# Brain-Computer Interface based communication in patients diagnosed with post-stroke aphasia

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*Introduction:* Brain-Computer Interfaces (BCI) which are based on the P300 evoked potential were successfully used for communication in patients who were paralyzed as a result of progressive neurodegenerative disease [1]. This substitution of language motor output via BCI might also be useful in patients diagnosed with post-stroke Broca aphasia as those patients cannot produce language while their language comprehension ability stays intact. One major problem reported by speech therapists is the high level of frustration in people with Broca aphasia. During the sub-acute rehabilitation phase in which cortical plasticity can be expected, these patients experience feelings of helplessness because they are not able to express themselves. By using a BCI system for language expression during rehabilitation, language areas may be activated and neuronal plasticity may be supported. However, first the feasibility of using BCIs with this target population needs to be demonstrated which we addressed with this study.

*Methods:* For data acquisition we used the P300 speller paradigm within the BCI2000 software environment [2]. Participants had to spell the words "BRAIN" and "POWER" for calibration, additional three five letter words in the copy-spelling mode ("FUCHS", "RADIO", "BLUME") and were also trained for free-spelling. We used 10 sequences of target letter flashing in every task. Participants were trained for at least three sessions.

*Participants:* Preliminary data of *N*=2 participants were collected (more being assessed currently). Both patients were diagnosed with post-stroke aphasia, showed a lesion in the left hemisphere were treated at the rehabilitation hospital Bavaria at Bad Kissingen, Germany. Participant A is male (36 years, 5 months after stroke) and was diagnosed with anomic aphasia and attention deficits. Participant B is female (46 years, 12 months after stroke), could express herself using spoken language and was diagnosed with neglect and inability to read. This study was approved by the Psychology Department Ethics Review Board of the University of Würzburg and participants gave informed consent before participation.

*Results:* Participant A could not use the speller matrix independently in the beginning and was unable to select any target letter correctly in session 1. We thus, used a paper based masking procedure such that only the letter to spell was visible for the patient. Beginning with session 2, the participant was able to select every letter correctly. In session 4, the participant performed free-spelling with an accuracy of 70% and in session six he could free-spell his wife´s name with an accuracy of 100%. Participant B could copy-spell with an accuracy of 100% in the first session and performed free-spelling with 100% accuracy in the third session. After copy-spelling an eight letter word which the participant was unable to read before, she could read the word aloud. The participant improved such that she could read 14 letter words without assistance.

*Discussion:* Both participants who were reported here were described as being severely affected by aphasia. In the case of participant A, the interdisciplinary therapists' team questioned his abilities for command following and comprehension in general. Even though we could not increase his expressive language abilities, we proved that this patient did understand language as he could use the BCI system after training also in the free-spelling mode. Participant B's reading deficits were described as being severe by her language therapist as well as by herself. In the third session of our BCI training she could read 14 letter words without assistance, a result her language therapist described as being stunning. Of course, in both reported cases we cannot disentangle other therapies' effects from BCI training effects. However, we showed that BCI use is possible in patients with post-stroke aphasia and clearly need more data to judge the potential benefit of using BCI systems to support rehabilitation in this target population.

*Significance:* If successful, the here described BCI based rehabilitation procedure might contribute to post-stroke aphasia recovery. So far, we can only report single cases and therefore cannot yet judge the full potential of the approach.

*References*

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