Mental fatigue, Boredom and Performance: Review and Prospects

Michel Audiffren*[1]

[1]CeRCA (CNRS-UMR 7295), Faculté des Sciences du Sport, Université de Poitiers, Poitiers – -, - : Université de Poitiers – France

Résumé

This symposium showcased the latest research on mental fatigue conducted by four teams from Europe and North America. Jelle Habay from the Vrije University of Bruxels first presented the most reliable methods to induce and measure mental fatigue. Then, Alison Lorcery from the University of Poitiers showed that mental fatigue is a reproducible phenomenon at the level of behavioral performance but that it is difficult to find a reliable measurement of mental effort, which is intrinsically linked to mental fatigue. Next, Alain Bouche from the University Bourgogne Europe suggested that aging people seem less resistant to mental fatigue than young adults. Finally, Thomas Mangin from the University of Montreal suggested that boredom could be a confounding factor that complexifies the study of mental fatigue.
These four presentations clearly illustrated that research on mental fatigue requires further development with the use of more rigorous and standardized protocols. The most commonly used protocol to study mental fatigue is the sequential task protocol (Mangin et al., 2023). When using this protocol, sport scientists have to carefully choose several key protocol parameters: (1) the duration and the cognitive load of the effortful task used to induce mental fatigue, (2) the nature of the control task that needs to be as similar as possible to the fatiguing task but as less boring as possible, (3) the principal outcome of the physical exercise carried out after the fatiguing and control tasks, (4) a way to measure mental effort with psychophysiological or brain imaging indexes throughout the different tasks. In addition, because there is a high interindividual variability in the sensitivity/resistance to mental fatigue (Habay et al., 2023), characteristics of the participants need to be also clearly reported (e.g., level of chronic/trait fatigue at baseline, level of physical activity at baseline). Moreover, to control for confounding/mediating factors, sport scientists have to assess several psychological variables: boredom felt during the fatiguing and the control tasks, effort perception during the physical exercise, motivation to perform the physical exercise before performing it. All these methodological precautions are necessary to answer further questions related to mental fatigue.

Two research questions appear to be a priority in the coming years. (1) Which brain mechanism mediates the mental fatigue phenomenon? (2) Is brain endurance training (BET) a reliable training method to increase resistance/tolerance to mental fatigue? Concerning the first question, the hypothesis of an accumulation of brain metabolites in specific brain regions (e.g., anterior cingulate cortex, dorsolateral prefrontal cortex, nucleus accumbens), which would be byproducts of effortful control and markers of mental fatigue, is really heuristic. Three candidates were proposed: adenosine (Pageaux et al., 2014; André et al., 2019),

*Intervenant

beta-amyloid proteins (Holroyd, 2024), glutamate (Pessiglione et al., 2025). Concerning the second question, Marcora et al. (2015) showed that it is possible to improve endurance performance and increase resistance to mental fatigue with BET. Determining the characteristics of the most effective training programs and the mechanisms mediating these gains in psychological endurance is really interesting for fundamental as well as applied research.

References

André, N., Audiffren, M., & Baumeister, R.F. (2019). An integrative model of effortful control. *Frontiers in Systems Neuroscience*, *13*, 79 https://doi.org/10.3389/fnsys.2019.00079

Habay, J., Uylenbroeck, R., Van Droogenbroeck, R., De Wachter, J., Proost, M., Tassignon, B., ... Roelands, B. (2023). Interindividual Variability in Mental Fatigue-Related Impairments in Endurance Performance: A Systematic Review and Multiple Meta-regression. *Sports Medicine - Open*, *9*(1). https://doi.org/10.1186/s40798-023-00559-7

Holroyd, C. B. (2024). The Controllosphere: The neural origin of cognitive effort. *Psychological Review*. https://dx.doi.org/10.1037/rev0000467

Mangin, T., Audiffren, M., & André, N. (2023). Réflexions théoriques et méthodologiques autour du concept de fatigue cognitive. *Movement & Sport Sciences - Science & Motricité*, *120*, 5-24. https://doi.org/10.1051/sm/2023001

Marcora, S. M., Staiano, W., & Merlini, M. (2015, May). A randomized controlled trial of brain endurance training (BET) to reduce fatigue during endurance exercise. *Medicine and Science in Sports and Exercise*, *45*, 198. Poster session presented at the American College of Sports Medicine (ACSM) 62nd Annual Meeting, San Diego, California.

Pageaux, B., Lepers, R., Dietz, K.C., & Marcora, S.M. (2014). Response inhibition impairs subsequent self-paced endurance performance. *European Journal of Applied Physiology*, *114*, 1095–1105. https://doi.org/10.1007/s00421-014-2838-5
Pessiglione, M., Blain, B., Wiehler, A., & Naik, S. (2025). Origins and consequences of cognitive fatigue. *Trends in Cognitive Sciences*. https://doi.org/10.1016/j.tics.2025.02.005