Sleep Science

Can Acetylcholine make you dream?

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Wakefulness involves diffuse activation of cerebral cortex through Ascending Reticular Activating System (RAS), which connects midbrain and pons to cortex through the thalamus and hypothalamus. RAS is primarily composed of the pedunculopontine tegmentum (PPT) & laterodorsal tegmentum (LDT) of pons, locus coeruleus nucleus (LC) and dorsal raphe nucleus (RN) which involves all classic neurotransmitters[1]. Smooth functioning of RAS is required for the maintenance of consciousness, regulation of sleep-wake transitions and attention. Monoaminergic neurotransmitters are considered to be highly active during wakefulness and slow wave sleep with very low activity during Rapid Eye Movement (REM) sleep, while cholinergic fibres are most active during REM sleep[2].

Because of the similarity between the EEG pattern of REM sleep and wakefulness, this phase is also denominated paradoxical sleep and is also known to be the phase of active dreaming. The dream is defined as an intense, perceptual experience which can be either sensory or motor, following a descriptive structure mostly described after REM sleep. Positron emission tomography (PET) studies have clearly demonstrated that brain metabolism is very much similar between wakefulness and REM sleep[3]. During a dream, even when a person is not connected to the external environment, the cortex dramatizes with the already stored memories mimicking hallucination. The content of the dream is the replica of real world involving sensory modalities making it difficult for the person to differentiate between the two[4].

Previous studies have shown an increase in Acetylcholine (ACh) in neocortex and hippocampus during different activities of wakefulness and REM sleep[5]. Muscarinic cholinergic receptors are essential for REM sleep, as it has been demonstrated with the knockout of the Chrm1 and Chrm3 genes[6]. Neocortical activation in REM sleep is sustained mainly by ACh, this creates a state of arousal without any simultaneous input from other neurotransmitters, and this may be responsible for the incoherent and bizarre character of the dream which cannot be recalled[7]. ACh has also got a definitive role in memory consolidation and retrieval. Cortical cholinergic neurons, which are stimulated by RAS may be responsible for the retrieval of events, facts, figures, places, etc. This phenomenon is substantiated by the fact that adults with certain brain areas damaged may not be able to dream at all and as children don't have much developed cognitive domain, they only develop dreaming after cognition development[8]. The significance of ACh in dreaming is further substantiated clinically, as Galantamine (Acetylcholine esterase inhibitor) is considered to be an effective agent to induce lucid dreams[9].

Considering the activity of ACh in maintenance of REM sleep and induction of lucid dreams by cholinergic potentiating agents, it is possible that cholinergic activity is essential for generating the contents of dreams. Further, there is possibility that dreams are secondary to cholinergic activation, as ACh is primarily responsible for generating REM sleep. These conclusions need to be evaluated under experimental and clinical settings.

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