Neural Network Differentiation of Perceived Motor Imagery Abilities as Measured by the Motor Rehabilitation Movement Imagery Questionnaire (MR-MIQ)

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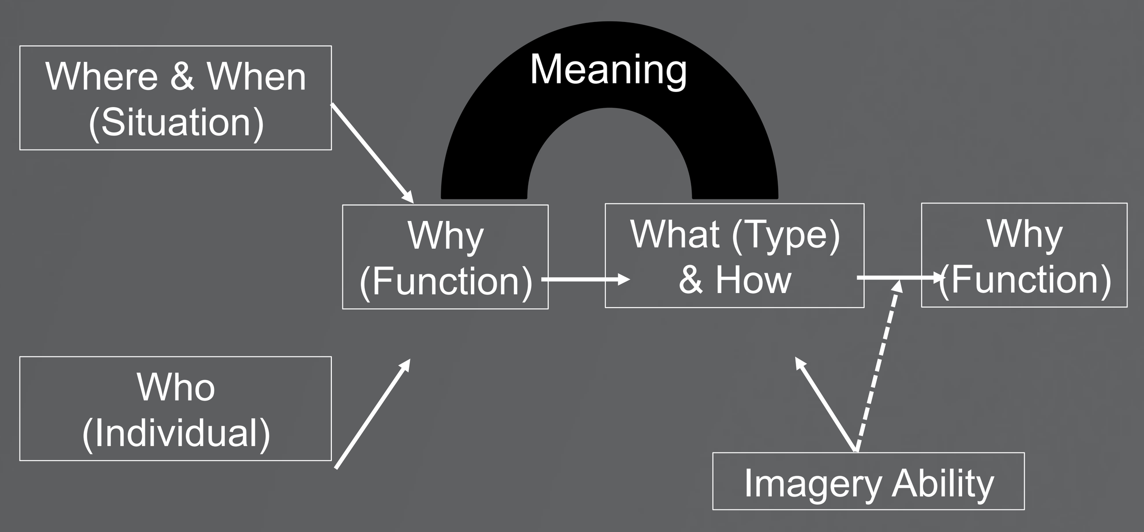
BACKGROUND

Imagery remains a prominent topic in both exercise and rehabilitation sciences, and is critical to refining theoretical models (1) to better inform the specificity of imagery interventions. The effectiveness of motor imagery (MI) as a performance enhancing strategy depends upon one's imagery aptitude. This ability is a function of experience interacting with genetic (biological) variability (2). Studies affirm that imagery abilities are not universal (3); rather, individuals have varying capacities to generate images depending on imagery mode (kinesthetic: KI) versus visual: VI) (4) and/or internal visual imagery (IVI) versus external visual imagery (EVI) perspective.

Figure 1. Revised Applied Model of Deliberate Imagery Use



In both behavioral and neural sciences, modes and perspectives are commonly assessed with the Movement Imagery Questionnaire-3 (5) or the Vividness of Movement Imagery Questionnaire-2 (7). Current brain imaging technologies enable exploration of the biological basis of intra-individual differences in MI abilities, supporting the 'functional equivalence,' (8).

Despite biological evidence supporting within-subject neural network differences for mode (4) and perspective (9), studies have not examined intra-individual differences in neural networks when participants purport to image MR-MIQ movements using their KI, IVI, and EVI abilities.

PURPOSE

1. To examine the construct validity of the MR-MIQ using both self-report and neural data,

2. To isolate common neural network associated with mental imagery found in the MR-MIQ

PARTICIPANTS

From an initial screening (n = 448), 205 female participants, 18-30 years old (M = 23.72 ± 2.42) were screened for MI abilities. Of those, 18 healthy participants screened as having good imagery abilities (MIQ-RS KI M= 47.58 ± 1.64, IVI M= 48.00 ± 1.29, EVI M= 47.74 ±1.69) were selected. All participants were right-handed, had normal or corrected-to-normal vision, self-reported no history of neurological or psychiatric disorders, and were not taking any medications.

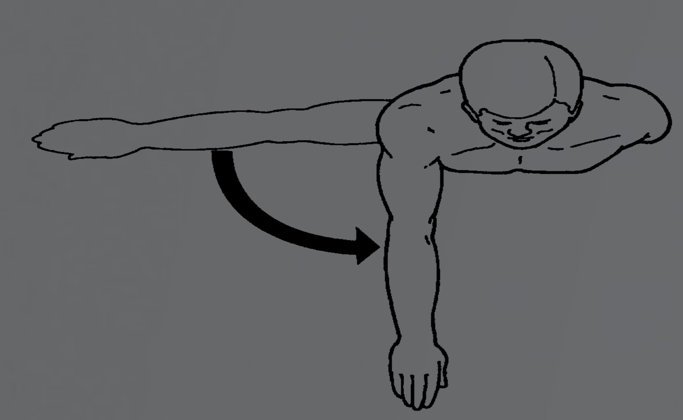
METHODS

Consenting participants completed a screening questionnaire for imagery experience and fMRI contraindications.

