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Research report

The relationship between corticospinal excitability during motor imagery and motor imagery ability

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ABSTRACT

It is commonly reported that transcranial magnetic stimulation (TMS) of the motor cortex during action observation and motor imagery results in increases in the amplitude of motor evoked potentials (MEPs) in muscles specific to the observed or imagined action. This study aimed to determine whether MEP amplitude was related to the motor imagery ability of participants. Participants were 15 healthy, right-handed adults (five male), with a mean age of 29.7 years. Motor imagery ability was measured using the Vividness of Movement Imagery Questionnaire-2 (VMIQ-2) and a hand rotation task. TMS was delivered during observation and imagery of a finger-thumb opposition sequence and MEPs were measured in the abductor pollicis brevis. Significant increases in MEP amplitude, from baseline, were recorded during observation and imagery conditions. The change in amplitude to both observation and imagery was expressed as a percentage of baseline amplitude. There was a significant correlation between MEP change for the imagery condition and imagery ability, with greater change linked to more vivid images and faster response times. The relationship between MEP change for the observation condition and imagery ability was less salient. This is the first study to show that the strength of corticospinal activation during imagery, which may be a determinant of the effectiveness of imagery training, is related to imagery ability in the general population, and has implications for clinical programs.

1. Introduction

Action observation and motor imagery have been flagged as potentially useful tools in rehabilitation from stroke and other brain injuries [1,2]. Improved methods to measure brain activity, including functional magnetic resonance imagining (fMRI) and transcranial magnetic stimulation (TMS), have shown that motor imagery and observation of actions, can, when used effectively, activate the neural motor system in a way that overlaps significantly with that activated during actual movement [3–7]. When physical movement is impossible, or perhaps very difficult, in the early stages following a brain injury, observation of relevant movements and task-specific motor imagery offer potential avenues to activate the neural motor system without physical movement needing to occur and is, therefore, not reliant on there being some level of residual function [1]. This early activation, specifically in areas of localised damage, may ensure that neuronal function is not lost as a result of inactivity that may otherwise result from the lack of proprioception from significantly reduced physical movement. Although theoretically exciting, the imagery interventions are not always successful [e.g. 8], and at this stage, the factors that may affect the success of such interventions have not been clearly defined.

One potentially influential factor may be the ability of the affected individual to form vivid motor images. This ability varies as a result of a number of factors, including motor experience, age and gender [9]. It seems intuitive that the extent of the vividness of a motor image would be associated with the pattern and/or level of neural activation in motor and related areas but, somewhat surprisingly, this relationship has received little attention from researchers. Studies in sport psychology suggest that athletes who utilise motor imagery regularly and report higher levels of imagery vividness for their sport specific tasks demonstrate different patterns of neural activation to novice or non-athlete groups who use motor imagery less [10,11]. Skilled performers also demonstrate significantly higher levels of corticospinal activation following TMS during imagery of movements related to their particular sport, when compared to novice performers [12]. However, these differences dissipate when assessing imagery of more general motor skills, unrelated to their sport [10,12]. It has been demonstrated

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