

Mental arithmetic (003-2014)

General Information

This data set consists of eight participants (three male, five female, mean age 26 years, standard deviation 2.8 years), which showed antagonistic hemodynamic response patterns (for details see [1]) during the performance of a mental arithmetic (MA) task. These data sets were used in a first investigation on single trial classification [2] of these responses. Furthermore, the same datasets were used in a comparison of five different classification methods (linear discriminant analysis (LDA), quadratic discriminant analysis (QDA), support vector machines (SVM), analytic shrinkage regularized LDA (sLDA), and analytic shrinkage regularized QDA (sQDA)) [3].

Experimental Paradigm

Participants were instructed to perform cue-guided mental calculations. During this task, they had to sequentially subtract a one-digit number from a two-digit number (the initial subtraction was presented visually on a monitor) as quickly as possible for 12 s (e.g. $97 - 4 = 93$, $93 - 4 = 89$, ...), followed by 28 s of rest (see Figure 1). Participants performed 18 or 24 trials of MA, respectively.

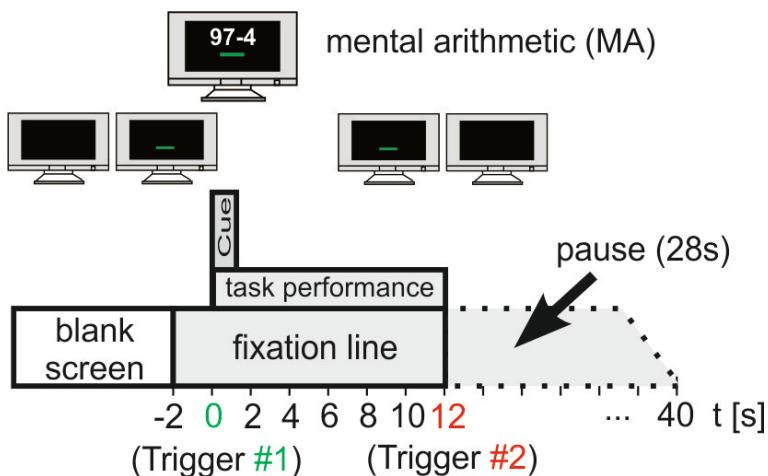


Figure 1: Time course of one trial. 2 seconds before the task started, a green bar appeared. After the cue (e.g., $97 - 4$), subjects had to perform MA for 12s followed by 28 s of rest.

Data Recording

A continuous wave system (ETG-4000, Hitachi Medical Co., Japan) was used to record brain oxygenation. The multi-channel system measures the changes of oxy-, deoxy-, and total-hemoglobin ([oxy-Hb], [deoxy-Hb], [total-Hb]) in the unit of mM mm and consists of 16 photo-detectors and 17 light emitters (3×11 grid), resulting in a total of 52 channels. The sampling rate was set to 10 Hz. The distance between source and detector was 3 cm. The lowest line of channels was arranged along the FP1–FP2 line of the international EEG 10–20 system, with channel 48 exactly at the FP1 position (Figure 2).

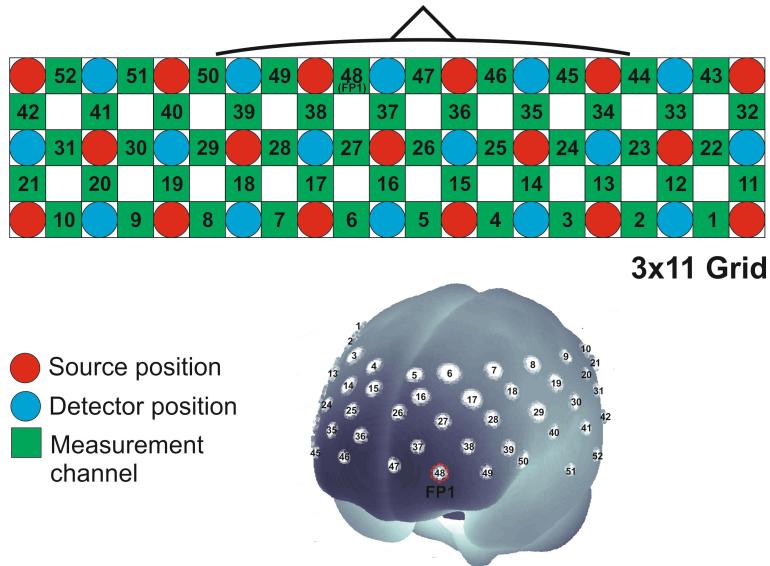


Figure 2: Schematic illustration of the multi-channel positional layouts for 52 channels (3x11 grid). The distance between source (colored red) and detector (colored blue) is 3 cm. The recorded channels (colored green) are between neighboring sources and detectors. Furthermore, the projections of the channel positions onto the cortical surface are shown. Modified from [4].

Data structure

Data of eight subjects are stored within `S0x.mat` (where x ranges from 1 to 8). Each file contains a variable data, which is a cell array of dimension $1 \times r$ (where r corresponds to the run and ranges from 1 to 3 for S01, S02, S03 and from 1 to 4 for S05, S06, S07, S08).

Each run `data{r}` contains the following variables: `X` (data [time x features], columns 1-52 correspond to [oxy-Hb], 53-104 to [deoxy-Hb], and 105-156 to [total-Hb]); `fS` (sampling frequency); `trial` (trigger positions in samples); `y` (class labels); and `classes` (class label description).

References

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- [2] G. Bauernfeind, R. Scherer, G. Pfurtscheller, and C. Neuper. Single trial classification of antagonistic oxygenated hemoglobin responses during mental arithmetic. *Med Biol Eng Comput*, 49(9):979–984, 2011.
- [3] G. Bauernfeind, D. Steyrl, C. Brunner, and G.R. Müller-Putz. Single trial classification of fNIRS-based brain-computer interface mental arithmetic data: a comparison between different classifiers. *Proceedings of the 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC'14)*, 2004-2007, 2014.
- [4] G. Bauernfeind. Using Functional Near-Infrared Spectroscopy (fNIRS) for Optical Brain-Computer Interface (oBCI) Applications. PhD thesis, Graz University of Technology, 2012.