

Motor imagery and music: The influence of music on mental rotation of bodily-related pictures

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ABSTRACT

The pursuit of excellence in sporting practices sheds light on the use of techniques beyond those that pertain to the physical training. Moreover, mental training is now considered a key aspect in an athlete's training routine, and as a consequence, mental imagery techniques have become popular among athletes and coaches since the mental practice of body movements reportedly improves the actual physical performance. One plausible explanation for this is the overlap between imagery and motor execution in terms of neural substrates activated in the pre-motor and motor cortical areas. Furthermore, music has been associated with enhancement in spatial-temporal reasoning, reflecting on performance in tasks that assess mental imagery processes, and this phenomenon is justified by the hypothesis of a direct cortical activation of areas responsible for spatial-temporal reasoning. It has also been reported that the motor system is actively involved in music processing, in which different patterns of neural activation in the pre-motor and motor cortical areas are elicited according to the rhythmic complexity of a stimulus, strengthening the hypothesis that musical stimuli may be responsible for improvement in motor imagery processes. To investigate this hypothesis, 30 Sports Science students completed a motor imagery-related cognitive task – a mental rotation of bodily-related pictures task - after exposure to three different stimuli (silence, music with complex rhythm and music with simple rhythm). Results showed no differences either in mental rotation performance, casting doubt on the hypothesis of improvement in imagery processes after music listening. **Keywords:** Functional equivalence hypothesis; Motor imagery; Mental rotation.



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INTRODUCTION

Cumming and Williams (2013) argue that the study of imagery is the centre pillar of applied Sports Psychology, since mental techniques used by athletes play a role in the self-regulation of thoughts, feelings and behaviours. Additionally, the evidence of some shared activation in neural substrates involved with imagery of movement and those of motor planning gives rise to the Functional Equivalence Hypothesis (Jeannerod, 1994), a hypothesis which provides mental imagery of motor movements (motor imagery) with some functional effects on motor behaviour and how the mind plans and produces skilled actions and movements, ultimately proposing that, through these neural pathways, imagery can improve performance.

As far as the relationship between mental imagery and cognitive performance is concerned, Rauscher et al. (1993) reported subjects' performance enhancement in cognitive tasks related to mental imagery after listening to music, and this enhancement was justified by the direct activation of cortical areas related to the subsequent task by the music. In line with this claim, neuroimaging studies (Grahn and Brett, 2007) have found out that different levels of neural activations in the pre-motor and motor areas are elicited according to the rhythmic complexity of a stimulus, whereas stimulus with simple rhythmic patterns elicited significantly stronger activation than stimulus with complex rhythmic patterns. Thus, this study investigates whether musical stimuli facilitate motor imagery processes and, consequently, the performance of a task that reliably assesses these processes and also relies on the neural activation of the pre-motor and motor areas: a mental rotation of bodily-related pictures (Hamada et al., 2018).

MATERIAL AND METHODS

Participants

Participants were 30 voluntary Sports Science students from Instituto Politécnico de Castelo Branco (24 males and 6 females), aged 18-25 years (M: 20.21 years, SD= 3.20 years). All participants reported their hearing as normal. No participant had previous experiences with mental rotation tasks.

Measures

As criteria of exclusion, the MIQ-3 translated and adapted to European Portuguese (Mendes et al., 2016) was employed in order to assess participants' mental imagery abilities, yielding no exclusion. Response times and accuracy in mental rotation tasks were computed by E-Prime 2.0 Psychological Software.

Procedures

Participants gave their informed consent to participate in the experiment, which was approved by the ethics committee of the University of Lisbon. Participants were placed in groups of 5 subjects each (1 female per group) and were exposed to all three stimuli for three consecutive days. The order of stimuli by which participants were exposed was counterbalanced. For the musical conditions, participants listened to 8:25 minutes of either the original version of an instrumental piece with a steady and simple rhythmic pattern (Space Katzler, by Motorcitysoul), or to the edited version of the song, in which the rhythmic patterns varied to purposely make rhythm perception more difficult (Grahn and Brett, 2007) and, consequently, elicit weaker neural activation in the pre-motor and motor areas. Participants remained in silence for the same time under the silence condition. After exposure to the stimuli, participants carried out a mental rotation task of pictures of hands and feet in different degrees of inclination (0°, 30°, 60°, 90°, 120°, 150°, 180°). Participants had to indicate whether the hand/foot depicted on the screen belonged to the left/right part of the body by pressing either the left or right arrow keys of the keyboard to left or right stimulus, respectively.

Analysis

Firstly, the Kolmogorov-Smirnov test was employed in order to check whether data distribution was normal or not normal. The results showed that distribution was not normal; hence, non-parametric tests (Friedman test and a Wilcoxon test) were applied to carry out further data analysis.

RESULTS

A Friedman test yielded no significant differences neither in Response Times nor in Accuracy after exposure to the three different conditions (silence, music with simple rhythm and music with complex rhythm) in mental rotation task: $X^2(2, N = 30) = ,467, p > 0,05$ for Response Times, and $X^2(2, N = 30) = ,883, p > 0,05$ for Accuracy.

DISCUSSION

In line with the claims by Rauscher et al. (1993) and Grahn and Brett (2007), it had been hypothesized that exposure to music that reportedly activates neural cortical areas involved in motor imagery processes and in the completion of a mental rotation task of bodily-related pictures would result in a better performance at the task when participants were exposed to music with simple rhythmic patterns, music with complex rhythmic patterns and silence, respectively. The results did not confirm the hypothesis, neither in Response times nor in Accuracy. In a study by Chabris et al. (1999) that disputes Rauscher et al.'s (1993) claim, it was hypothesized that instead of directly activating cortical areas responsible for improvement in mental/motor imagery processes, music could be seen as a vehicle that changes arousal/mood levels and, as a consequence of this alteration, could improve subjects' performance in tasks that assess mental/motor imagery processes. This claim should be thoroughly examined in future studies.

CONCLUSIONS

Results provided no support for the hypothesis that music improves mental/motor imagery processes since no differences in performance in mental rotation task of bodily-related pictures were found after participants' exposure to either musical stimuli or silence. More studies are needed in order to investigate whether music may improve mental/motor imagery processes in different circumstances and settings compared to those of the present study, and if so, the main reasons for such improvement.

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