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INTRODUCTION

The use of psychophysiological data to better understand real-time learning: the fragile balance between the validity of data and the authenticity of data collection contexts

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Researchers in neuroeducation, through their use of brain imaging, electroencephalography, oculometry and pupillometry, among other techniques, collect psychophysiological data in real time or very close to real time, to better understand phenomena related to teaching and learning. Their work and methodologies could meet a transdisciplinary research need since many researchers, in education sciences and cognitive psychology among others, have been calling for some years now to the development and application of such real-time methods of data collection (e.g. Boekaerts, 2017; Campbell, 2011; Campbell & Pagé, 2012; Gerjets, 2017; Mercier & Charland, 2013; Timms, DeVelle, & Lay 2016), to enrich and develop theoretical models by combining them, notably, to behavioral data. These real-time data collection methods allow the study of processes related to metacognition (e.g. Schwartz, Scott, & Holzberger, 2013), self-regulation and self-regulated learning (e.g. Dion, 2015; Effeney, 2011); learning modalities (Lee *et al.*, 2006), student reflective thinking during learning (Durall *et al.*, 2017), or cognitive state and cognitive load variations in a learning context (e.g. Liu *et al.*, 2017; Mills *et al.*, 2017). There are many application examples of these methods in education and, more recently, they seem to abound in the contexts of e-learning, hypermedia, and technology-enhanced learning (Chen, 2017; Chen & Wang, 2017; Chen & Wu, 2015; Conrad & Bliemel, 2017; Wu, Tzeng, & Huang, 2014), and this is reflected in this issue.

To find out more about the different types of applications of psychophysiological data in education, the reader is invited to consult Antonenko, van Gog, & Paas' (2014) article, Goswami's chapter (2010), and the book directed by Masson & Borst (2017).

However, the use of psychophysiological data in real time in the field of neuroeducation is still in development and the studies in this direction, as they emerge, would gain to be known and disseminated in transdisciplinary scientific journals and communities. This very first thematic issue of the *Neuroeducation* journal aims to regroup some of them and coincidentally puts forward two interrelated challenges, specific to this young field of research: (1) the importance of the validity of real-time data for their interpretation, and (2) nearing as close as possible authentic school contexts or educational environments (e.g. Mercier *et al.*, 2012). These two challenges seem to be interfering to the extent that efforts to achieve one can harm the achievement of the other, and vice versa.

This thematic issue includes two experimental studies and two methodological articles, all of which reflect the emergence of the use of psychophysiological data to address educational issues, as well as the above-mentioned double challenge related to validity and authenticity contexts.

The Skelling-Desmeules (2018) article in science didactics presents an experimental research aiming to understand the impact of learners' interest in an educational video game in science (*Mécanika*) on their performance. The cognitive and affective dimensions of situational interest were measured in real time using electroencephalograms and pupillometry.

Di Fabio *et al.*'s (2018) study aims to describe the impact of gestures (hand movements) on the cognitive load of the child, as measured by eye tracking, in a context of mathematical problem solving on a tablet.

The first methodological article, that of Lapierre (2018), is a proof of concept resulting from the development of a technique generating time markers in a video, according to different types of psychophysiological data of a filmed participant, to facilitate the analysis of the data and possibly the interpretation, for example, of the expression of a cognitive state such as behavioral, cognitive and emotional commitment.

Finally, Léger *et al.* (2018) propose a series of methodological recommendations to optimize the balance between valid and reliable eye-tracking data, and the most natural interaction possible of young children with a tablet, in a learning context. These guidelines are derived from three similarly designed studies conducted by the authors.

References

Antonenko P. D., van Gog T., & Paas F. (2014). Implications of neuroimaging for educational research. In J. Spector, M. Merrill, J. Elen, & M. Bishop (Eds.), *Handbook of Research on Educational Communications and Technology* (pp. 51-63). New York, NY: Springer. https://doi.org/10.1007/978-1-4614-3185-5_5

Boekaerts, M. (2017). Cognitive load and self-regulation: Attempts to build a bridge. *Learning and Instruction*, 51, 90-97. https://doi.org/10.1016/j.learninstruc.2017.07.001

Campbell, S. R. (2011). Educational neuroscience: Motivation, methodology, and implications. *Educational Philosophy and Theory*, 43(1), 7-16. https://doi.org/10.1111/j.1469-5812.2010.00701.x

Campbell, S. R., & Pagé, P. (2012). La neuroscience éducationnelle: enrichir la recherche en éducation par l'ajout de méthodes psychophysiologiques pour mieux comprendre l'apprentissage. *Neuroéducation*, 1(1), 115-144. https://doi.org/10.24046/neuroed.20120101.115

Chen, C. H. (2017). Measuring the differences between traditional learning and game-based learning using electroencephalography (EEG) physiologically based methodology. *Journal of Interactive Learning Research*, 28(3), 221-233. https://www.learntechlib.org/p/174121/

Chen, C. M., & Wang, J. Y. (2017). Effects of online synchronous instruction with an attention monitoring and alarm mechanism on sustained attention and learning performance. *Interactive Learning Environments*, 1-17. https://doi.org/10.1080/10494820.2017.1341938

Chen, C. M., & Wu, C. H. (2015). Effects of different video lecture types on sustained attention, emotion, cognitive load, and learning performance. *Computers & Education*, 80, 108-121. https://doi.org/10.1016/j.compedu.2014.08.015

