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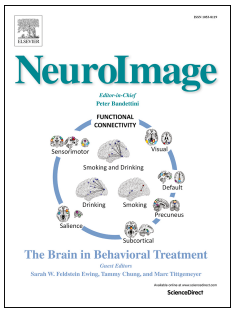

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A Subject-Transfer Framework for Obviating Inter- and Intra-Subject Variability in EEG-Based Drowsiness Detection

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Abstract

Inter- and intra-subject variability pose a major challenge to decoding human brain activity in brain-computer interfaces (BCIs) based on non-invasive electroencephalogram (EEG). Conventionally, a time-consuming and laborious training procedure is performed on each new user to collect sufficient individualized data, hindering the applications of BCIs on monitoring brain states (e.g. drowsiness) in real-world settings. This study proposes applying hierarchical clustering to assess the inter- and intra-subject variability within a large-scale dataset of EEG collected in a simulated driving task, and validates the feasibility of transferring EEG-based drowsiness-detection models across subjects. A subject-transfer framework is thus developed for detecting drowsiness based on a large-scale model pool from other subjects and a small amount of alert baseline calibration data from a new user. The model pool ensures the availability of positive model transferring, whereas the alert baseline data serve as a selector of decoding models in the pool. Compared with the conventional within-subject approach, the proposed framework remarkably reduced the required calibration time for a new user by 90% (18.00 min to 1.72±0.36 min) without compromising performance (p = 0.0910) when sufficient existing data are available. These findings suggest a practical pathway toward plug-and-play drowsiness detection and can ignite numerous real-world BCI applications.

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