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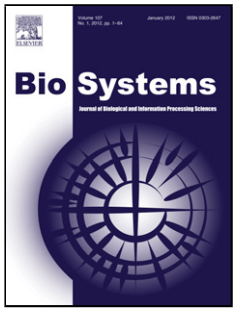

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Functional data analysis of single-trial auditory evoked potentials recorded in the awake rat

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Abstract

Evoked potentials (EPs) reflect neural processing and are widely used to study sensory perception. However, methods of analyzing EP have been limited mostly to the conventional ensemble averaging of EP response trials to a repeated stimulus, and less so to single-trials analysis. Here we applied a new approach – functional data analysis (FDA) – to study auditory EP in the rat model of tinnitus, in which overdoses of salicylate (SS) are known to alter sound perception characteristically, as the same way as in humans. Single-trial auditory EPs were analyzed, after being collected on a daily basis from an awake rat, which had been surgically implanted with intracranial electrodes over its auditory cortex. Single-trial EP integrals were generated with sound stimuli (tones and clicks) presented systematically over an intensity range. The results were approximated using the cubic spline to give sets of smoothed response-level functions in dependence on the sound intensity. These functional data were analyzed using the methods of FDA. Comparisons between daily intensity series for each sound type were done using cross-distance measures based on the response-level functions in both the original form and the first-derivative form. From the results of FDA, the first-derivative form was found to provide a clearer separation when EP data from Control groups were compared to the data from SS groups. This is also true when the daily data were compared within the more variable SS-group itself. In addition, at the high-intensity region where SS-action is presumably strong, we also observed characteristic changes in two statistical parameters, mean and skewness, of the cross-distance representations. Results suggested that FDA is a sensitive approach for EP studies, and it can become a powerful tool for the research in neural science, particularly neuropharmacology.

Keywords: auditory cortex, evoked potential integral, functional data, salicylate, semimetric, tinnitus

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