FUNCTIONAL SIGNIFICANCE AND SHORT-TERM TEST-RETEST RELIABILITY OF EEG MICROSTATES

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Background: The analysis of the EEG into microstates representing a distinct topographical organization of the power of the EEG signal over the skull is an established method, but the test-retest reliability of the EEG microstates and their functional interpretation remain unclear.

Aims: To investigate the functional significance of the EEG microstates classes and their pair-wise transitions, as well as to establish their within-session test-retest reliability.

Method: We recorded 30-channel EEGs in 20 healthy volunteers during three eyes-closed conditions: mind-wandering, silent verbalization (repeating the word 'square' every 2 sec), and visualization (visualizing a square). Each condition lasted three minutes and the sequence of three conditions was repeated four times (two runs of two repetitions). The participants' alertness and their sense of effort and focus during each condition was rated using visual-analogue scales. The EEG data were 2-20 Hz bandpass-filtered and analyzed into four canonical micro-state classes: A, B, C, and D.

Results: EEG microstate lasses C and D were persistently more dominant than classes A and B in all conditions. Of the classical micro-state parameters, the average micro-state duration was the most reliable one. The duration of micro-state class D was longer in the mind-wandering condition (106.8 ms) than during verbalization (102.2 ms) or visualization (99.8 ms), with a concomitantly higher coverage (36.4 % vs. 34.7 % and 35.2 %), but otherwise it was difficult to associate the four micro-state classes to particular mental states. As for the transitions from one microstate to another, only the transitions between classes C and D (and in particular those from C to D) were significantly higher than what would be expected from the respective states' occurrences. The transition probabilities, however, did not distinguish between conditions, and their test-retest reliability was overall lower than that of the first-order parameters such as duration and coverage. The test-retest reliability was higher at the beginning of each run.

Conclusions: Further studies are needed to establish the functional significance of the canonical EEG microstates. This might be more fruitfully achieved by looking at their complex syntax beyond pair-wise transitions using methods as previously proposed (Nehaniv and Antonova, 2017). To ensure greater test-retest reliability experimental designs should allow for shorter epochs with regular breaks.

Keywords: EEG microstates, Resting state EEG, Resting-state networks, Neuroimaging, Biomarkers

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