Abstract View

A NEW WAY TO LOOK AT SLEEP

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We developed SPEARS, a fast, unsupervised, internally consistent algorithm for analyzing EEG sleep data. For each recording, relevant bands at Delta and Gamma frequencies are extracted by normalizing the whole night spectrogram in time, thereby overcoming limitations on the analysis imposed by the 1/f nature of sleep EEG, permitting the accurate detection of high-frequency signals that have low amplitudes but significant variability. These bands and their 2nd-order statistics were used to construct an initial parameter space in which to analyze sleep data. Each epoch was first scored as slow wave sleep (SWS) or NSWS (non-SWS), and as rapid eye movement (REM) or NREM (Non-REM) sleep. Following an optional smoothing step, epochs scored as both NSWS and NREM are rescored as intermediate whereas epochs scored as REM and SWS are rescored as outliers. REM forms a spear in the space defined by Delta, Gamma/Delta and the time derivative of Delta. SWS forms a spear in the space defined by Delta, Gamma/Delta and the time derivative of Gamma/Delta. In a 3-D space spanned by Delta, Gamma/Delta and the standard deviation of each epoch or derived by PCA reduction of the initial parameter space, REM and SWS form orthogonal planes. This separation method and computation of relevant statistics can be executed at a 1 sec resolution in less than 3 mins for a full night recording and was successfully applied to single channel EEG data from mice, birds and humans including subjects with diverse pathologies. Given its speed, reliability and applicability, this technique is a fast, economic and quantitatively rigorous alternative to the Rechtschaffen-Kales method in clinical and comparative sleep research.

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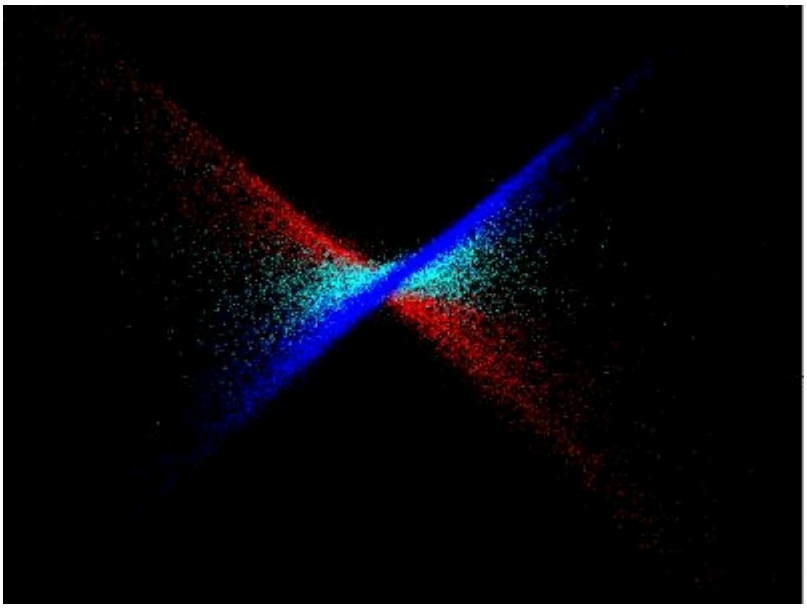

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