A Strategy Against Acute Mental Fatigue: A Neural Oscillations Investigation

Axel Girault*[1], A Lorcery[1], N André[1], O Bernard[2], A Benraïss[1], and M Audiffren[1]

[1]Centre de Recherches sur la Cognition et l'Apprentissage [UMR 7295] – Université de Poitiers = University of Poitiers, Université de Tours, Centre National de la Recherche Scientifique, Université de Tours – France

[2]Laboratoire Mobilité, Vieillissement, Exercice – Université de Poitiers = University of Poitiers – France

Résumé

Introduction

Cognitive effort is a constant component of daily life, influencing decision-making and the capacity for sustained attention during effortful tasks (Ricci et al., 2007) . Prolonged engagement in such tasks can lead to acute mental fatigue (AMF) and impaired cognitive function (Lorist et al., 2005). Understanding AMF and its underlying mechanisms is essential for coping with it more effectively, particularly in sports requiring endurance capacity. The principal aim of the present study is to identify behavioral and electrophysiological markers of AMF during a 30-min cognitive task requiring continuous working memory updating. More precisely, two wave bands already associated with AMF (i.e., theta and alpha waves stimulus-locked power densities) were examined as a function of time on task (Klimesch, 1999).

Methods

Seventy adults attended three sessions. During the first session, participants trained on the dual 2-back (D2B) task. In the second and third sessions, participants performed either a control task (watching a documentary) or a fatiguing task (D2B task). The order of the second and third sessions was counterbalanced across participants. The D2B task included 1,100 trials with 67% of 'no' trials (no match between trial n and n-2) and 33% of 'yes' trials (match between trials n and n-2). Electroencephalographic (EEG) activity was recorded continuously with 64 electrodes. The data were sampled at 1,000 Hz and recorded using a Biosemi system. Preprocessing of the EEG data was performed using BrainVision. Stimulus-locked theta and alpha wave power densities were extracted from the signal with a time–frequency analysis using Morlet wavelets on the median central electrode (Cz).

Results

Reaction times for correct responses decreased over time, but significantly more sharply for 'no' trials. Error rate for 'yes' trials (i.e., omissions) increased significantly over time, whereas error rate for 'no' trials (i.e., false alarms) remained stable throughout the task. D-prime, an index of discrimination between trials n and n-2, decreased over time. Stimulus-locked

*Intervenant

theta wave power density (STWD) increased significantly in the last part of the task for the 'yes' and decreased throughout the task for the 'no' trials. Stimulus-locked alpha wave power density (SAWD) increased over time for 'yes' trials and decreased over time for 'no' trials. In addition, we observed a significant correlation between the decrease in STWD for 'no' trials and the decrease in d-prime over time.

Discussion

Based on behavioral and electrophysiological data, we can conclude that participants had the tendency to respond 'no' more and more automatically over time and consequently deployed less and less cognitive effort to perform the task and thus decreased their ability to discriminate between trials n and n-2 over time. Subjective data suggest that this disengagement of effort would be due to boredom and a decrease in motivation.

Conclusion / Perspective

To better understand these strategies for coping with mental fatigue, it would be interesting to direct our future research towards a more individual understanding of acute mental fatigue. Because we know that, depending on background and/or training for example, not every subject reacts in the same way, and the strategies put in place to deal with acute mental fatigue can vary from person to person.

References

Ricci, J. A., Chee, E., Lorandeau, A. L., & Berger, J. (2007). Fatigue in the U.S. Workforce:

Prevalence and Implications for Lost Productive Work Time: *Journal of Occupational and Environmental Medicine*, *49*(1), 1-10. https://doi.org/10.1097/01.jom.0000249782.60321.2a

Lorist, M. M., Boksem, M. A. S., & Ridderinkhof, K. R. (2005). Impaired cognitive control and

reduced cingulate activity during mental fatigue. *Cognitive Brain Research*, *24*(2),199-205.

https://doi.org/10.1016/j.cogbrainres.2005.01.018

Klimesch, W. (1999). EEG alpha and theta oscillations reflect cognitive and memory performance: A review and analysis. *Brain Research Reviews*, *29*(2-3), 169-195. https://doi.org/10.1016/S0165-0173(98)00056-3