



HAL
open science

Single trial classification of the level of presence in VR

Emile Savalle, Léa Pillette, Ferran Argelaguet Sanz, Anatole Lécuyer, Kyung-Ho Won, Marc J.-M. Macé

► To cite this version:

Emile Savalle, Léa Pillette, Ferran Argelaguet Sanz, Anatole Lécuyer, Kyung-Ho Won, et al.. Single trial classification of the level of presence in VR. Cortico 2023 - Collectif pour la Recherche Transdisciplinaire sur les Interfaces Cerveau-Ordinateur, May 2023, Paris, France. pp.1. <hal-04088525>

HAL Id: hal-04088525

<https://hal.science/hal-04088525v1>

Submitted on 4 May 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY-NC 4.0 - Attribution - Non-commercial use - International License

Single trial classification of the level of presence in VR

E. Savalle¹, L. Pilette¹, F. Argelaguet¹, A. Lécuyer¹, K. Won¹, M. J.-M. Macé¹

¹Univ Rennes, Inria, CNRS, IRISA, Rennes, France

Introduction: Virtual reality (VR) relies heavily on the sense of presence - the feeling of being physically present in a virtual environment (VE) [1]. Currently, presence is mainly assessed through subjective questionnaires, which cannot be completed while users experience VR as it would disrupt their immersion [2]. To address this limitation, we propose to explore the feasibility of using electroencephalography (EEG) to monitor users' level of presence and classify it based on the reaction to oddball stimuli.

Material, Methods: We immersed 24 participants in a VE using a Head-Mounted Display (HMD). Our participants experienced 2 VR conditions: 1) one where their feeling of presence was regularly disrupted by an abrupt presentation of the real environment in the HMD (i.e. breaks in presence [3]) and 2) an undisrupted one. Meanwhile, an oddball paradigm was played on loudspeakers, i.e., sequences of repetitive sounds, infrequently interrupted by a deviant sound, 20 % of the time [4].

Results : To assess the viability of a single-trial classification of presence levels, we used Riemannian geometry to classify the reaction to the oddball stimuli from our 2 conditions. We classified EEG data filtered between 1 and 20Hz, and tested our classifiers using the 5-fold cross validation method.

Channels	Fz Cz Pz	Fz Cz Pz	Fz Cz Pz	Fz FC1 FC2 C3 Cz C4 CP1 CP2 P3 Pz P4 POz	Fz FC1 FC2 C3 Cz C4 CP1 CP2 P3 Pz P4 POz	Fz FC1 FC2 C3 Cz C4 CP1 CP2 P3 Pz P4 POz
Epoch duration	[0, 1]s	[0, 0.5]s	[0.1, 0.4]s	[0, 1]s	[0, 0.5]s	[0.1, 0.4]s
Averaged accuracy	71.7% +-0.18	71.5% +-0.17	67% +- 0.16	80% +- 0.18	76.5% +- 0.17	70% +- 0.17

Figure 1. Accuracies of riemannian classifiers trained on different channels and epochs duration.

As expected from the literature [4], Fig1. shows that channels Fz, Cz and Pz are relevant and allow classification accuracies (between 67 and 72%) above chance level (62%), although using most electrodes produces higher accuracies (70 to 80%).

Also, reducing the epoch duration around the traditional event related potentials used in oddball paradigm (0.1 to 0.4s post stimuli) allows better than random accuracy. However, the bigger the epoch duration, the higher the accuracy, especially when using most channels.

Discussion: This study shows presence can be measured using an oddball paradigm. However, future work should investigate new kinds of more ecological oddball stimuli.

[1] Schuemie, M. J., Van Der Straaten, P., Krijn, M., & Van Der Mast, C. A. (2001). Research on presence in virtual reality: A survey. *Cyberpsychol. Behav.*, 4(2), 183-201.

[2] Slater, M. (2004). How colorful was your day? Why questionnaires cannot assess presence in virtual environments. *Presence*, 13(4), 484-493.

[3] Slater, M., Brogni, A., & Steed, A. (2003). Physiological responses to breaks in presence: A pilot study. In *Presence 2003: The 6th annual international workshop on presence* (Vol. 157). Cleveland, OH: Citeseer.

[4] D. Morlet, P. Ruby, N. André-Obadia, and C. Fischer. The auditory oddball paradigm revised to improve bedside detection of consciousness in behaviorally unresponsive patients. *Psychophysiology*, 54(11):1644–1662, 2017.