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Measuring presence in a virtual environment using electroencephalography: A study of breaks in presence using an oddball paradigm

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Introduction: Presence is one of the main factor conditioning the user-experience in virtual reality (VR). It corresponds to the illusion of being physically located in a virtual environment [1]. Presence is usually measured subjectively through questionnaires. However, questionnaires cannot be filled in when the user is experiencing presence, as it would disrupt the feeling [2]. The use of electroencephalography (EEG) to monitor users while they are immersed in VR presents an opportunity to bridge this gap and assess presence continuously. This study aims at investigating whether different levels of presence can be distinguished from EEG signals.

Material, Methods & Results: We immersed 18 participants in a VR environment using a Head-Mounted Display (HMD). Our participants experienced two experimental conditions: 1) a continuous experience in VR and 2) a VR experience where their feeling of presence was negatively affected by an abrupt presentation of the real environment inside the HMD (i.e. breaks in presence [3]). While our participants were within the virtual environment, they were presented with an oddball paradigm, i.e., sequences of repetitive sounds, infrequently interrupted by a deviant sound (20% of all stimuli) played on loudspeakers.

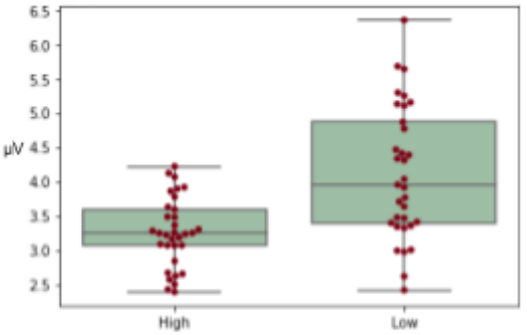

Fig.1: Average P300 amplitude across subjects recorded from 270 to 340 ms after each deviant stimulus for the High and Low presence context.

We focused our EEG analysis toward the reaction to the deviant stimuli, as this reaction modulates the amplitude of the P300. Preliminary results indicate a significant difference in the amplitude of the P300 between the high and low presence context (Figure 1). When a subject is in a low presence context (condition 2), the P300 is higher in amplitude, reflecting a higher attention to the real environment (hence a lower presence in the virtual environment).

Discussion: This study shows that electroencephalography can be used to assess presence using an oddball paradigm. However, the use of oddball sounds can impact the feeling of presence for some users. Future works should propose new kinds of less disruptive stimuli. *Significance*: We propose here a new objective and less intrusive way to continuously measure presence in a VR environment.

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