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Relationship between the level of mental fatigue induced by a prolonged cognitive task and the degree of balance disturbance

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Introduction - Mental fatigue (MF) refers to a change in psychophysiological state caused by prolonged period of demanding activity (Boksem et al., 2005). MF can affect balance control by impairing executive functions and reducing attentional resources (Hachard et al., 2020). Even though there might be large inter-individual differences in neurobehavioral responses to MF, no study has addressed the issue of inter-individual variability in balance control impairments due to MF. Hence, this study investigated the effects of MF induced by a demanding cognitive task on balance control by addressing the issue of the heterogeneity of individuals' responses.

Methods - Twenty healthy young active participants were recruited. They had two sway as little as possible with the eyes open and closed when standing on a force platform before and after performing a 90-minute AX-CPT. The NASA-TLX test was used to assess the subjective manifestations of MF. Objective cognitive performance was measured using results from the AX-CPT. Inter-individual differences in behavioural deterioration due to MF were analysed with a hierarchical cluster analysis. In order to examine the relationships that could exist between behaviour typologies from subjective workload, cognitive performance and balance control data, the cluster number of each participant was assigned as a categorical variable in each type of cluster and contingency tables between cognitive performance / subjective workload and balance control categorical variables were constructed. The link between these variables were tested with the Fisher's exact test for count data.

Results – The cluster analysis revealed that the achievement of the AX-CPT induced various levels of MF and balance impairments within the whole sample. Three clusters were identified

with the NASA-TLX and balance control data and two clusters were identified with the AX-CPT data. The Fisher's exact test showed that there was a significant association between balance clusters and NASA-TLX clusters ($p = 0.02794$) and between balance clusters and AX-CPT clusters ($p = 0.02671$) only when balance control was assessed with the eyes open.

Discussion – The significant relationship between the level of MF and the degree of balance disturbance observed when participants stood with the eyes open suggests that inter-individual differences in vulnerability to MF could stem from differences between subjects in the level of engagement of visual attention and/or from differences in field dependency for balance control. These findings show that the implementation of a similar prolonged demanding cognitive task induces a strong heterogeneity in subjects' responses, with marked individual differences in MF vulnerability that affect balance control differently according to the sensory context.

References

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