Investigating the effects of motor imagery training: the hypnotizability model

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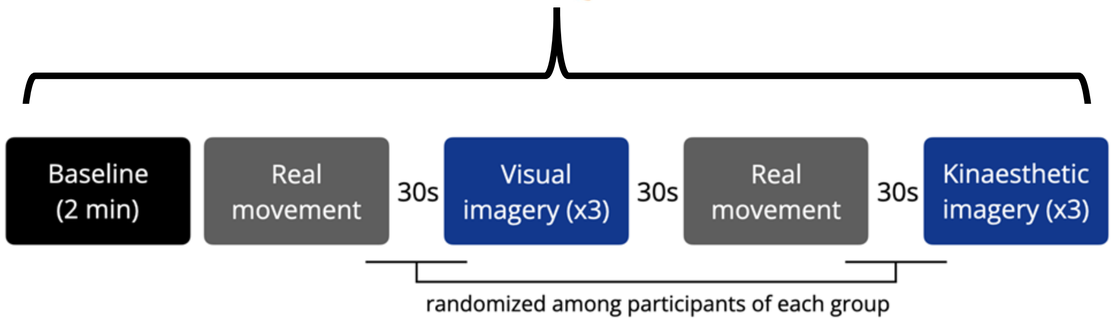
Introduction

Long exposure to extreme environments, such as microgravity during spaceflights, has been reported to induce weightlessnes-related physiological changes, including sensorimotor integration and interoceptive abilities impairment. Among the general population, these abilities have extreme variability, also depending on the psychophysiological trait of hypnotizability. Indeed, hypnotizability is associated with behavioral and brain morphofunctional differences, including lower interoceptive accuracy, measured by heartbeat evoked cortical potential (HEP), more adaptive interoceptive sensitivity, and stronger functional equivalence (FE) between actual and imagined action/perception, which represents the neural readout of motor imagery (MI) abilities. Effective MI requires the presence of correct body representation, which is influenced by interoception, and this corroborates the mutual exacerbation of sensorimotor and interoceptive abilities in microgravity condition. In the light of the foregoing evidence, the interaction between MI and interoception can be influenced by hypnotizability. The aim of the study was to define the profiles of high, medium and low hypnotizable participants (highs, mediums, lows) regarding the association between interoception and motor imagery.

Participants

25 lows
11 mediums
16 highs

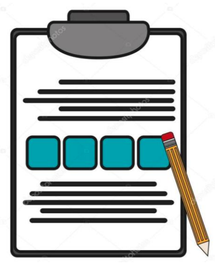
Participants underwent electroencephalogram (EEG) recording during actual and imagined movement in visual (ΔV) and kinesthetic (ΔK) modalities. After each MI trial, they reported MI efficiency (Ve, Ke) with a Numeric Rating Scale (NRS).



