THINK AND SPELL: TOWARD A FASTER, BETTER P300 BCI

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The P300 is a well-studied ERP component present in most adults. It is typically evoked in an "oddball" paradigm in which two types of stimuli, one frequent and one infrequent, are presented to a subject who is asked to pay attention only to the infrequent stimulus. For example, if several areas on a monitor are sequentially flashed and the subject is asked to press a button when one area is illuminated, flashes in the attended area will produce a P300, while unattended flashes will not. This characteristic suggests that users could communicate their interest in events via EEG activity alone through voluntary control of attention. Brain Computer Interface (BCI) systems using this characteristic of the P300 have been demonstrated (Farwell and Donchin 1988, Bayliss and Ballard 2000, Donchin et al. 2000), but many avenues for improving such a system remain unexplored. Two studies were conducted to explore which display parameters were best for a P300 BCI system. In the first study, subjects viewed an 8 x 8 display containing English letters and other characters. Rows or columns of characters were briefly flashed, and subjects were asked to count the flashes of a target character while ignoring other events. Subjects participated in 6 conditions, with three different ISIs (125, 250, 500 ms) and two different approaches to grouping flashed characters (single row or column vs. multiple row or column flashes). As expected, P300 amplitude and area were larger in response to attended vs. unattended flashes. P300 and N1 amplitude were reduced in both flash conditions at faster presentation speeds. Targets which were flashed more frequently in the multiple flash condition produced greatly reduced P300 amplitude; the decline in amplitude was more severe than in previous studies of P300 and target probability. While subjects could reliably count flashes of the target character at all speeds in the single flash condition, many had trouble with the counting task in the multiple flash condition at higher speeds. The second study sought to explore the advantages and drawbacks of different grid sizes. Subjects were asked to count target flashes in three different grid sizes (4x4, 8x8, and 12x12) with the ISI between flashes of 500 ms. Counting accuracy was excellent in all three conditions, and attended flashes again produced a larger P300 in all subjects. Results suggest that improved brain computer interfaces (BCIs) based on attentional differences in the EEG are feasible, and further elucidate the optimal display and analysis parameters for such a system. (These data will also be presented in poster format.)