

**Introduction**

Studies investigating dual-task performance [4, 1] or retrieval of prospective memory (PM) and configuration of PM tasks [1, 9] gave insight into the capabilities of the brain to perform tasks in parallel and to switch between them [2]. However, most experiments are conducted under controlled conditions. Here, we investigate electroencephalographic (EEG) activity recorded under natural conditions during human-machine interaction (HMI) that can be used to passively support the human [2] in multi-task situations, e.g., telemanipulation of robotic systems and mission control [5]. For this passive support, the success of information processing can be predicted with the help of single-trial EEG analysis and classification [7]. A successful execution of multiple tasks requires an efficient strategy of attention division, the detection and evaluation of important, task-relevant information, retrieval of intended action from long-term memory, post-retrieval monitoring, and the coordination processes characterized by several overlapping event-related potentials (ERPs) [6]. The goal of the study was to investigate the effect of multi-task conditions on positive parietal ERP components evoked by infrequent task-relevant and task-irrelevant stimuli.

**Methods**

Experimental Design: Thirteen subjects (age: 27 to 39 years; right-handed; normal or corrected-to-normal vision; one subject was excluded due to eye artifacts) participated in the experiments (see Fig. 1). Subjects performed two tasks: oddball and labyrinth oddball within two counterbalanced sessions. In each session, subjects performed an oddball task and responded to target stimuli (randomly mixed among frequent standard and rare deviant stimuli) with a ratio of 1:1.2:1 and an ISI of 900 and 1100 ms) by pressing a buzzer. During the oddball condition, subjects were asked to hold both knobs of the labyrinth game while focusing on a ball placed in the middle of the labyrinth board, whereas during the labyrinth oddball condition, they were requested to play the game.

Data Recording: EEG was recorded with a 64-channel actiCap system (extended 10-20 system; Brain Products GmbH, Munich, Germany) and filtered between 0.1 Hz to 100 Hz. The averaged data was analyzed by repeated measures ANOVA with “stimulus type” (standard, deviant, oddball) as factors. For each, an “interval” (0-100 ms, 100-200 ms, 200-300 ms, 300-400 ms, 400-500 ms, 500-600 ms, 600-700 ms, 700-800 ms, 800-900 ms, 900-1000 ms) and “time window” (350-450 ms, 450-550 ms, 550-650 ms, 650-750 ms, 750-850 ms, 850-950 ms, 950-1050 ms) as within-subjects factors and “condition” (labyrinth oddball and oddball) as between-subjects factors. Post-hoc Bonferroni corrections were applied.

**Discussion and Conclusions**

Deviant and target stimuli could be shown to evoke positive parietal ERP activity under both oddball conditions. Complex behavior during HMI (labyrinth oddball condition) elicits a broader positive parietal ERP component under target stimuli, with higher amplitude in the early and late windows. The stronger positivity effect in the early window at electrode Pz for target compared to non-target deviant stimuli is probably caused by differences in P300 expression due to different behavioral relevance of the stimuli [6, 8]. On the one hand, differences in the late positivity effect of target versus deviant stimuli in the late window that were only observable under labyrinth oddball condition are likely to be caused by the parietal prospective positivity, elicited by configuration of PM tasks as shown in [1, 4]. The significant difference of the later part of the parietal positive ERP component might be detectable by a classifier. When applying Brain Reading [5] or passive BCIs [10], this detectable difference could, for example, be used to change the support of a human interacting with a machine regarding the requirements of the PM task. Hence, results found in this study are highly relevant for the improvement of the passive support of HMI, as already shown for the prediction of successful recognition of task-relevant stimuli [3].

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**References**