Conrad, C. D., & Bliemel, M. (2017). Psychophysiological measures of cognitive absorption and cognitive load in e-learning applications. In A. Pär, N. Levina, & S. S. Kien (Eds.), *Proceedings of the 36th International Conference on Information Systems (ICIS)*. Dublin, Ireland : AIS. http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1074&context=icis2016

Di Fabio, M.-L., Sénécal, S., Léger, P.-M., & Charland, P. (2018). L'influence de la gestuelle sur la charge cognitive en contexte d'apprentissage des mathématiques sur application éducative numérique. *Neuroeducation*, 5(1), 13-25. https://doi.org/10.24046/neuroed.20180501.13

Dion, J.-S. (2015). Bases théoriques pour l'étude de l'autorégulation enseignante par électroencéphalographie: vers de nouvelles recherches en neuroéducation. *Approche Neuropsychologique des Apprentissages chez l'Enfant* (A.N.A.E.), 27(134), 63-70.

Durall, E., Leinonen, T., Gros, B., & Rodriguez-Kaarto, T. (2017). Reflection in learning through a self-monitoring device: Design research on EEG self-monitoring during a study session. *Designs for Learning*, 9(1), 10-20. http://doi.org/10.16993/dfl.75

Effeney, G. (2011). *The development of executive function and self-regulated learning in adolescent males*. Ph.D. thesis, University of Queensland, Australia.

Gerjets, P. (2017). Learning and problem-solving with hypermedia in the twenty-first century: From hypertext to multiple web sources and multimodal adaptivity. In S. Schwan & U. Cress (Eds.), *The Psychology of Digital Learning* (pp. 61-88). Cham, Switzerland: Springer International Publishing. https://doi.org/10.1007/978-3-319-49077-9_4

Goswami, U. (2010). Neuroscience in education. In C. L. Cooper, J. Field, U. Goswami, R. Jenkins, & B. J. Sahakian (Eds.), *Mental Capital and Wellbeing* (pp. 55-62). Oxford, UK: Wiley-Blackwell.

Lapierre, H. G. (2018). Exploration automatisée de données vidéo à partir d'un fil de données psychophysiologiques : une preuve de concept en sciences de l'éducation. *Neuroeducation*, 5(1), 26-32. https://doi.org/10.24046/neuroed.20180501.26

Lee, L., Lee, M., Lee, H., Guiroy, I., Hong, T., & Williams, W. (2006). Quantitative EEG as an identifier of learning modality. *U.S. Patent Application No. 11/430,555*. https://docs.google.com/viewer?url=patentimages.storage.googleapis.com/pdfs/US20060257834.pdf

Léger, P.-M., Sénécal, S., Karpova, É., Brieugne, D., Di Fabio, M.-L., & Georges, V. (2018). Setup guidelines for eye tracking in child and teenager research in the context of learning by interacting with a tablet. *Neuroeducation*, 5(1), 33-40. https://doi.org/10.24046/neuroed.20180501.33

Liu, X., Tan, P. N., Liu, L., & Simske, S. J. (2017). Automated classification of EEG signals for predicting students' cognitive state during learning. In *Proceedings of the International Conference on Web Intelligence* (pp. 442-450). New York, NY: ACM. https://doi.org/10.1145/3106426.3106453

Masson, S., & Borst, G. (Eds.). (2017). *Méthodes de recherche en neuroéducation*. Québec : Presses de l'Université du Québec.

Mercier, J., & Charland, P. (2013). An agenda for neuroeducation: relating psychophysiological and behavioral data across time scales of learning. *Neuroeducation*, 2(1), 71-86. https://doi.org/10.24046/neuroed.20130201.71

Mercier, J., Léger, P.-M., Girard, C., & Dion, J.-S. (2012). Bridging the gap between cognitive neuroscience and education: Psychophysiological and behavioral data collection in authentic contexts. *Neuroeducation*, 1(1), 5-28. https://doi.org/10.24046/neuroed.20120101.5

Mills, C., Fridman, I., Soussou, W., Waghray, D., Olney, A. M., & D'Mello, S. K. (2017). Put your thinking cap on: Detecting cognitive load using EEG during learning. In *Proceedings of the Seventh International Learning Analytics & Knowledge Conference* (pp. 80-89). New York, NY: ACM. https://doi.org/10.1145/3027385.3027431

Schwartz, N. H., Scott, B. M., & Holzberger, D. (2016). Metacognition: A closed-loop model of biased competition–evidence from neuroscience, cognition, and instructional research. In R. Azevedo & V. Aleven (Eds.), *International Handbook of Metacognition and Learning Technologies* (pp. 79-94). New York, NY: Springer Science+Business Media. https://doi.org/10.1007/978-1-4419-5546-3_6

Skelling-Desmeules, Y. (2018). Impacts des dimensions cognitives et affectives de l'intérêt situationnel sur la performance à un jeu vidéo éducatif en science. *Neuroeducation*, 5(1), 7-12. https://doi.org/10.24046/neuroed.20180501.7

Timms, M., DeVelle, S., & Lay, D. (2016). Towards a model of how learners process feedback: A deeper look at learning. *Australian Journal of Education*, 60(2), 128-145. https://doi.org/10.1177/0004944116652912

Wu, C.-H., Tzeng, Y.-L., & Huang, Y. M. (2014). Understanding the relationship between physiological signals and digital game-based learning outcome. *Journal of Computers in Education*, 1(1), 81–97. https://doi.org/10.1007/s40692-014-0006-x