Motor imagery and low-frequency sound similarly modulate brain oscillations

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Résumé

Introduction

The behavioral benefits following motor imagery-based practice may be explained, at least partially, by the activation of sensorimotor brain regions that overlap those engaged during actual movement (Jeannerod, 2001). EEG studies showed that motor imagery increased brain activity in contralateral sensorimotor or posterior areas (e.g., Pfurtscheller & Neuper, 1997), often characterized by a power decrease in alpha (8–12 Hz) and beta bands (13–20 Hz). However, other studies showed the opposite results or even a null effect. These discrepancies may be attributed to interindividual variations (Höller et al., 2012).

A promising approach to unify these responses is to facilitate the motor imagery task with additional sensory input, such as low-frequency sound stimulation. This method is based on the principle that specific audible sound frequencies, due to their vibratory properties, can be used to stimulate the brain via the auditory pathways, thereby regulating oscillatory brain activity. Although there is limited literature on cortical activity modulations, recent studies discovered that listening to low-frequency sounds around 200-400 Hz modulates beta and alpha power within centroparietal cortices (Dos Anjos et al., 2024). The study of low-frequency sound listening and its combination with motor imagery may overcome the inter-individual variations in brain activity during motor imagery.

The current study aimed to provide a comprehensive understanding of the neural responses

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*Intervenant

elicited by motor imagery, low-frequency sound listening, and the combination of both.

Method

Twenty healthy volunteers performed four conditions: i) imagined right finger flexion/extension movements, ii) low-frequency sounds listening, iii) combination of motor imagery and sound listening, and iv) rest. The participants listened to low-frequency sounds over headphones played by a low-frequency sound generator (Alphaboxâ system, Allyane), at frequencies spanning from 200 to 400 Hz, at 50 Hz steps. EEG activities were continuously recorded through the BioSemi system with 64 electrodes according to the 10–20 International system. Spectral analysis was performed with Fast Fourier Transform for alpha (8–12 Hz) and beta (13–20 Hz) frequencies. To perform analyses on spectral data, two regions of interest (ROIs) were selected: the sensorimotor cortex and the right and central parieto-occipital cortex.

Results

We observed variable brain activity across participants during both motor imagery and low-frequency sound listening, with a bimodal distribution of alpha-band reactivity. One group of 12 individuals displayed increased alpha power within contralateral sensorimotor and ipsilateral medial parieto-occipital regions during motor imagery. Another group (8 individuals) exhibited a decrease in alpha band power within sensorimotor areas. Interestingly, low-frequency sound listening elicited a similar pattern of brain activity within both groups. However, the combination of motor imagery and sound listening did not result in additional changes in alpha and beta power amplitudes, regardless of group (groups based on individual alpha-band reactivity).

Discussion

Our study provides several notable findings concerning the influence of motor imagery and low-frequency sound listening on brain oscillations. First, our data not only reaffirms the findings of previous research, but also expands our understanding by revealing various modulations in the alpha and beta frequency bands during motor imagery and low-frequency sound listening. Indeed, these modulations show substantial inter-individual variability of alpha band in sensorimotor and parieto-occipital regions, but consistent beta band decrease. Second, the combination of motor imagery and listening to low-frequency sounds showed no additional alpha or beta modulation compared with these processes in isolation.

Perspective

Further studies are recommended to explore the potential influence of timing in the interaction of two interventions, in particular to determine whether further modulation of brain activity becomes apparent when the two interventions are administered sequentially.

References

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