertical column of board mental imagery enhanced and supported the motor task whatever shape and size of objects. Mental rehearsal and visual objects based on Ebbinghaus phenomenon enhanced.

In sum these results approve that mental imagery is not pictorial information, but also perceptual representations which mainplanes the motor system, these findings have opened many questions for future studies about left- and right-hand tasks during rotation and mental imagery for motor system. Addition to Ebbinghaus phenomena (objects size) during mental rehearsal and mental rotation.

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