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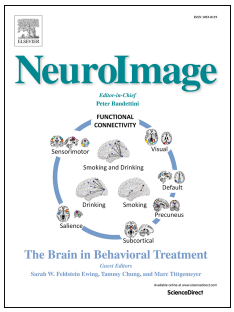

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Tracking wakefulness as it fades: micro-measures of Alertness

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Abstract

A major problem in psychology and physiology experiments is drowsiness: around a third of participants show decreased wakefulness despite being instructed to stay alert. In some non-visual experiments participants keep their eyes closed throughout the task, thus promoting the occurrence of such periods of varying alertness. These wakefulness changes contribute to systematic noise in data and measures of interest. To account for this omnipresent problem in data acquisition we defined criteria and code to allow researchers to detect and control for varying alertness in electroencephalography (EEG) experiments under eyes-closed settings. We first revise a visual-scoring method developed for detection and characterization of the sleep-onset process, and adapt the same for detection of alertness levels. Furthermore, we show the major issues preventing the practical use of this method, and overcome these issues by developing an automated method (micro-measures algorithm) based on frequency and sleep graphoelements, which are capable of detecting micro variations in alertness. The validity of the micro-measures algorithm was verified by training and testing using a dataset where participants are known to fall asleep. In addition, we tested generalizability by independent validation on another dataset. The methods developed constitute a unique tool to assess micro variations in levels of alertness and control trial-by-trial retrospectively or prospectively in every experiment performed with EEG in cognitive neuroscience under eyes-closed settings.

Keywords:

Alertness, micro-measures, Electroencephalography, drowsiness, wakefulness, sleep, arousal, variability, validation.