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Home use of an electroencephalographic-based BCI by people with amyotrophic lateral sclerosis (ALS): use of impedance to judge system readiness.

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Introduction: We are studying long-term independent home use of a P300-based BCI by people with amyotrophic lateral sclerosis (ALS) ([1] and Heckman et al., this meeting). Successful electroencephalographic-based BCI use requires reliable EEG recording. At home, the quality of the EEG depends on environmental conditions and a trained System Operator (SO) (e.g., the primary caregiver) who must place an eight-channel electrode cap on the home user before starting the BCI system and ensure that it functions properly. Thus, reliable BCI home use requires a robust easy-to-use BCI system and a properly trained SO. The goal of this study is assess the effectiveness of a tool that provides SOs with information about impedance prior to system startup. And the reliability of impedance as a predictor of BCI performance of an EEG-based BCI as well as

Material, Methods and Results: Set up for the Wadsworth BCI Home System begins with the SO logging onto diagnostic software (DS). The DS guides cap selection and placement, and provides the SO with information about hardware connections, cap use, impedance, and signal quality. After placing the electrode cap and before starting the system, the SO is shown color-coded impedance values on a dynamic display of the electrodes on the head: red (attention required, >40 KΩ), yellow (<40 KΩ, acceptable) and green (<20 KΩ, excellent). When the SO views any yellow-green combination, s/he inspects the filtered analog signal (HP=.5Hz, LP= 30Hz) for artifacts. Obvious artifacts are corrected with routine procedures (e.g., noticeable 60 Hz requires attention to the ground). Intractable artifacts may reflect a problem with a cap, for example, and result in a support call to the Wadsworth. Once the DS routine is complete, the SO may start the system. We looked at 1325 10-selection copy-spelling records recorded over 17 months from fifteen male home users with ALS who needed assistance with written and/or spoken communication (Ave age=58.3+11.6; Ave ALSFRS=17.4+12.3));. Ninety-two percent of the 10599 impedance measures were in the yellow-green range (<40KΩ), $\bar{x}$=22(SD 75). An ANOVA demonstrated that impedance values of under 40 KΩ remained a source of significant variance in BCI performance, and that some of that information was subject specific.

Discussion: SOs used the DS guidelines most of the time, indicating such tools can assist in regulating signal quality in the home setting. Further analysis of these data recorded in the home may reveal easier and more significant ways to impart information about the EEG. Understanding the relationship between impedance, signal quality and successful BCI use will assist investigators and developers in evaluating their methods, and, ultimately benefit the home users.

Significance: Quality control of the EEG in the home can be supported by the use of simple diagnostic tools. However, impedance alone may not be sufficient as an indicator of data quality. Additional and concurrent information may be necessary to ensure greater EEG-based BCI reliability.

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References

[1] Sellers et al., Amyotroph Lateral Scler. 11:449-55, 2010