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Neurophysiological correlates of mind-wandering, towards a predictive BCI-based Neurofeedback

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Introduction: A brain computer interface (BCI) able to predict the disengagement of attention, e.g. mind-wandering episodes, regardless of the task being performed bears useful applications. Converging neuroscientific evidence has determined that our ability to remain attentive to a task, over a prolonged period of time, is subject to strong fluctuations. Recent electroencephalography (EEG) studies have identified neurophysiological signals reflecting inadequate task engagement preceding attentional lapses, in particular modulation of P300 amplitude and α-activity [1, 2, 3]. The present study investigated the evolution of neurophysiological signals preceding the report of 5 different levels of attention, from on-task to mind-wandering without awareness, during a breath-counting task and a sustained attention to response task (SART, [4]).

Material and Methods: Twenty-six healthy subjects (12 female; 23.4 ± 3.2 years) performed two tasks, a breath-counting task and a fixed version of the SART. The former asked participant to fixate a cross, count each breath from 1 to 9 and press the left mouse button for the first eight counts and the right mouse button for the final count before starting anew. The SART presented subjects with numbers from 1 to 9 subsequently and participants were required to respond with a button press to each number except the target (here number 6). Subjects were instructed to monitor their attention and interrupt the task if they noticed their thoughts stray from the task. Thought probes also interrupted the task at pseudo-random times. The probes presented subjects with a 5-step scale to categorize their level of attention/mind-wandering just prior to the interruption, (1) on-task (no mind-wandering), (2) on thoughts pertaining to the task, (3) distracted by internal sensations or external distractions, (4) on reminiscing or planning thoughts, (5) daydreaming (mind-wandering without awareness).

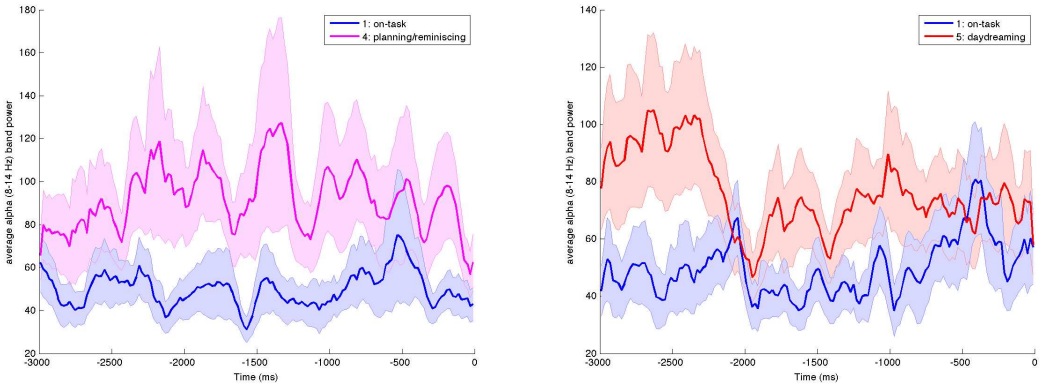

Figure 1. *Smoothed average **α** band power measured over channel POz for all participants with standard errors of the mean. Left; the average **α** band power for the 3000ms period prior to the on-task (blue) and planning/reminiscing (magenta) reports during the breath counting task. Right; the average **α** band power for the 3500ms period prior to the on-task (blue) and daydreaming (red) reports during the SART (the sudden desynchronisation at around -1900ms is the result of the appearance of the SART stimulus).*

Preliminary results: Analysis of the 64-channel EEG recorded data revealed that average α activity prior to thought probes differentiates between the on-task and planning/reminiscing condition during the breath counting task and between the on-task and daydreaming with awareness reports during the SART (Fig. 1). These preliminary results are encouraging for further analysis to determine whether mind-wandering could be detected online for the development of a Neurofeedback training (NFT).

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