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Distinct brain potential of balance perturbation and error processing

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***Introduction**:* The maintenance of balance is a complicated process in the human brain, which involves multisensory processing. Neuroimaging studies showed that a specific cortical activity called perturbation-evoked potential (PEP) appears in EEG during balance perturbation [1]. PEPs are primarily recognized by the N1 component localized in the fronto central regions. In this study, we tested whether the N1 is an indicator of the cognitive error processing by imposing two types of perturbations consisting of error and correct perturbations.
***Material, Methods and Results**:* Fifteen participants sat in a glider, and they were tilted to the left and right directions by using KUKA KRc1 robot. Tilting direction was shown on the screen 2-4 s before the balance perturbations to inform the participants about the direction of the upcoming movement. At some rare cases of the experiment, participants were exposed to an opposite direction of the expected/shown direction, which was considered as error perturbation. A schematic of the experiment is depicted in Figure 1a.

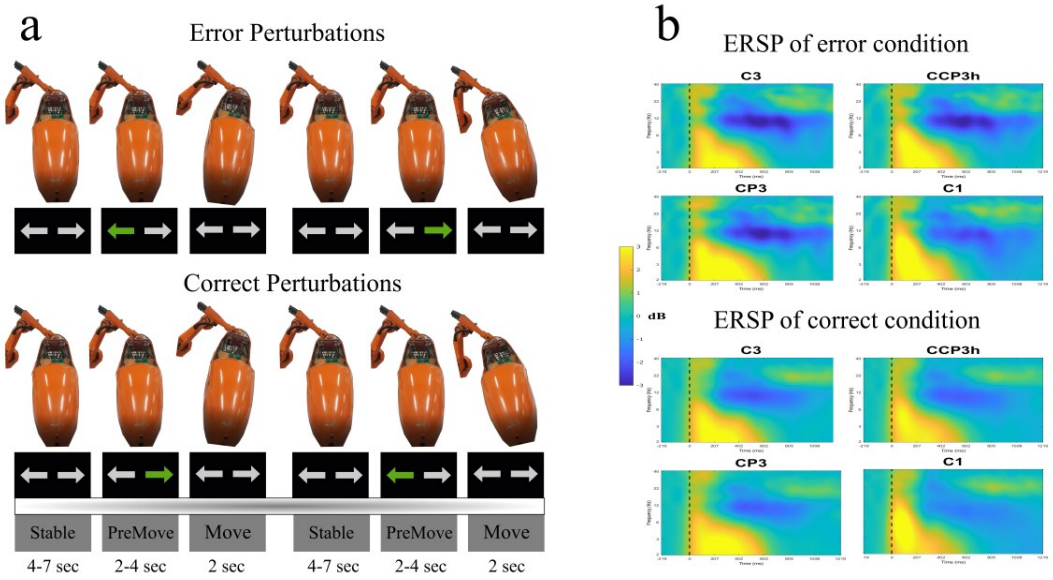

Figure 1. *Experimental setup and results. The glider was tilted to left and right directions (Panel a). Averaged ERSP plots of 15 participants scaled power in dB were displayed for channels C3, CCP3h, CP3 and C1 (Panel b).*

We measured EEG signals using 63 active shielded Ag/AgCl electrodes (ANT-neuro) with a sampling rate of 512 Hz. EEG data were bandpass filtered between 0.5 and 40 Hz, then we extracted 2-s epochs (-0.5 to 1.5 s) with respect to perturbation onset obtained from accelerometer data. To assess the neural correlates of error and correct perturbations, we calculated and plotted event-related spectral perturbation (ERSP) by using the inter-trial variance (Figure 1b). In this way, we unmasked the effect of the PEP from EEG (de)synchronization. Next, we performed the cluster-based permutation test, corrected by a 2000 random permutation test with a $p = 0.025$.
***Discussion**:* The results shows that a (de)synchronization happened in the time period of 0-0.5 s, and 0.5-0.8 s for both conditions. Spectral suppression of alpha band was significantly different in error condition over central regions. This phenomenon is named error-related alpha suppression (ERAS) [2], and it is associated with conscious sensations of error. No differences were observed between error and correct perturbations in the time range of N1 potential.
***Significance**:* Our findings indicated that early cortical responses of balance perturbation are not associated with neural error processing, and errors induce distinct cortical responses that are distinguishable from brain dynamics of N1 potential.

References

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