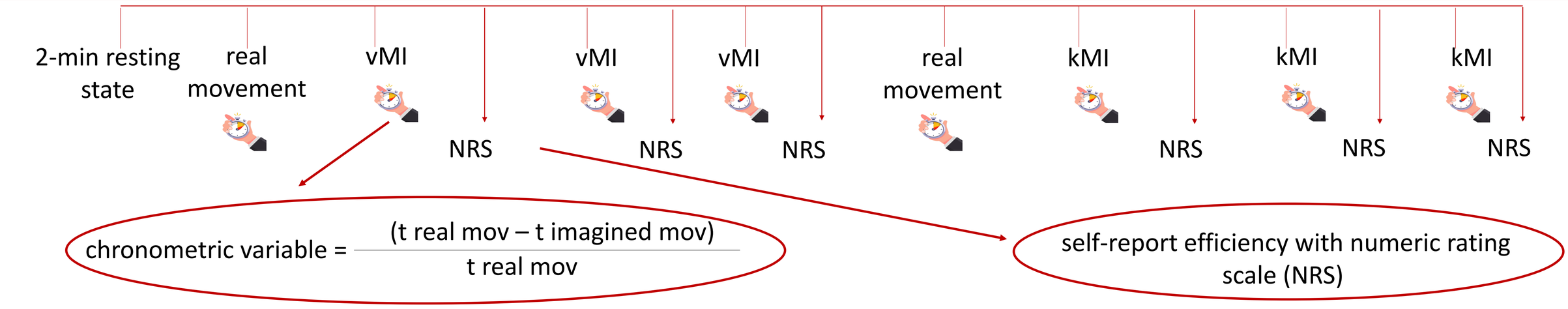
Cognitive assessment

-Stanford Hypnotic Susceptibility Scale, SHSS
-Tellegen Absorption Scale, TAS
-Multidimensional Assessment of Interoceptive Awareness, MAIA

EEG was performed during the entire session.

