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Electroencephalogram during Natural Reading: Theta and Alpha Rhythms as Analytical Tools for Assessing a Reader's Cognitive State

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Abstract : Electrophysiology of information processing in reading is certainly a popular research topic. Natural reading, however, has been relatively poorly studied, despite having broad potential applications for learning and education. In the current study, we explore the relationship between text categories and spontaneous electroencephalogram (EEG) while reading. Thirty healthy volunteers (mean age 26,68 ± 1,84) participated in this study. 15 Russian-language texts were used as stimuli. The first text was used for practice and was excluded from the final analysis. The remaining 14 were opposite pairs of texts in one of 7 categories, the most important of which were: interesting/boring, fiction/non-fiction, free reading/reading with an instruction, reading a text/reading a pseudo text (consisting of strings of letters that formed meaningless words). Participants had to read the texts sequentially on an Apple iPad Pro. EEG was recorded from 12 electrodes simultaneously with eye movement data via ARKit Technology by Apple. EEG spectral amplitude was analyzed in Fz for theta-band (4-8 Hz) and in C3, C4, P3, and P4 for alpha-band (8-14 Hz) using the Friedman test. We found that reading an interesting text was accompanied by an increase in theta spectral amplitude in Fz compared to reading a boring text (3,87 μV ± 0,12 and 3,67 μV ± 0,11, respectively). When instructions are given for reading, we see less alpha activity than during free reading of the same text (3,34 μV ± 0,20 and 3,73 μV ± 0,28, respectively, for C4 as the most representative channel). The non-fiction text elicited less activity in the alpha band (C4: 3,60 μV ± 0,25) than the fiction text (C4: 3,66 μV ± 0,26). A significant difference in alpha spectral amplitude was also observed between the regular text (C4: 3,64 μV ± 0,29) and the pseudo text (C4: 3,38 μV ± 0,22). These results suggest that some brain activity we see on EEG is sensitive to particular features of the text. We propose that changes in theta and alpha bands during reading may serve as electrophysiological tools for assessing the reader's cognitive state as well as his or her attitude to the text and the perceived information. These physiological markers have prospective practical value for developing technological solutions and biofeedback systems for reading in particular and for education in general.

Keywords : EEG, natural reading, reader's cognitive state, theta-rhythm, alpha-rhythm
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