EEG-based Brain-Computer Interface for Communication and Control: Independent Home Use
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People affected by severe motor disorders such as amyotrophic lateral sclerosis (ALS), brainstem stroke, cerebral palsy, and spinal cord injury need alternative methods for communication and control. They may not be able to use even the most basic conventional assistive technologies, which all rely in one way or another on muscles. Studies from this and other laboratories have shown that humans, including those with severe motor disabilities, can learn to control sensorimotor rhythms and other features of scalp-recorded electroencephalographic (EEG) activity and that they can use this control to select letters or icons, or move a cursor in up to three dimensions. Such multidimensional control could be used to control a prosthesis or a robotic arm. Currently, we are showing that people with ALS can use EEG-based brain-computer interfaces (BCIs) for communication and control independently in their homes.

Amyotrophic lateral sclerosis (ALS) is a progressive motoneuron disease that causes inexorable loss of motor function. As the disease progresses, remaining muscle function, sometimes including eye-movement control, is severely impaired or lost. Individuals diagnosed with ALS, who meet study criteria, participate in an initial 50-min evaluation session that establishes their ability to use a P300-based BCI. Subsequent home visits verify performance and ensure that the application software meets the needs of the user. Caretakers are then trained to position the electrode cap properly on the scalp; to operate the home system’s software; and to recognize common EEG artifacts (e.g., 60-Hz line noise). Finally, Internet access is provided to allow both daily data transfer, and remote oversight and parameter updates.

Once initial user parameters are set, and caretakers are trained, independent home use begins. All data are passed over the Internet to the laboratory for inspection. Along with their independent sessions, BCI users complete daily or weekly calibration sessions. Calibration data is labeled for correct and incorrect selections and is used to update classification coefficients. Lab personnel track performance, inspect the EEG record, monitor total use, examine text files written by the caretakers and transferred with the data, maintain regular phone contact with the caretakers and/or email contact with the users, and visit the user to address problems when necessary. Studies are currently underway to automate many of these procedures to produce more reliable and stable EEG recordings, and, thus more robust BCI performance. At the same time, laboratory studies support improved BCI methods. Efforts are focused on: making the home system more intuitive and user- and caregiver-friendly, improving the electrode mounting, increasing functionality, and further reducing the need for technical support.

We expect this work to establish that the communication and control applications provided by the BCI system are heavily used by people with ALS and other severe motor disorders. We expect to show that the BCI can allow people, who would otherwise become totally locked in, to continue to interact with their families and friends; and that long-term use of the BCI system can be provided with minimal technical support. We anticipate that BCI use will produce lasting improvement in the lives of the users and in the lives of those close to them. (NCMRR, NICHD, NIH (HD30146), NIBIB/NINDS, NIH (EB00856), JS McDonnell Foundation, Altran Foundation, ALS Hope Foundation, Deutsche Forschungsgemeinschaft (DFG), NEC Foundation, Brain-Communication Foundation (BCF))

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