Chapter 95

An Applied Driving Evaluation of Electrodermal Potential as a Measurement of Attentional State

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Traditional electroencephalography (EEG) systems are the gold standard for measuring levels of alertness, have shown mixed but arguably promising results in measuring cognitive workload,[1] and can be used even in applied roadway tasks to detect neural correlates of complex decision-making.[2] However, high-quality, multichannel EEG arrays tend to be expensive and time-consuming to set up. Wrist-wearable electrodermal potential (EDP) devices promise classification of EEG states without such limitations. The lone description of such a device in the present literature describes a generalized measure of attentional state constructed from EDP that achieves accuracy of 84.2% in distinguishing, in a laboratory setting, between relaxed participants with eyes closed and patients actively engaging in visual search.[3] Such a measure, provided it remained reasonably reliable under actual field conditions, would have broad neuroergonomic potential. At the same time, such a system would have to overcome and address a number of technical challenges to practically provide the functionality suggested by the developers. Thus, a careful, realistic, and independent evaluation of this technology under actual driving conditions appeared warranted. As such, the present work sought to evaluate a Freer Logic BodyWave EDP wearable, and, in particular, the attentional index provided by this device, to determine if it could distinguish between levels of demand imposed on a driver. A gender-balanced and age-diverse sample of experienced drivers drove on-road while connected to the EDP wearable as well as a heart monitor. Participants experienced epochs of driving alone, and epochs of driving and being parked while completing a working-memory "n-back" task,[4] in which they were presented with a stream of single-digit numbers and were instructed to either verbalize the number (0-back), the immediately preceding number (1-back), or the number two-places back in the sequence (2-back). It was hypothesized that both heart rate and EDP would be able to distinguish between these levels of load. Heart-rate data indeed showed significant differences between baseline driving and each level, in a pattern suggesting a successful manipulation: the n-back task elevated demand in an orderly fashion, and demand was much higher in the "driving plus n-back" conditions than in the "parked plus n-back" conditions. The EDP attention metrics showed trends that appear to match these patterns, but none reached the level of significance ($\alpha=0.05$). A closer look at the alpha, beta, delta, and theta indices, which underlie the BodyWave EDP wearable-reported attention metric,[3] show some promise, and help explain this orderly but nonsignificant pattern. Nonetheless, it appears that EDP wearables need more development before they are robust to noisy, applied contexts like on-road driving.

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