Comparing Sensorimotor Rhythms, Slow Cortical Potentials, and P300 for Brain-Computer Interface (BCI) use by ALS patients – a within subjects design

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Introduction

- Severely paralyzed people often need communication tools that do not depend on muscle control. Brain-computer interfaces (BCIs) measure specific features of brain activity and translate them into device commands. Most current noninvasive BCIs use sensorimotor rhythms (SMR), slow cortical potentials (SCPs), or the event-related P300 potential. We are comparing BCI use with these features in people with amyotrophic lateral sclerosis (ALS) in a within subjects design.
- We are also assessing the interaction of psychological variables (i.e., current mood, motivation, quality of life, depression) and BCI use.

Slow Cortical Potentials

Methods

During each trial in the SCP training the patient was presented with an active target at either the top or bottom of a computer screen. A cursor moved steadily across the screen, with its vertical movement controlled by SCP amplitude. The patients task was to hit the target. Successful SCP regulation was reinforced by an animated smiling face and a chime.

Study Design:
- N = 4 patients completed, 8 patients in final study
- 20 sessions

Results

- None of the patients learned to successfully hit the targets.
- Some patients did learn to make a differentiation between negative and positive SCPs.

Psychological variables

Objectives:
To elucidate the interaction between psychological factors and BCI use.

Methods:
Before and after each training block QoL and depression were measured using questionnaires. Before each training session mood and motivation were measured.

Results:
Psychological factors appear to influence BCI use, but in an individual manner. E.g:

- Incompetence fear

Conclusions

- These initial results suggest that SMRs provide the best overall performance across patients with ALS.
- SMR seems to be more reliable over time than P300.
- In addition, although P300 based BCI has an apparent advantage in that it requires no initial user training, it appears to be effective for some users only.
- SCP use seems to be more difficult and may require more training.
- Psychological variables appear to affect performance. This suggests that their evaluation could help improve BCI training protocols and help to establish the practical value of BCI applications. E.g.:
  - The interaction between psychological factors and BCI use differs between patients. In patient A for example, challenge the patient saw in the training session was related to his performance.
  - An overall finding shows that ‘Fear of Incompetence’ declines over P300 and SMR training session, but is not related to performance.

Future Plans

- With six of the patients from this study, we plan ongoing training. Our aim is to work towards a clinical application.
- We would like to develop and test a complete auditory BCI in ALS patient

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References