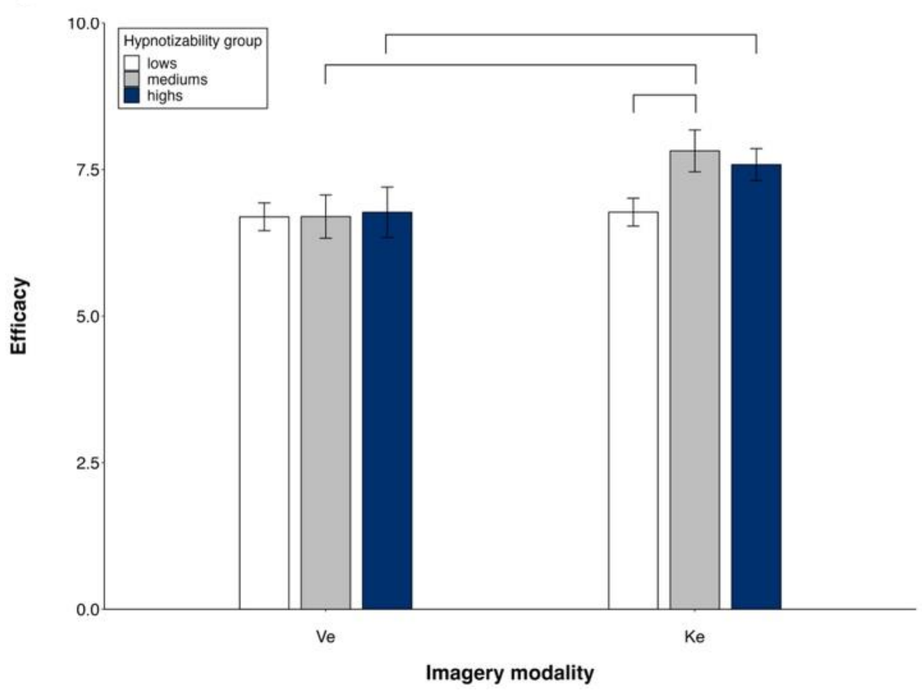


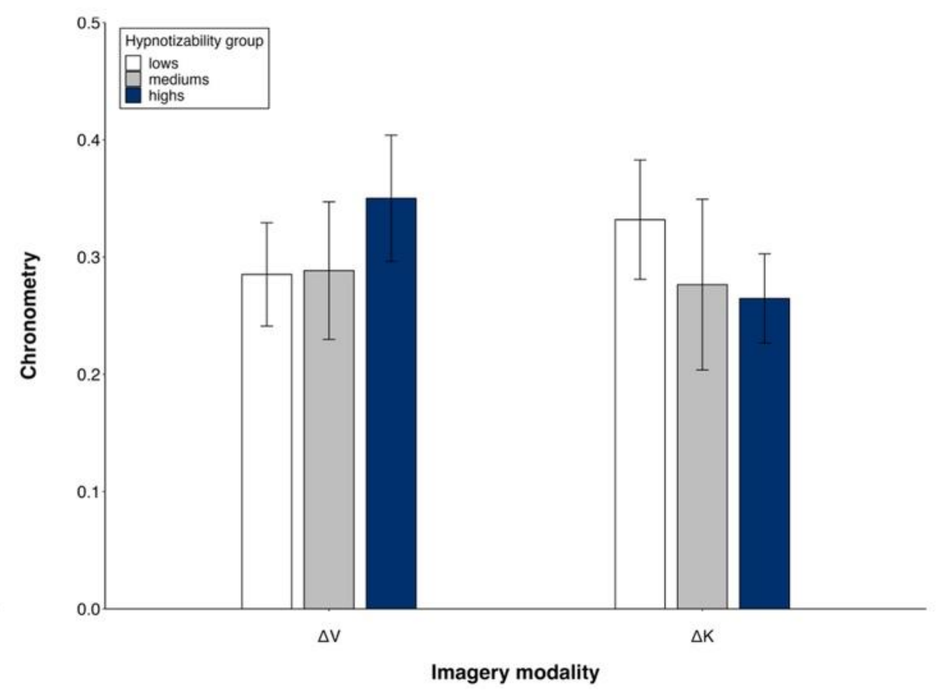
Session protocol

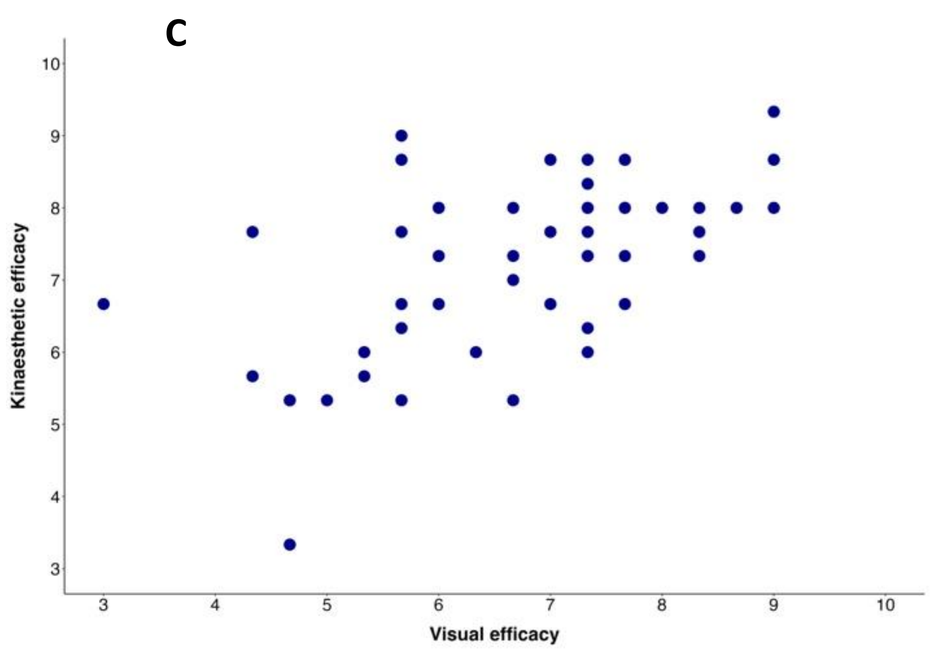


Better imagery is indexed by similar actual and imagery movement duration.

