Are BCIs Coming of Age as AAC Systems?

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Abstract. This paper discusses the issues central to transitioning brain-computer interfaces (BCIs) to fully functional augmenative and alternative communication (AAC) systems, and the importance of reporting quantitative performance data based on language sampling to show the effectiveness of communication competence.

Keywords: Augmentative and alternative communication (AAC), performance measurement, language activity monitor (LAM), language sample

1. Introduction

In the areas of augmentative and alternative communication (AAC) measurement of performance is essential in research and clinical practice. For brain computer interfaces (BCIs) to come of age as AAC systems measuring the effectiveness of BCIs to support communication would be an expectation. Consequently, as translational research efforts more BCIs out of the laboratory to be recommended by speech-language pathologists (SLPs) as an AAC system then quantitative data are critical to make informed decisions about effectiveness and value. BCI research and development as well as clinical AAC practice benefits from the use of clearly defined or standardized measures to compare performance between and within AAC speakers and systems.

2. Performance Measurement

Various tools and resources are available to support systematic observations of an AAC speaker's communication competence with an intervention. Automated performance monitoring provides quantitative data based on units of measurement to evaluate an AAC speaker's communication competence [Hill and Romich, 2001]. The built-in data logging feature or Language Activity Monitor (LAM) on several AAC systems, integrated and/or analysis software, and external tools offer effective and efficient methods for monitoring gains in performance. The AAC team is responsible for identifying the most reliable and valid measures to collect spoken and written language samples for analysis.

The collection and analysis of language samples is the most authentic procedure for identifying communication competence. The parameters used to measure communication competence are similar across the lifespan and are well documented. Typical data related to the subsystems of language (semantics, morphology, syntax) include standard and defined measure of vocabulary, syntactic diversity, and the length and complexity of utterances. Performance measures that should be routine for AAC system use include frequency of spelling, word prediction or other methods representing language, accuracy, average and peak communication rates (wpm), selection rates (bps), rate index to name a few. A variety of language sampling contexts may be recommended to collect the most representative example of an individual's language functioning and use of a BCI system. Obviously, the most representative sampling would be obtained from communication occurring during activities of daily living. Without using automated data logging, capturing these data would not be possible.

3. Research on Brain-Computer Interfaces (BCIs)

BCIs are showing to be of significant practical value to patients in advanced stages of ALS and lock-in syndrome for whom conventional AAC systems, all of which require some measure of consistent voluntary muscle control, are not satisfactory options. In these individuals, brain signals (e.g. P300 potentials) might be good alternatives to channel for access to assistive technologies. When the Language Activity Monitoring (LAM) function is installed in a P300 BCI system time stamped logfiles can be collected to measure communication performance [Hill, 2004]. Word-based and utterance-based performance measures can be used to evaluate the effectiveness of the BCI system as an AAC intervention with this population over time [Ruff et al., 2011].

BCI studies at the University of Pittsburgh and the University of Michigan as well as the Veteran Administration (VA) HealthCare System are collecting and analyzing performance and outcomes data on BCI use.

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The BCI/AAC model used in these efforts allows the evaluation of performance across three levels: 1) BCI control interface, 2) BCI user interface, including linguistic elements, and 3) communication contexts. Manipulation of the control allows for gaining information on the calibration selection processes of the P300 BCI system. Manipulation of the user interfaces is providing opportunities to compare performance using different methods to represent language. Currently, BCI user interfaces provide access to spelling and word prediction with limited availability of graphic symbols. However, research is planned to implement multi-meaning icons on a BCI system. Providing for multiple AAC language representation methods (LRMs) allows for comparison of the frequency of use of the various LRMs and the communication rates achieved using specific LRMs.

A comparison of research protocols shows that various sampling contexts are being used to report communication performance that includes: 1) copy spelling; 2) picture description tasks; 3) interview tasks; 4) daily conversation; 5) email. In addition, trends in the use of various application programs are being monitored for usage patterns. Having multiple sampling contexts is allowing for the performance comparisons of summary measures identified above.

4. Summary

BCIs are in transition from laboratory-tested control interfaces to an emerging access option for AAC. Since the goal of AAC is to optimize communication for people who cannot speak, systematically studying how BCI features and communication contexts provides opportunities for investigating the variables that affect communication performance and user satisfaction. The BCI studies that use performance data to guide practice will foster BCI systems becoming more mature and functional AAC systems.

References

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