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Newsletter

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REM Sleep and Memory Part I: What We Know

What evidence do we have that dreaming has anything to do with the consolidation of memories? The idea stems from the notion that if a dream reflects events recently experienced while awake, it may be that the rehearsal of learned information in dreams results in their consolidation into memory.[1] In rats, a number of studies have demonstrated the link between REM sleep and memory.[2] Learning for rats in these studies usually involved linking the association of a stimulus with either a positive reinforcement such as a food reward or a negative reinforcement such as a loud obnoxious sound or even an electric shock. Many of these studies showed that with learning comes an increase in REM sleep. Other studies have shown that when rats are deprived of REM sleep following training, learning is impaired.[3]

An increase in REM sleep in humans has been reported following training in various experiments including trampolining,[4] intensive learning of a foreign language,[5] learning Morse code,[6] and visual field inversion.[7] Brain imaging in humans reveals an increase in brain activity may be seen during learning in the appropriate parts of the brain that are involved with the task at hand. The same regions of the brain are again activated during subsequent REM sleep.[8 9]

Brainwave recordings in animals[10 11] have provided support for the view that memory undergoes reactivation during REM sleep, by showing that the same brain areas that are activated during learning while awake are again activated during that night's REM sleep. This reactivation is likely orchestrated from the waveforms that originate in the brainstem and proceed to the sensory relay of the thalamus before proceeding up to the visual cortex thereby driving changes in the imagery of the dream. These waveforms are linked with the actual rapid eye movements of REM sleep.[12] These brainstem impulses have been recorded in cats and rats.[13 14] It is believed that these impulses which originate in the REM generating nuclei of the brainstem are the initiators and propagators of REM sleep.[15 16] It is thought that they are what drive the actual eye movements that are associated with action in the dream and that they may represent at least part of the mechanism associated with "welding" in the new connections between recent and existing memories.[17]

When rats actively explore a new environment, individual neurons in the hippocampus may fire only when the rat is in a specific location of the maze. Another may fire for the next part of the maze, and so on as the firing pattern of all the neurons in the hippocampus thereby form a spatial map of the maze. It was because of this discovery that these hippocampal neurons were initially named hippocampal "place" cells, since they would fire when the rat was in a specific place.[18] Since the initial discovery of place cells, it has become apparent that they not only encode location, but can also encode for other important information such as a change in the perspective of the environment, or when other important associations are made that may not have bearing on the exact location of the animal.[19] It is emotional relevance that decides which experiences or thoughts are temporarily stored in the hippocampus.[20 21]

Stay tuned for the next newsletter: "REM Sleep and Memory, How it might Work".

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