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Review Paper

Exploring the Relationship between Visual Memory Consolidation and Dreaming During the Transition from NREM to REM Sleep: A Systematic Review

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ABSTRACT

This systematic review investigates the intricate relationship between visual memory consolidation and dreaming during the transition from Non-Rapid Eye Movement (NREM) to Rapid Eye Movement (REM) sleep in human subjects. Recognising the pivotal role of these sleep stages in memory processes and dreaming, we employed a comprehensive search strategy to identify relevant literature. A total of 23 studies were included in the quantitative synthesis, focusing on methodologies assessing visual memory and dreaming experiences during the NREM-REM transition. Each study underwent rigorous evaluation for risk of bias to ensure the reliability and validity of findings, with those identified as having a high risk of bias given less weight in result synthesis. Our analysis highlights the importance of understanding the interplay between visual memory consolidation and dreaming during the NREM-REM transition, shedding light on fundamental aspects of sleep-dependent memory processes and dreaming.

Keywords: *Visual Memory, Sleep, Dreams, Rapid eye movement sleep, NREM Sleep and Memory Consolidation*

Sensory memory is the initial phase of memory, storing raw sensory inputs for a brief period, allowing the brain to begin processing this information (Sperling, 1960). Visual memory involves the relationship between perceptual processing and the encoding, storage, and retrieval of visual representations (Baddeley, 2003). It is crucial for recognizing faces, objects, and places. Visual memory includes two main components: visual working memory (VWM) and visual episodic long-term memory (VLTM) (Luck & Vogel, 1997). VWM temporarily stores and manipulates visual information for tasks like mental arithmetic, reading comprehension, and navigating environments, and is mediated by posterior brain mechanisms, with its capacity determined by both the number of objects and their complexity (Luck & Vogel, 1997). VLTM, responsible for the permanent storage and retrieval of visual experiences, is linked to increased regional cerebral blood flow in the prefrontal cortex and anterior cingulate cortex (Brewer et al., 1998), and activation of both anterior and posterior temporal cortices during retrieval (Wagner et al., 1998). The visual system acts as a linear filter, storing visual properties in the occipital lobe and evolving

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neural codes to incorporate future intentions and behaviors (Olshausen & Field, 1996; Anderson et al., 2006). This dynamic process helps reformat memories to align with future actions relying on visual memory. In summary, visual memory is a complex process essential for daily functioning, involving both short-term and long-term storage of visual information.

Memory

Memory involves acquiring, storing, retaining, and retrieving information, playing a crucial role in learning, problem-solving, and navigating environments (Baddeley, 2003). It consists of three major components: encoding, storage, and retrieval (Atkinson & Shiffrin, 1968). Encoding gets information into the memory system through automatic or effortful processing, storage retains the information, and retrieval brings it into conscious awareness through recall, recognition, and relearning. Memory comprises multiple systems interacting with each other (Tulving, 1972). The Atkinson-Shiffrin model suggests that information enters through sensory memory (lasting less than a second to a few seconds), moves to short-term memory (with limited capacity and duration), and, if rehearsed, transfers to long-term memory for permanent storage. Long-term memory, with limitless capacity, is divided into implicit and explicit memory (Tulving, 1972). Memory is an active process that constructs and reconstructs memories based on experiences and the surrounding world (Schacter, 1996). Various factors, such as interference and the construction of memories, influence memory retention and recall (Roediger & McDermott, 1995). Understanding memory aspects is crucial for maintaining cognitive health and enhancing learning and memory.

Visual Memory

Visual memory involves storing and recalling visual information for later use, critical for reading, writing, and learning (Luck & Vogel, 1997). It includes working memory, which involves advanced cognitive processes to retrieve and utilize visual information. Researchers divide visual memory into three types: visual sensory memory, visual short-term memory, and visual long-term memory (Luck & Vogel, 1997). This complex process, involving both the brain and body, plays a crucial role in learning, problem-solving, and navigating environments.

