An Applicative on-line EEG Tool for Enhancing Treatment Efficacy in the Rehabilitation Setting

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Introduction

There is growing evidence that rehabilitation is most effective when active participation in the rehabilitation process is fully promoted by therapists and committed to by patients, for example after cerebrovascular accident. Significantly better outcome was achieved by engaged over non-engaged patients. It is believed that top-down attention generates plasticity, which is necessary to recover the damaged bottom-up function.

The aim of the this study was to evaluate whether a simple to use single channel EEG tool can be used to monitor the effective attention level of an individual - (the Brain Engagement Index – BEI) in a manner, which can enhance standard motor rehabilitation treatment sessions.

Materials and Methods

Subjects
First part: 13 healthy control subjects without any neurological sensorimotor deficit, were included in the study.
Second part: 14 patients hospitalized at "Reuth" Rehabilitation Hospital after CVA. A specific motor treatment goal was selected for each patient

Tools
EEG was sampled using the dry-electrode MindWave system (NeuroSky Inc.,San Jose, CA), with one frontal electrode (~Fpz) and one reference electrode on the earlobe . The sampled data was transferred via wireless connection to the experiment computer and the BEI was processed online. The Brain Engagement Index (BEI) computation is based on principal component analysis, the strength of the component is averaged over each 10 seconds interval and is then normalized to a [0-1] range to form the BEI– see **Fig. 1**

Experimental protocol
First part: thirteen healthy control subjects underwent BEI monitoring during motor exercise with a robotic device (MediTouch ArmTutor) , which enables standardized control of varying levels of difficulty – see **Fig. 2**

Second part: fourteen sub-acute stroke patients were treated in two sessions: one with - see **Fig 3** and one without therapist utilization of feedback regarding their level of engagement (the sessions were randomly ordered). Single session treatment outcomes were evaluated according to videos taken before and after training a specific task. Two assessors blinded to whether feedback was used or not, assessed the positive/negative change following single session treatments. Each session was also evaluated by an independent observer.

Results

- ✓ A relation between exercise difficulty and BEI was demonstrated- see **Fig 2**.
- ✓ Positive clinical outcomes were obtained when the BEI index was high and it seems possible to harness the feedback for better outcome in the majority of patients see **Figs. 4,5**

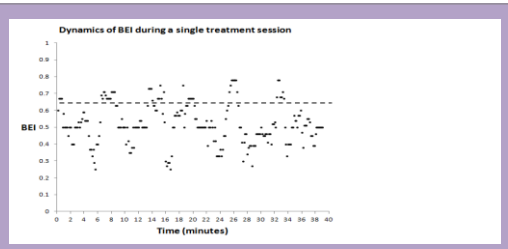


Fig. 1 The BEI is presented at intervals of 10 seconds. Each interval point summarizes the data of 60 seconds before it. 46/234 (~0.2) BEI points are above the 0.65 threshold during this session.

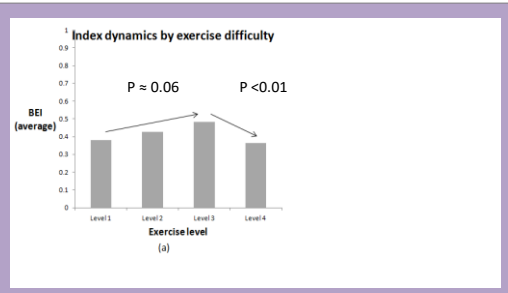


Fig. 2 BEI correlates with exercise difficulty and with practice.

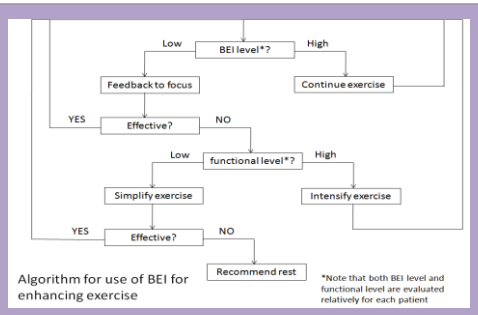
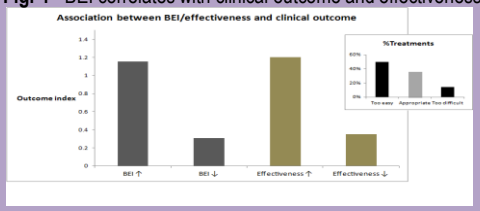


Fig. 3 Treatment algorithm

Fig. 4 - BEI correlates with clinical outcome and effectiveness



Outcome index as a function of both BEI and treatment effectiveness preferences between the sessions. Inset: distribution of average treatment effectiveness for all 28 treatment sessions performed (14 subjects X 2 treatment sessions per subject).

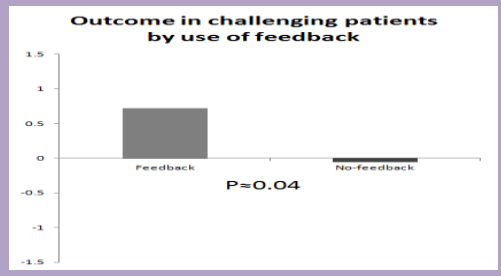


Fig. 5 – Clinical outcome is better with feedback use for the majority of patients

Conclusions

In this work we show that it is possible to extract an attention related biomarker from a simple-to-use EEG system during a standard motor rehabilitation session in a manner, which can guide the treatment and lead to improved clinical outcome.

References

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