# Optimized Individual Mental Tasks to Control BCIs

Karina Statthaler[1]*, David Steyrl[1], Andreas Schwarz[1], Maria K. Höller, Gernot. R. Müller-Putz[1]

[1] Institute of Neural Engineering, BCI-Lab, Graz University of Technology, gernot.mueller@tugraz.at.

**Abstract**

Various mental tasks can be used to control a brain-computer interface (BCI), but not every task or combination is suitable for every user, which makes it necessary to find the individual one for each user.

We recorded the electroencephalogram (EEG) of five healthy people and one end user using 32 active electrodes equidistantly spread over frontal and sensorimotor areas. Guided by the Graz-BCI paradigm, each participant performed 7 different mental tasks [1] and a rest class. For each possible mental task combination a 5x5 fold cross validation was computed to estimate classification accuracies: (i) Six separate common spatial pattern filters were trained on EEG data of second 4 to second 7 after the visual cue in a one vs. one class manner. (ii) We applied the first and the last two CSP projections and calculated 24 logarithmic bandpower features. (iii) A multiclass analytical shrinkage regularized linear discriminant analysis was trained using features located 2.5, 3.5 and 4.5 seconds after the visual cue. (iv) Filter and classification models were applied to the test data for performance evaluation.

*Table 1: Best individual four task combination for six volunteers. Significanzlevel [2] was 30,5%.*

| participants | best task combination | | | | mean acc [%] |
|---|---|---|---|---|---|
| S1 | feet | mental subtraction | spatial navigation | auditory imagery | 47,58 |
| S2 | hand | mental subtraction | spatial navigation | auditory imagery | 47,86 |
| S3 | feet | hand | mental rotation | auditory imagery | **69,77** |
| S4 | feet | word association | mental rotation | rest | 37,18 |
| S5 | feet | hand | mental rotation | rest | 50,32 |
| End user 1 | feet | hand | mental subtraction | rest | **65,79** |

We successfully determined the most performant mental task combinations of six volunteers. Best combinations included at least one motor imagery and for four users also a brain teaser task (mental subtraction and word association as defined in Friedrich et al.). This work supports the findings of [1], namely that BCI performance can be improved by determining user-specific mental tasks.

**References**

[1]  E. Friedrich, C. Neuper and R. Scherer, "Whatever works: Systematic user-centered training protocol to optimize brain-computer interfacing individually", PLOS ONE, vol. 8, no. 9, 2013.

[2]  G.R. Müller-Putz, R. Scherer, C. Brunner, R. Leeb, G. Pfurtscheller," Better than random? A closer look on BCI results", Int. J. Bioelectromagnetism, vol.10(1), pp. 52-55, 2008.

**Short Biography**

Karina Statthaler is an undergraduate student of biomedical engineering at Graz University of Technology. This abstract represents the main findings of her Bachelor thesis which is done within the GRAZ-BCI racing team. For her masters, she plans on specializing in Neural Engineering.