

Measuring EEG Sleep Spindle Frequency

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The Electroencephalogram (EEG) is a recording from the scalp that reflects electrical signals from the brain. It is made on chart paper that moves underneath pens that are connected to galvanometers, which read the electrical signals from electrodes. The electrodes are placed on several areas on the skull. The EEG is especially helpful in the study of sleep state changes.

EEG is usually divided into four bands: delta ranging from 0 to 4 Hz, theta from 4 to 8 Hz, alpha from 8 to 13 Hz, and beta from 13 to 30 Hz. Alpha waves are brought about by the closing of the eyes and subsequent relaxation. In contrast, it is abolished by the opening of the eyes, or the alert caused by any mechanism, such as thinking. Beta waves are described as “fast” activity, and thus is the dominant rhythm in patients who are alert or anxious. Inversely, theta waves are described as “slow” activity, normal for sleep and for children under 13 years of age. Delta waves are the slowest waves, which are the normal and dominant rhythm in infants. They are strongest when one is in a dreamless sleep.

Sleep is divided into three main stages: Waking, Quiet Sleep or NREM (non-REM), and REM. Waking is when the body prepares for sleep (i.e. muscles relax and eye movement slows). NREM is divided into 4 stages: S1, S2, S3, and S4. S1 is described as drowsiness, thus it contains mostly theta waves. If one is aroused from this stage, he/she might feel as though no sleep was achieved. S2 includes periods of light sleep, during which the body prepares to enter deep sleep. S3 is the deep sleep stage, thus containing mostly delta waves. S4 is described by deep sleep more intense than

S3. It contains slow delta waves of high amplitude, indicating deep sleep and rhythm continuity.

Following NREM is REM or Rapid Eye Movement, during which intense dreaming occurs due to heightened cerebral activity. The first period of REM lasts 10 minutes, with subsequent periods lengthening until the final one, which lasts for one hour. It contains mostly beta waves.

Sleep spindles, which occur mostly during Stage 2 of NREM, are defined as short lasting sleep EEG theta waveforms that last for 1 second. They are described as the “waxing and waning” of frequency at 7- 14 Hz. There is growing evidence that spindles could be markers of sleep quality because of their sleep-maintaining nature. Some believe that sleep spindles are responsible for allowing for deeper stages of sleep to begin.

A team of scientists from Finland has recently developed an Automatic Analysis of sleep spindle frequencies throughout the night. For their study, they detected the sleep spindles of 10 healthy subjects and 10 subjects with Obstructive Sleep Apnoea disorder. They observed that the spindle frequency of healthy subjects rose during the night, While that of apnoea subjects remained slow throughout the night.

References:

- E. Huupponen, et al., “Automatic Analysis of Electro-Encephalogram Sleep Spindle Frequency throughout the Night,” *Medical and Biological Engineering and Computing*, Vol. 41, p. 727-732, 2003.

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- <http://www.dreamviews.com/sleepstages.php>