Nonlinear dynamical analysis of EEG in sleep

Nonlinear dynamical analysis of EEG in sleep: a review of current literature.

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Progress in the study of complex nonlinear dynamical ('chaotic') systems has led to the development of a variety of methodological tools for the analysis of nonlinear dynamics in time series data.

Several of these methods have been applied to study changes in EEG and MEG dynamics related to perceptual processing, cognitive tasks, brain pathology (e.g. Alzheimer's disease), as well as states such as anaesthesia and sleep. The first published study to apply such measures on the human EEG had in fact involved sleep

recordings (Babloyantz, Salazar, & Nicolis, 1985), and since then an increasing number of studies have used nonlinear analysis methods to investigate changes in brain dynamics during sleep. A summary of the underlying concepts and some of the methods used for nonlinear time series analysis will be presented, and the current literature of nonlinear sleep EEG research will be reviewed. Findings from these studies suggest that nonlinear measures of sleep EEG can provide additional information not accessible with linear (e.g. frequency-based) measures, and may also be better at discriminating between certain sleep stages (e.g. stages 1 and 2). Despite these promising findings however, there is a notable lack of studies applying nonlinear EEG methods to investigate sleep pathology; the potential use of these methods for the diagnosis of certain sleep disorders, and their role in understanding the brain dynamics underlying healthy and pathological sleep will be discussed.

Babloyantz, A., Salazar, J. M., & Nicolis, C. (1985). Evidence of chaotic dynamics of brain activity during the sleep cycle. Physics Letters, 111A (3), 152–156.