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User Test and EEG Insights of Bimodal, Visual and Vibrotactile, Stimulation

Gabriela Herrera Altamira1, Stéphanie Fleck2, Anatole Lécuyer3, Laurent Bougrain1

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OBJECTIVES

1. Understand the brain activity due to visual and VT stimuli before using it as feedback for KMI-based BCI.
2. Define the VT configuration that better corresponds to the virtual environment and offers the best user experience.
3. Ensure the vibrotactile stimulation is coherent and synchronized with the visual stimulation.
4. Study the effects of the vibration on the EEG signals.

INTRODUCTION

Kinesthetic motor imagery (KMI) is a mental task often used in Brain-Computer Interfaces (BCI).

KMI is a hard task lacking kinesthetic feedback. Vibrotactile (VT) feedback may help the user and support MI [1], but the required intensity and activation sequence choices remain vague.

VT stimulation elicits electroencephalography (EEG) modulations [2], yet, it is unclear whether the EEG activity depends on the vibration intensity and activation pattern.

We assessed the effects on EEG signals of coupling VT and visual stimuli and its associated perceptual coherence.

METHODS

Experimental Procedure

18 neurotypical participants compared 4 different VT configurations to select the one that best matched a virtual grasping movement. (COERLE, approval number: 2022-17).

Vibration was applied on the left arm and the virtual hand shown was the left one.

VT configurations:

- Number of motors
- Activation patterns

Four stimulation levels:

- Intensity
- Duration

One VT configuration per run

16 trials per run (4x each level)

Information recorded: EEG (64 channels), users evaluations for each configuration.

RESULTS

User evaluation

Users preferred the 3-motor device configuration and the sequential activation pattern.

Activity in alpha and beta

- Bilateral ERDs are elicited by visual and VT stimulation in alpha and beta.
- Contralateral ERDs in alpha+low beta are present in the 4 levels while the ipsilateral ERD was present only in Medium and High conditions.
- Contralateral occipital ERDs are present mainly in alpha+low beta.

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