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Lessons learned on Implantable BCIs for Home Use

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Introduction: The Utrecht NeuroProsthesis (UNP) study aims at accomplishing independent home use of an implantable BCI for communication by individuals with locked-in syndrome (LIS). Although conducting research on home use of implantable BCIs is highly complex, the eventual successful clinical implementation of the technology will rely on sharing of procedures and experiences of ongoing studies, which typically include only a limited number of participants. We have recently described the methodological considerations that should be taken into consideration for studies on implanted BCIs, based on our experience during the UNP study [1]. Here we report on several, sometimes anecdotal, observations we made during the long-term collaborations with the UNP participants, and that may be relevant for the assessment of the effects of environmental and user-related factors on performance of an implanted BCI.

Material, Methods and Results: Three people with LIS (UNP1, UNP4 and UNP5) have received the UNP implant. Electrodes were placed over the sensorimotor hand area and connected via subcutaneous leads to an implanted amplifier/transmitter device that was placed in the sub-clavicular area. From our limited sample, we noted that LIS etiology may influence the spectral features underlying the BCI control signals, as reported in [2], and that the dynamics of these spectral features during the night requires dedicated decoders for nocturnal BCI use. We also noted that residual movements, sensory stimulation of the hand, as well as attempted movements of several other body parts, such as foot and eyes, can activate the same region as attempting to control the hand. Surprisingly, external sources of perturbations, such as during vehicle transportation, driving on cobblestones, and use of mechanical ventilation, seemed to influence the signal as well. Finally, two subjective reports of the participants are also worth noting. First, there seems to be some limit to the speed at which a user can attempt to move, and practice seems to increase the speed at which movement can be attempted. Second, all participants agree that attempting movement of the hand requires focus. For example, UNP1 reported on several occasions that effort is higher when her hands are cold, or when her hand is not positioned 'properly'.

Discussion and significance: In general, it is important to ask for the user's opinion about a BCI system on a regular basis since subjective experiences can affect the perceived usability of a BCI system. We believe that sharing not only quantitative scientific results and methodological considerations, but also any interesting incidental findings and subjective observations may contribute to defining important topics for more detailed investigation with more participants, eventually leading to improved standardization, and effective clinical implementation of (implanted) BCIs.

References

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