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Exploring the neurophysiological background of tonic and phasic REM sleep: evidence from scalp EEG and intrathalamic recordings

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Rapid Eye Movement (REM) sleep is traditionally viewed as a homogeneous state, characterized by the combination of high cortical activity indexed by low voltage, mixed frequency electroencephalographic (EEG) oscillations and low muscle tone, as well as by the occurrence of relatively fast eye movements. Although the heterogeneity of NREM sleep regarding sleep stability and arousability are well established very few studies examined REM sleep in this regard. This is surprising as REM sleep is composed of two markedly different microstates: phasic and tonic periods, the former being characterized by eye movements, muscle twitches, and irregular autonomic activity interspersed between the apparently more quiescent tonic periods. Phasic and tonic periods also differ with respect to awakening and arousal thresholds, external information processing and even mental experiences. Here we summarize the main differences between these REM microstates and present our findings regarding spontaneous cortical oscillations during phasic and tonic states as measured by scalp EEG and intrathalamic recordings. Our results provide further support for the notion that phasic and tonic REM periods are markedly different neural states. We speculate

that during phasic REM the brain transitionally decouples from the external environment and submerges in inwardly generated sensory and motor activity, whereas during tonic states vigilance, environmental awareness, and attentional processes reflecting a more wake-like state are partially reinstated. Since REM sleep has been associated with many psychological processes and disorders (e.g. emotional memory consolidation, dreaming, depression, PTSD), exploring the neurophysiological background of tonic and phasic REM sleep could lead to important new insights.