Results







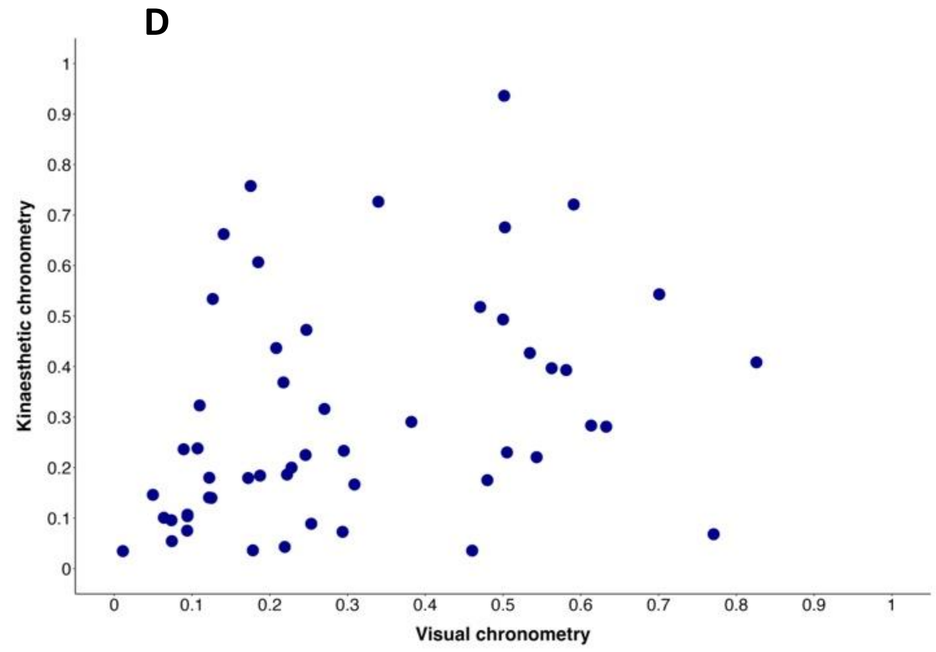


Fig. A: Repeated measures ANOVA revealed significant differences between imagery modalities (Ke > Ve, $F(1, 49)=16.14$, $p < .001$) and a significant Modality x Group interaction ($F(2, 49)=3.918$, $p=.026$). Post-hoc analysis revealed a significant difference between imagery modalities in highs (Ke > Ve, $F(1, 15)=7.69$, $p=.02$) and mediums (Ke > Ve, $F(1, 10)=7.56$, $p=.02$) and no difference in lows. Ke was greater in mediums than in lows ($p=.049$). Controlling for MAIA dimensions abolished all differences.

Fig. B: Repeated measures ANOVA did not reveal significant differences between groups and imagery modalities. No differences emerged controlling for MAIA dimensions.

Fig. C: ΔK and ΔV were significantly correlated between each other ($\rho=.41$, $p=.002$). The correlation survived by controlling for SHSS ($\rho=.43$, $p=.002$) and for MAIA dimensions ($\rho=.43$, $p=.013$). Within-group analysis revealed a significant correlation within mediums ($\rho=.65$, $p=.032$) and lows ($\rho=.44$, $p=.027$), but not within highs.

Fig. D: Ke and Ve significantly correlated between each other ($\rho=.548$, $p=.0001$) and the correlation did not change controlling for SHSS ($\rho=.597$, $p=.0001$) and MAIA dimensions ($\rho=.597$, $p=.0001$) Within-group analysis revealed a significant correlation between Ke and Ve ($\rho=.71$, $p=.002$) only in highs.

The mean amplitude of the early HEP component extracted from C4 channel was correlated with MAIA *self-regulation* and *body listening* (*self-regulation*, $r=.33$, $p=.043$; body listening, $r=.33$, $p=.046$), but the correlation did not survive Bonferroni correction ($p=.006$).

Discussion

-The greater efficacy of Ke compared to Ve is in line with other studies which reported that kinesthetic imagery was experienced better than visual imagery by elite athletes, who did not exhibit any significant difference in visual and kinesthetic chronometry (Williams et al., 2015).
-Motor experience interacts with imagery abilities and might prevent significant differences in chronometry between groups.
-Lows' lower absorption compared to mediums and highs could have contributed to their absence of difference between modalities of imagery.
-Interoceptive sensitivity influenced the difference between the subjective experience of visual and kinesthetic MI in the three groups, but not chronometric differences. Thus, interoceptive sensitivity may influence MI in healthy participants and suggests its potential use as a reliable behavioral index of FE.
-Since MI could have a therapeutic effect before, during and after exposure to microgravity to counteract adverse effects of weightlessness (Guillot & Debarnot, 2019), these findings shed light on possible future application of interoceptive training to further potentiate MI effects in astronauts, on the basis of their hypnotizability level.