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Association between hypnotizability, motor imagery and interoception.

Background: Long exposure to extreme environments, such as microgravity during spaceflights, has been reported to induce weightlessnes-related physiological changes, including sensorimotor integration (Van Ombergen et al., 2017) and interoceptive abilities impairment (Guo et al., 2023). 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 (Santarcangelo, 2024). Effective MI requires the presence of correct body representation, which is influenced by interoception (Badoud & Tsakiris, 2017), 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.
Methods: Healthy subjects aged between 19 and 35 years were recruited and categorized using the Stanford Hypnotic Susceptibility Scale, Form A. They were administered with questionnaires measuring trait absorption (Tellegen Absorption Scale, TAS) and interoceptive sensitivity (Multidimensional Assessment of Interoceptive Awareness, MAIA). They underwent electroencephalogram (EEG) and electrocardiogram (EKG) acquisitions during movement execution and MI in kinesthetic (K) and visual (V) modalities. MI performance was computed as normalized absolute difference between actual and imagined movement duration ([(actual movement duration – imagined movement duration)/actual movement duration]), MI efficacy was reported by subjects on a Numeric Rating Scale that ranged from 0 to 10. HEP analysis during MI conditions is in progress. ANOVA was used to assess between-group difference and Spearman's correlation was used to assess associations between variables in each group.
Results: 16 highs, 11 mediums, and 25 lows underwent the experimental procedure. TAS scores were significantly different between hypnotizability groups ($F(2,49) = 6.44$, $p < 0.006$) with highs' scores higher than lows ($t(1,34) = 3.21$, $p <= 0.006$), mediums higher than lows ($t(1,25)=2.82$, $p < 0.02$) and no difference between highs and mediums. Only MAIA noticing differed among hypnotizability groups ($F(2,49) = 3.74$, $p = 0.03$) with highs > lows ($p = 0.05$). Significant differences between groups were observed for kinesthetic efficacy (Ke) ($F(2,49) = 4.08$, $p = 0.02$), which was higher in mediums than in lows ($p = 0.05$), whereas visual efficacy (Ve), kinesthetic and visual chronometric variables (□Kd, □Vd) did not differ among groups. A significant correlation was observed between Ke and Ve in highs ($\rho = .71$, $p = 0.002$) and between □Kd and □Vd in mediums ($\rho = .65$, $p = 0.032$) and lows ($\rho = .44$, $p = 0.027$). After Bonferroni correction ($p = 0.006$), in highs there was no significant correlations between MAIA dimensions and imagery variables, in mediums Ke correlated with MAIA self regulation ($\rho = 0.78$, $p = 0.005$) and in lows it correlated with not worrying ($\rho = 0.54$, $p = 0.006$), and attention regulation ($\rho = 0.66$, $p = 0.0003$).
Discussion: Highs' Ke was not associated with any MAIA dimensions, while it correlated with self regulation in mediums and with the ability to orient attention towards bodily signals and not be worried by unpleasant information in lows. This suggests that the experience of the kinesthetically imagined movements is independent from interoceptive sensitivity in highs, in contrast to lows and mediums. The observed correlations between visual and kinesthetic chronometric variables in mediums and lows suggest that in the majority of the general population there is no preference for visual or kinesthetic modality of imagery. 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.

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