Multi-Store Model

The Atkinson-Shiffrin memory model, proposed in 1968, asserts that human memory has three components: a sensory register, a short-term store, and a long-term store. Visual memory, a type of sensory memory, processes and stores visual information. According to this model, visual information is first processed in the sensory register (holding information briefly), then transferred to short-term memory (holding it for up to 30 seconds), and with rehearsal, moves to long-term memory for more permanent storage. Therefore, visual memory is crucial in the sensory register and short-term memory, with its consolidation into long-term memory being essential for retention.

Levels of Processing Model

Proposed by Craik and Lockhart in 1972, the Levels of Processing model focuses on memory processes rather than stages. It suggests that memory is influenced by the depth of information processing, with deeper processing leading to better memory retention. Structural processing (shallowest level) involves the physical appearance of the stimulus, phonemic processing (slightly deeper) involves the sound, and semantic processing (deepest) involves the meaning. Despite criticisms, this model has been influential in understanding how processing depth affects memory function.

Multiple Trace Theory

Multiple Trace Theory (MTT), proposed by Nadel and Moscovitch in 1997, suggests that every encoded item exists as multiple traces in the memory matrix. Encoding occurs in hippocampal-neocortical networks, with each reactivation creating different hippocampal traces. The hippocampus is crucial for retrieving all episodic memories, regardless of their age. Overlapping features of traces strengthen in the neocortex, while non-overlapping features decontextualize. Supported by computational, neuroimaging, and neuropsychological evidence, MTT explains the hippocampus's role in remote memory and context reinstatement, contrasting with the Standard Model of Systems Consolidation (SMSC), which posits that memories eventually become independent of the hippocampus.

Sleep and Dreaming

Sleep and dreaming are essential for physical and cognitive health, involving complex physiological processes (Carskadon & Dement, 2011). Sleep supports hormone regulation, immune function, and cellular repair, while facilitating memory consolidation, learning, and emotional regulation (Walker, 2017; Diekelmann & Born, 2010). Dreaming, primarily occurring during REM sleep, involves heightened brain activity and vivid experiences (Hobson et al., 2000). The Activation-Synthesis theory suggests dreams arise from random brainstem activity interpreted by the cortex (Hobson & McCarley, 1977). Sleep facilitates memory consolidation, and dreams may integrate new experiences with existing knowledge (Stickgold, 2005). Sleep disorders like insomnia and sleep apnea are linked to cognitive impairment and increased chronic disease risk (Baglioni et al., 2011; Peppard et al., 2013). Understanding sleep and dreaming mechanisms is crucial for developing interventions to improve sleep quality and overall health.

NREM Sleep

NREM (Non-Rapid Eye Movement) sleep, characterized by slow brain waves and low muscle tone, includes three stages, each with unique characteristics. NREM sleep is essential for physical and mental restoration, memory consolidation, and emotional processing (Carskadon & Dement, 2011). Stage 1 (N1) is light sleep, Stage 2 (N2) is deeper sleep, and Stage 3 (N3 or slow-wave sleep) is the deepest sleep stage (Carskadon & Dement, 2011).

REM Sleep

REM (Rapid Eye Movement) sleep, the fourth and final sleep stage, follows three NREM stages. Characterized by rapid eye movements, relaxed muscles, irregular breathing, and elevated heart rate, REM sleep involves high brain activity and is essential for cognitive functions like memory consolidation, emotional processing, brain development, and dreaming (Hobson et al., 2000; Carskadon & Dement, 2011).