Participants (n=205) completed the Movement Imagery Questionnaire-3 (MIQ-3: 12 items) (5) and it's rehabilitation version (Motor Rehabilitation: MIQ: 21 items) (5), a 21 item questionnaire that assesses the ease/difficulty of generating images of movements on a Likert scale from 1 (very hard to see/feel) to 7 (very easy to see/feel). In addition the Vividness of Movement Imagery Questionnaire-2 (VMIQ-2) (7) was completed. The VMIQ-2 is a 36-item questionnaire that assesses imagery vividness of motor tasks on a Likert scale from 1 (perfectly clear/ vivid) to 5 (no image at all). Inter-scale correlations indicated relatedness between the questionnaires (r = 0.25-0.77, p < .001).

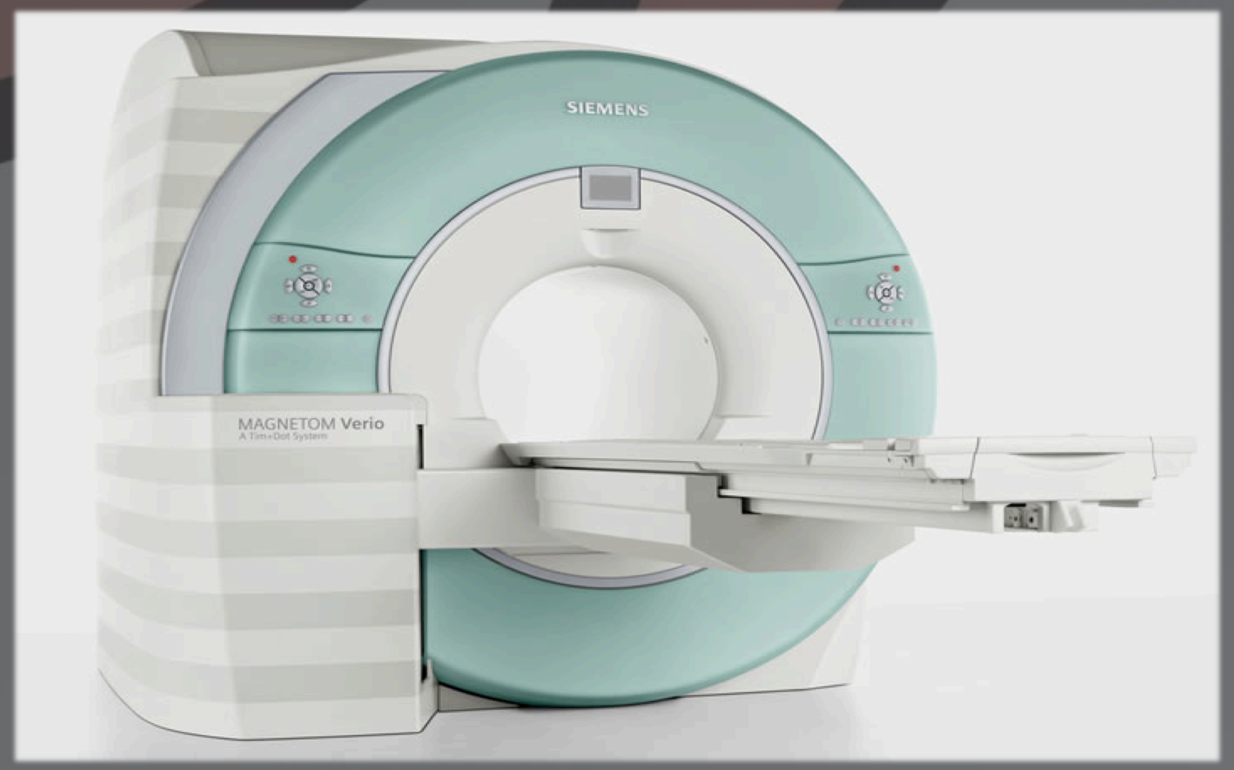
Participants screened as scoring six or seven on each MIQ-RS item) were 1) educated about fMRI using a mock scanner; 2) practiced the arm rotation task; and 3) performed the task during electromyography recording.

Figure 2. Arm Rotation Task



Subsequently, participants imagined the arm rotation task in four experimental conditions (KI, IVI, EVI and REST) with their eyes closed during fMRI scanning. After scanning, all participants completed a manipulation check of imagery use.

