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DYNAMICAL COMPLEXITY ANALYSIS OF SACCADIC EYE MOVEMENTS IN TWO DIFFERENT PSYCHOLOGICAL CONDITIONS

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Abstract

Saccadic eye movements of a normal subject were assessed through semi-quantitative analysis algorithms based on linear and non-linear test application in order to highlight the dynamics type characterizing saccadic neural system behavior. These movements were recorded during a simple visually-guided saccade test and one with a cognitive load involving button pressing to show a decision. Following the application of specific computational tests, chaotic dynamical trend dominancy was mostly revealed with some differences between the two saccade recording conditions: auto-correlation time was increased from 170 to 240 by cognitive task superposition and the Hurst exponent was enhanced from 0.52 to 0.76, denoting more persistence in the dynamics of saccadic system during increased neural activity related to cognitive task.

Keywords

visually guided saccades; infrared eye tracking system; chaos theory; computational tests

1. INTRODUCTION

Complex non-linear behavior in cellular membranes and physiological systems was shown two decades ago [1, 2], with special interest in chaotic neuron firing and related bifurcation behavioral issues [3, 4]. Chaos signature in neural cells and networks was found by mathematical approaching like the FitzHugh-Nagumo equations and the Hindmarsh-Rose equations [5, 6]. The extraction and processing of various temporal data series is very useful to distinguish between stochastic and chaotic processes. Computational tools based on Lyapunov formalism, attractor reconstruction and assessing its fractal dimension, surrogate data analysis etc. could be the alternative to traditional methods that failed to provide specific information on neural activity evolution. It seems that full understanding of the various types of activities in neurons and neural sub-systems dynamics, the connections between them and the resulting behavioral patterns is not possible without computational