NEUROPLASTIC EFFECTS OF A GAMIFIED VR BASED MULTIPLE OBJECT TRACKING APPLICATION

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Introduction

Training via 3D Multiple Object Tracking (MOT) tasks have been shown to increase perceptual-cognitive capacity on football players [1] and overall game perception. Virtual Reality (VR) provides immersion and engagement, offering a unique sense of visual-spatial awareness for the user [2]. This study presents the first findings of the neuroplasticity effects and the perceptual-cognitive improvement that such training tasks can instigate based on a serious game that combines 3D-MOT and VR, measured via behavioral and high-density EEG recordings.

Materials and Methods

The serious game targeted iOS/Android devices in combination with a cardboard VR headset. The 3D-MOT task implemented in the serious game included tracking a selected number of moving balls among others for 5 seconds. The balls' movement was pseudo-random based on data from passes recorded in real-world football matches. Five participants were recruited and trained for a total of 18 sessions across 3 weeks. Before and after the training, high density EEG recordings were conducted to measure the neuroplasticity. ERPs were evoked using a typical MOT paradigm [3]. EEG signals were analyzed in source space using LORETA [4] after subtracting the responses to the one condition (an attended ball flashes) from the responses of the other condition (an ignored ball flashes), in sensor space. Images were evaluated statistically via a parameter-free cluster permutation method [5].

Results

Results indicated an increase of the EEG Global Field Power in the time-window of 250 – 350 ms after stimulus' onset. Source localization indicated a statistically significant increase of the cortical strength, located bilaterally in the Hippocampus ($p<.01$) and the Anterior Cingulate Gyrus ($p<.05$).

Discussion

A combination of 3D-MOT and VR, enhanced by football informed pseudo-random movement of the targets, induces significant neuroplastic changes in Hippocampus; a cortical region responsible for visuo-spatial processing and memory [6]. It also affects Anterior Cingulate Gyrus; a region that is responsible to maintain active goals during the execution of ongoing tasks [7]. Our preliminary, but promising, results need to be confirmed by a larger sample to be conclusive.

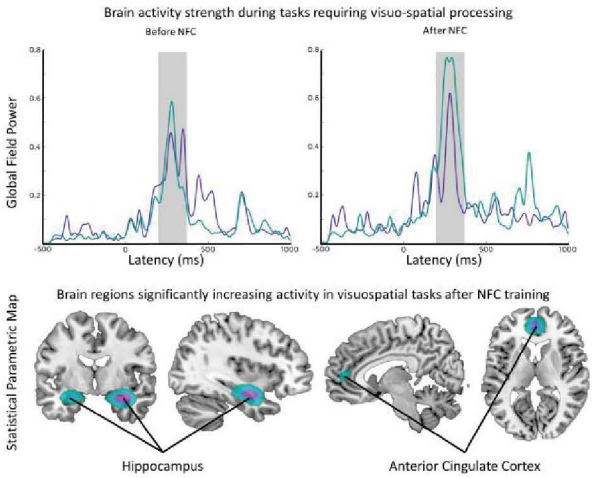

Figure 1: Preliminary EEG results (post – pre training)

References

1. Romeas, T.; Guldner, A.; and Faubert, J. 3D-Multiple Object Tracking training task improves passing decision-making accuracy in soccer players. *Psychology of Sport and Exercise*, 22, (2016), 1–9.

2. Antoniou, P.E.; Arfaras, G.; Pandria, N.; Athanasiou, A.; Ntakakis, G.; Babatsikos, E.; Nigdelis, V.; and Bamidis, P. Biosensor real-time affective analytics in virtual and mixed reality medical education serious games: Cohort study. *JMIR Serious Games,* 8, 3 (2020), e17823.

3. Sternshein, H.; Agam, Y.; and Sekuler, R. Eeg correlates of attentional load during multiple object tracking. *PLoS ONE*, 6, 7 (2011), 22660.

4. Pascual-Marqui, R.D.; Michel, C.M.; and Lehmann, D. Low resolution electromagnetic tomography: a new method for localizing electrical activity in the brain. *International Journal of Psychophysiology*, 18, 1 (1994), 49–65.

5. Maris, E.; and Oostenveld, R. Nonparametric statistical testing of EEG- and MEG-data. *Journal of Neuroscience Methods,* 164, 1 (2007), 177–190.

6. Maguire, E.A.; Gadian, D.G.; Johnsrude, I.S.; Good, C.D.; Ashburner, J.; Frackowiak, R.S.J.; and Frith, C.D. Navigation-related structural change in the hippocampi of taxi drivers. *Proceedings of the National Academy of Sciences of the United States of America*, 97, 8 (2000), 4398–4403.

7. Heilbronner, S.R.; and Hayden, B.Y. Dorsal Anterior Cingulate Cortex: A Bottom-Up View. *Annual Review of Neuroscience*, 39, (2016), 149–170.

Keywords

3D Multiple Object Tracking, VR, Neuroplasticity, Football-Informed, Serious Game