High-frequency oscillations and rhythmic slow activity during virtual navigation, REM sleep and wake-sleep transitions: Studies on intracranial recordings in humans

Results:

This study relied on nine epilepsy surgery candidates implanted with foramen ovale electrodes. 1.5-3Hz rhythmic slow activity (RSA) was a predominant activity pattern during REM sleep in most patients. This activity was also found to be highly synchronous both intra- and interhemispherically. Positive half-waves of the 1.5–3Hz RSA were identified by a semi-automatic automatic algorithm during REM sleep. High-frequency activity was assessed as root mean square (RMS) for 11 consecutive 20 Hz–wide frequency bands between 20 and 240Hz. Calculating individual spectra revealed a broad but definite peak in the high-frequency band in seven cases (hemispheres). Statistical analysis revealed a clear phase-coupling of high-frequency activity in all patients and for most of the high-frequency bands studied. This phase relation was similar across the high frequency bands within the same patient and hemisphere. This allowed us to use individually defined fixed intervals of 0.1 s to statistically compare RMS values corresponding to the peak and the trough of the triggered RMS curve. Typically the preferred phase occurred before the RSA peak used as trigger. In most cases modulation statistics exhibited a U-shaped curve with highest significance levels in the middle frequency bands (60–80Hz and 80–100Hz). Compared to these bands modulation generally weakened across both decreasing and increasing frequency ranges. Such a phase-coupling between delta and gamma activity is similar to that seen between theta and gamma in rodents. We consider this commonality to be an additional reason for regarding delta rather than theta as the human analogue of RSA in animals.

Published work:

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