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Tactile BCI training for elderly people

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Introduction: Tactile BCI have been demonstrated to perform lower than visual and auditory BCI [1]. In our previous study we were able to achieve mean accuracies as high as 85.8% but did so at the price of low ITRs [2]. Recently the beneficial effect of training on auditory BCI performance has been demonstrated[3], [4]. Whether this effect can also be utilized for tactile BCI performance has not been examined.

Methods: N=8 healthy elderly participants aged 50-73 (mean = 60, SD = 6.7) participated in a five-session training. All participants were naïve with regards to BCI. Tactile stimulators (C2 tactors; Engineering Acoustic Inc., Casselberry, USA) were used to stimulate participants left thigh (above knee), right thigh (above knee), abdomen (above navel) and lower neck (at the height of C4 to C8). Stimulus duration was 220 ms, inter-stimulus interval 400 ms, stimulation frequency 250 Hz. 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 attended five training session each starting with three calibration runs, each lasting approximately 3 minutes. Afterwards, participants navigated a virtual wheelchair trough two virtual courses. Each course required 14 correct movement commands, deviating commands had to be corrected and the maximum number of commands was restricted to 22. During training, number of sequences was fixed to 8 sequences to facilitate high accuracy and prevent frustration. After the last training session participants navigated the courses with an individually adapted and therefore, reduced number of sequences.

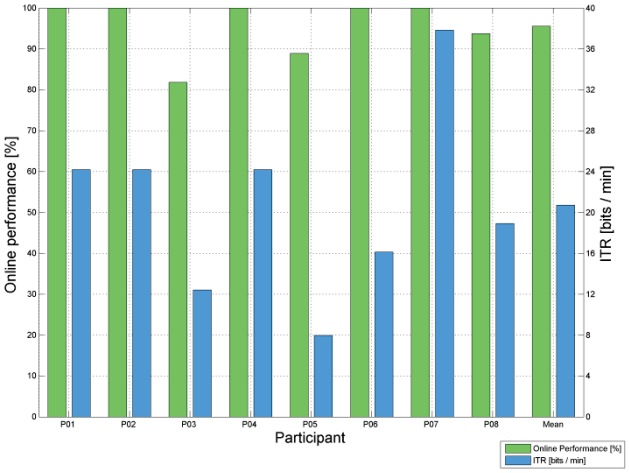

Figure 1 Individual and average post-training Accuracies and ITRs

Results: All participants achieved above random control in session one with an average accuracy of 89.02%. Accuracy increased to 91.46% during training. We calculated the single trial performance offline and found a significant increase ($X2(4)=11.86$, $p<.05$, $r_{session1\ to\ 5}= .33$) between session one and session five. During the post-training task participants achieved a mean accuracy of 95.56% and an information-transfer-rate of 20.73 bits / min.

Discussion: Within this study we demonstrated the beneficial effects of training on tactile BCI performance. Furthermore, we were able to achieve high accuracy and information-transfer rates on a level previously unreported for tactile BCI. Notably our results were achieved with participants aged 50-73 years, representing the target population for neurodegenerative diseases or stroke. Taken together, our results demonstrate that high viability can be achieved using tactile BCI.

Significance: We present a previously unreported combination of high accuracy and speed in a tactile BCI. This was achieved by elderly participants after a five-session training and demonstrates the viability of high performing tactile BCI for the target population of BCI aiming at replacing lost function.

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References

[1] F. Aloise, I. Lasorsa, F. Schettini, A. Brouwer, D. Mattia, F. Babiloni, S. Salinari, M. G. Marciani, and F. Cincotti, "Multimodal stimulation for a P300-based BCI," *Int. J. Bioelectromagn.*, vol. 9, pp. 128–130, 2007.
[2] T. Kaufmann, A. Herweg, and A. Kübler, "Toward brain-computer interface based wheelchair control utilizing tactually-evoked event-related potentials," *J. NeuroEngineering Rehabil.*, vol. 11, no. 1, p. 7, 2014.
[3] E. Baykara, C. A. Ruf, C. Fioravanti, I. Käthner, N. Simon, S. C. Kleih, A. Kübler, and S. Halder, "Effects of training and motivation on auditory P300 brain-computer interface performance," *Clin. Neurophysiol.*, vol. [Epub ahead of print], 2015.
[4] S. Halder, I. Käthner, and A. Kübler, "Training leads to increased auditory brain–computer interface performance of end-users with motor impairments," *Clin. Neurophysiol.*, vol. [Epub ahead of print], p. -, 2015.