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Tactile BCI performance of sensory experts

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Introduction: In direct comparison visual BCI have been shown to outperform tactile BCI [1]. However, it has been shown that extensive sensory training in the tactile modality can lead to cross modal activation of the primary visual cortex in blind [2] as well as in sighted [3] subjects. Within this study we intend to examine whether this effect translates into increased tactile BCI performance.

Methods: Healthy (control participants, n=9) and visually impaired (sensory experts, n=9) participants were recruited. Control participants reported no regular activities related to sensory expertise, all sensory experts were able to read braille. Tactile stimulators (C2 tactors; Engineering Acoustic Inc., Casselberry, USA) were used to stimulate fingers commonly used for braille reading, i.e. index and middle finger of both hands. Stimulus duration was 220 ms, inter-stimulus interval 400 ms, stimulation frequency 250 Hz. Control participants also took part in visual stimulation. EEG was acquired with 12 passive Ag/AgCL electrodes at positions Fz, FC1, FC2, C3, Cz, C4, P3, Pz, P4, O1, Oz, and O2. Ground and reference were at the right and left mastoid. Impedance was kept below 5 kOhm. Signals were amplified using a g.USBamp (g.tec Engineering GmbH, Graz, Austria) and recorded at a sampling rate of 512 Hz. Participants performed three calibration runs (10 sequences) and four copy tasks using seven, five, three and one sequence for tactile and visual (control participants only) modality. Here we report results for three and one sequence(s) only, as for five and seven we faced a ceiling effect.

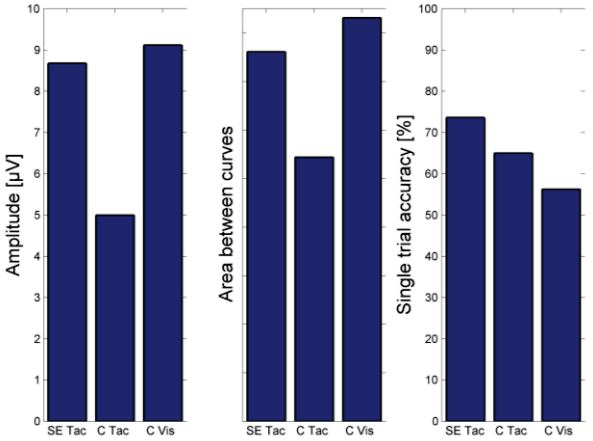

Figure 1 Amplitude, area between curves and single trial accuracy for sensory experts (SE) and control participants (C) for tactile and visual modality.

Statistical analysis: To compare tactile BCI performance between the groups we calculated a repeated measures ANOVA with sequences (2) as within and group (2) as between subject factors, and performance as dependent variables. The same analysis was conducted to compare tactile performance of sensory experts and visual performance of control participants. Amplitude and area between curves were compared using t-tests.

Results: In the tactile modality, performance of sensory experts was higher than that of control participants for three ($F(15) = 4.826$, $p < .05$) and one sequence ($F(15) = 4{,}924$, $p < .05$). Area between curves was higher for sensory experts as compared to control participants ($t(15) = 1.866$, $p < .05$, $r = 0.434$), P300-amplitude, however, was not significantly different. Visual P300-amplitude was significantly higher than tactile P300-amplitude of sensory experts ($t(14) = 2.074$, $p < .05$, $r = 0.485$), area between curves, however, showed no significant differences. In line with this, we found no significant differences between visual performance of control participants and tactile performance of sensory experts.

Discussion: Within this study we demonstrated the effect of sensory expertise gained by non BCI-related tasks on tactile BCI performance. Sensory experts outperformed control participants in the tactile modality. Additionally sensory experts were able to achieve tactile performance on the level of visual performance of control participants.

Significance: The results demonstrate the effect of expertise on performance with a tactile BCI. Thus, the lower performance with tactile BCIs is likely to be overcome with training.

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