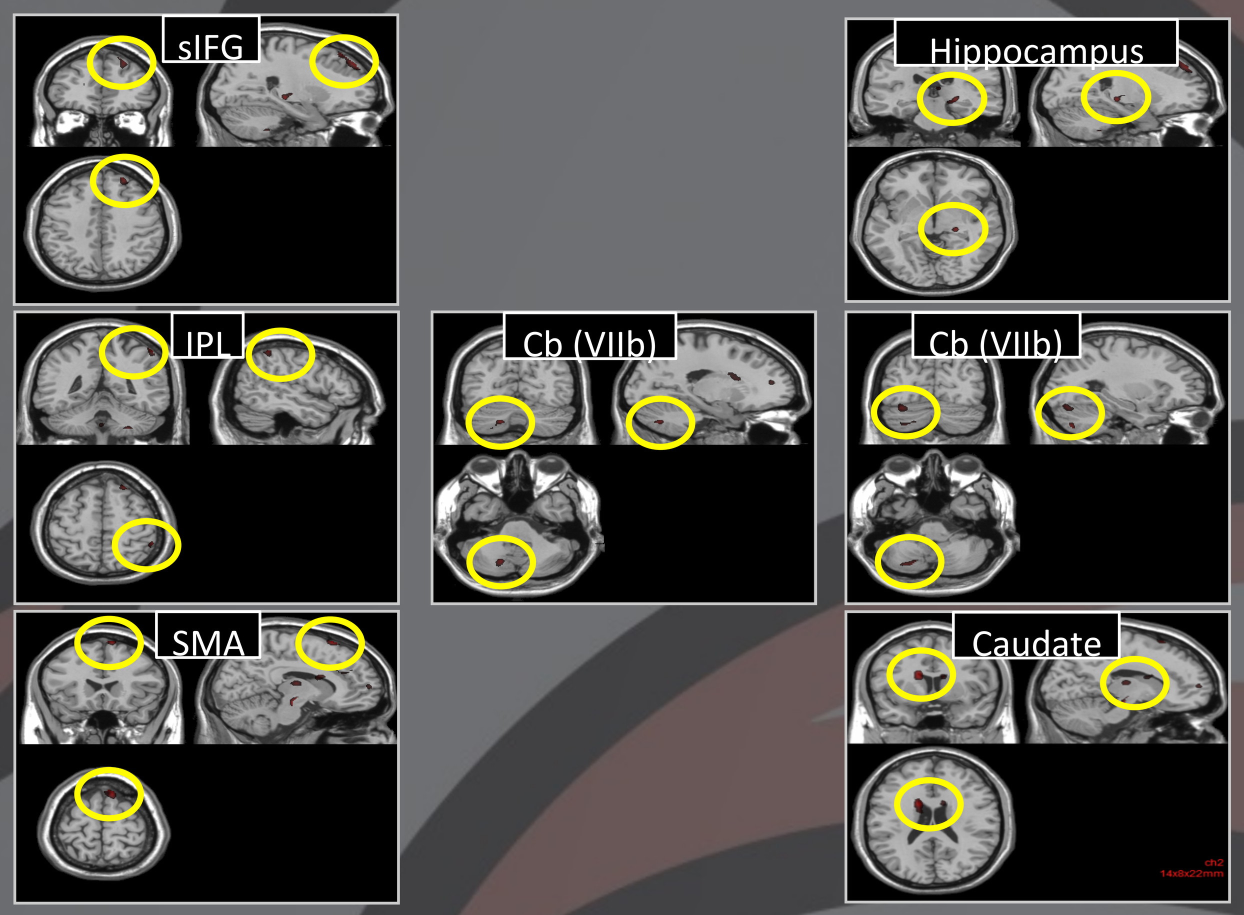
All data were pre-processed using SPM 8, and then analyzed using a general linear model. One sample t-tests were used to examine the following contrasts: KI-rest, IVI-rest, EVI-rest, KI-IVI, KI-EVI, IVI-KI, IVI-EVI, EVI-IVI, and EVI-KI. Activated clusters were considered significant at p < 0.001 and a spatial extent threshold of 3 voxels



RESULTS

Neuroanatomically, when compared to rest, KI activated motor-related areas (frontal areas, supplemental mot area (SMA), and subcortical parts of the cerebellum), IVI activated the inferior parietal lobule (IPL), and EVI activated the temporal cortex.

Figure 3. KI > IVI



DISCUSSION

This was the first known study to compare neuroactivity during imagery of an MIQ-RS item. While present findings support previous research distinguishing KI from VI, they also differ in that similar activation patterns were found during IVI and EVI. This may indicate that imagery mode may be more important than perspective when imaging a motor skill. Our results may stem from our sample, the MIQ-RS movement we chose, or the imagery abilities examined.

CONCLUSIONS

In general, our results support the idea that imagery categories that are distinguishable using self-report are also represented distinctly in the brain. However, between modality differences reported here should be interpreted cautiously given limitations to the current design. Further biological evidence delineating the breadth of imagery abilities (i.e., emotional regulation) is needed to support the theoretical role of different MI abilities in interventions targeting learning, competition and rehabilitation contexts.

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