Bumps, Blind Source Separation, Synchrony and Alzheimer's

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Alzheimer's disease (AD) is the most common neurodegenerative disorder. Since the number of individuals with AD is expected to increase considerably in the near future, reliable treatment and diagnosis of AD are critical. EEG could be used as a cost-effective screening tool for early detection and diagnosis of the MCI (Mild Cognitive Impairment) stage, which may change the objectives of treatment: if AD could be reliably diagnosed in an early stage, medical treatments could be used to delay or, hopefully, even bring the disease progress to a halt. Our long-term research objective is to develop signal processing methods that improve EEG specificity for diagnosing AD; we wish to discover EEG signal features that not only significantly differ in AD patients, but also allow us to reliably separate AD patients and control subjects.

Oscillatory bursts in EEG signals may play a specific functional role, distinct from ongoing background EEG activity. Such bursts can be extracted using bump models (Vialatte, et al., 2009). It has been shown that the bump modeling of EEG signals is a promising candidate for population-wide early detection of Alzheimer's disease (Vialatte, et al., 2007). However, the features extracted by the procedure lead to a complex classifier, to be trained with a limited number of samples. Therefore, a more compact event representation was developed, by extracting the time-frequency structure of EEG signals (graphs of bumps) and their propagation to distant locations: the Stochastic Event Synchrony (SES) method (Dauwels, et al., 2009).

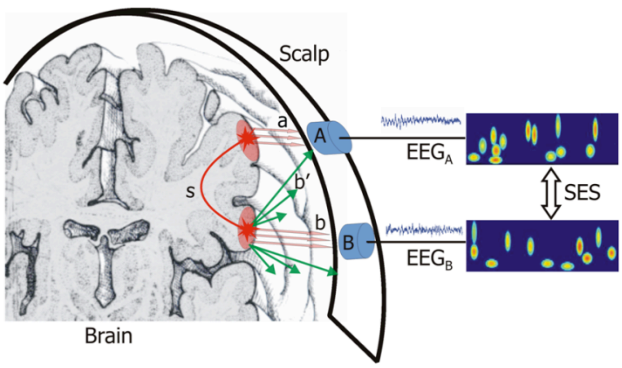

Figure 1 : Stochastic Event Synchrony

Two databases were investigated: one with 22 Mild Cognitive Impairment subjects and 38 age-matched control subjects; one with 17 Mild AD and 24 age-matched control subjects. The analysis was performed in a two-stage approach, where first a Blind Source Separation approach was applied to remove non-cerebral signals from EEG signals, then 30 synchrony measures were computed, and the best features selected. A correct linear classification rate above 83% was obtained for both patient groups as opposed to age-matched controls, using only two features: full-frequency directed transfer function (a synchrony measure), combined with the similarity measure provided by SES. This study opens avenues for future researches on larger datasets that are being gathered.

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