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The Influence of the Mental Rotation Task on Mental Rotation Skills in Badminton

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The current study is the first to examine the idea that badminton players may use mental rotation skills to imagine the flight direction of the shuttlecock. The study included badminton experts, near-experts, and non-badminton players and asked them to complete a specially designed mental rotation task, inspired by the methods from Shepard and Metzler (1971). The findings showed no significant group difference between the three expertise groups. This is in support of previous research examining visuo-spatial skills in badminton (Ozel, Larue, & Molinaro, 2002; 2004; Wang et al., 2015). The current study therefore concluded that badminton players may not have greater mental rotation capacity than other groups. However, these studies found that the badminton players responded quicker on the task than non-badminton players. The current study therefore hypothesised that badminton players might have greater mental rotation awareness, rather than mental rotation capacity, which allows them to respond quicker to visuo-spatial tasks.

Keywords: mental rotation, visuo-spatial skills, capacity, awareness, cognition, badminton, expertise

Introduction

The mental rotation task (MRT) is beneficial for examining visuo-spatial skills (the skill to manipulate images mentally) (Shepard & Metzler, 1971; Vandenberg & Kuse, 1987; Johnson, 1990; Heppe, Kohler, Fleddermann, & Zentgraf, 2016), as it requires individuals to imagine an image from all possible angles until they have enough information to decide if the image looks identical or different to another image. Badminton players use information from the opponent to decide what action is going to be played (Kamruddin & Mannan, 2019). Because the opponent is standing across the net, players receive a version of this information, much like looking into a mirror, and must therefore mentally rotate the information before they can anticipate events. The badminton players in the current study were therefore expected to frequently use mental rotation, and the current study hypothesised them to have greater mental rotation skills than near-experts and non-badminton players.

This is the first study to examine the direct relationship between badminton and mental rotation. However, the studies by Ozel, Larue, and Molinaro (2002; 2004) asked individuals with different athletic backgrounds to complete the MRT. Their analysis grouped the individuals according to their skills, and the results showed that the group with badminton players completed the task more quickly, and with greater accuracy, than other groups. Hence, badminton players may potentially have displayed greater mental rotation skills. Moreover, although not

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an MRT, Wang et al. (2015) included the matching-to-sample test and asked badminton players to determine if images were identical or different when presented side-by-side or one after the other. The results showed no group differences on the test, but the badminton players completed the task quicker than the non-badminton players. These studies suggest that badminton players may have greater visuo-spatial capacity than non-badminton players. To examine this, the current study will ask 72 participants (25 expert badminton players, national level players, 23 near expert badminton players, county level players, and 24 non-badminton players) to complete the MRT.

Methods

The current study included a specially designed online version of the MRT on the website Bubble (Hamandi, 2020). Bubble allowed the researcher to, as needed, manipulate the presentation of the images, and to extract data from each participant for the analysis stage of the study. To complete the study, participants needed access to the internet to access Bubble. They created personal logins and instructions to the study were provided on the first slide of the study.

The methods were inspired by Shepard and Metzler (1971) and Vandenberg and Kuse (1987). In their study, Shepard and Metzler (1971) included 1,600 images and presented these in groups of 200 to the participants. The images were three-dimensional, black and white cubes, with three right angles, and rotated over the vertical axis in steps of 20 degrees between 1-180 degrees. Participants had to decide, without time limits, if an experimental image, positioned next to an original image, was identical or different to an original figure by pulling a lever.

Vandenberg and Kuse (1987) presented 20 of the 1,600 images, from the study by Shepard and Metzler (1971), in groups of four, to participants by placing four experimental images next to an original image. Two of the experimental images were rotated, identical to the original image, and the other two experimental images were mirror images of the original image or other images. These last two images acted as distractors.

In comparison, the current study utilised the images from Peters and Battista (2008). Like the images in the MRT by Shepard and Metzler (1971), these images were black and white cubes and contained three right angles. In comparison to the methods by both Shepard and Metzler (1971) and Vandenberg and Kuse (1987), these images were rotated either 15, 30, 60, or 90 degrees, and the original image was presented above two experimental images (this to represent the view of a badminton player standing opposite the player) (see Figure 1). One of the experimental images was a rotated version of the original image, and the other acted as a distractor and was a rotated version of another image. The study included 88 trials and participants had to click on the image they thought looked the most like the original image. The trial automatically moved on if participants had not chosen an image within 10 seconds. Prior to the study, a trial study with a five-second response time was tested. These results indicated a possible ceiling effect, and the response time was therefore extended to the current 10-second.

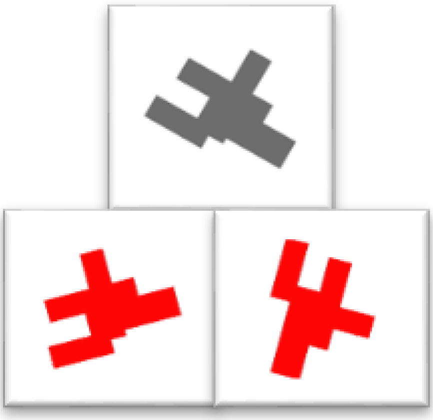

Figure 1. An example of a trial in the current study.
Notes. The images below (in red) are the experimental images, and the image above (in black) is the original image.

Results

For the analysis, *expertise* (experts, near-experts, non-badminton players) acted as the independent variable, and *correct answers on the MRT* acted as the dependent variable. The aim was to examine the effect of expertise on the MRT.

The Kolmogorov-Smirnov test showed that scores on the MRT followed normal distribution, $p < 0.01$, supported by measures of skewness, -1.01, and kurtosis, 1.12. Further, the Levene's test of variance was not found to be significant, $p > 0.05$, and parametric testing therefore took place.

The one-way ANOVA compared results between the three expertise groups and presented non-significant differences between the groups, $F(2, 69) = 0.02$, $\eta p^2 = 2.59$, $p > 0.05$. The study therefore did not find a significant effect of expertise on the MRT.

Discussion and Conclusion

The current study designed a new version of the MRT to examine the effect of badminton expertise levels on the MRT. No effect of expertise on the MRT was found, and the results therefore contradicted previous findings that showed that experts outperform novices on the MRT (such as, Dror, Kosslyn, & Waag, 1993; Naito, 1994; Ozel et al., 2002; 2004; Pietsch & Jansen, 2018). However, the current study supported the findings by Wang et al. (2015), by showing that group differences between badminton players and non-badminton players may be non-existent on visuo-spatial testing. Badminton players may lack transferable skills, and as a result, they did not score higher on the MRT than the other badminton expertise groups. Future research may wish to design a cognitive test that is applicable to badminton.

The studies by Ozel et al. (2002; 2004) and by Wang et al. (2015) found badminton players to respond faster than non-badminton players on the MRT and the matching-by-sample test. Many training drills in badminton require players to repeatedly produce the same responses to events. The badminton players may consequently have acquired the skill to quickly retrieve and encode information, resulting in enhanced reaction times, which may be transferable to visuo-spatial testing. However, the badminton players may not necessarily have greater visuo-spatial capacity than non-badminton players, as seen in the study by Wang et al. (2015), and in the current study. Future research may wish to repeat the current methods and, should the badminton players produce faster correct responses on the MRT, then it might be assumed that badminton players have greater processing skills, possibly resulting in greater mental rotation awareness, rather than greater mental rotation capacity, which might allow them to respond quicker to the task. Further research is needed to examine this idea.

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