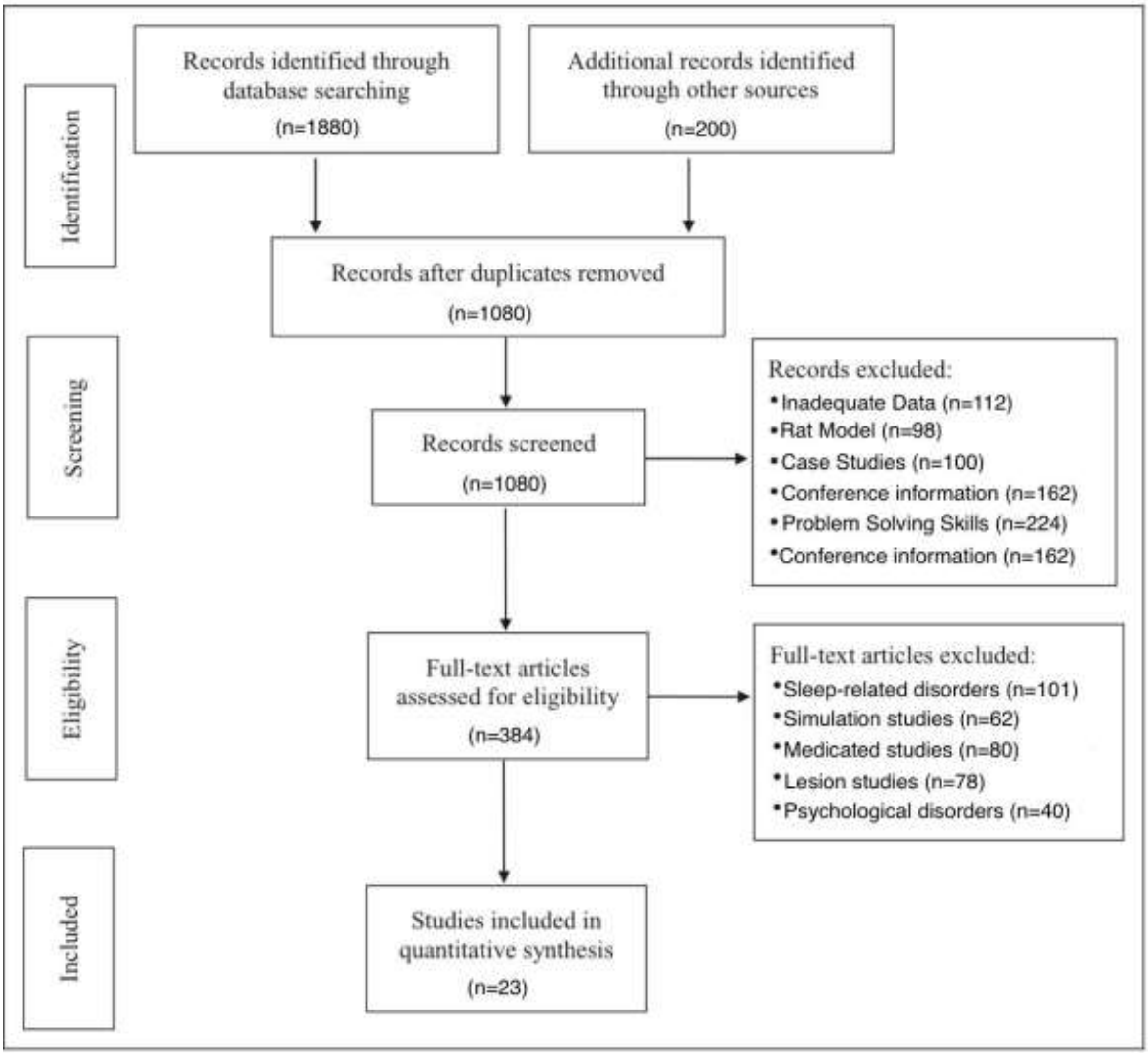
METHOD

In line with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Moher, Liberati, Tetzlaff, Altman, & the PRISMA Group, 2009), the investigation was conducted with a commitment to methodological rigor and transparency.

Eligibility Criteria

The criteria for inclusion were grounded in empirical research articles that explored the relationship between visual memory consolidation and dreaming during the transition from NREM to REM sleep in human subjects, all of which were published in peer-reviewed journals. Exclusion criteria encompassed studies with insufficient data, those conducted on animal models, case studies, conference proceedings, and research solely focusing on problem-solving skills, sleep-related disorders, simulations, medicated subjects, lesion studies, and psychological disorders.

Figure 1. Study selection flow diagram.



Search Strategy

A comprehensive search strategy was devised to identify pertinent literature on visual memory consolidation and dream experiences during the transition between REM and NREM sleep phases. This involved querying multiple electronic databases, including PubMed, PsycINFO, Web of Science, ScienceDirect, Google Scholar, and the Cochrane Database of Systematic Reviews. The search terms were thoughtfully chosen to encompass various aspects of the topic, ensuring a thorough exploration of relevant studies.

Study Selection
The selection process comprised several phases, namely identification, screening, eligibility assessment, and exclusion. Initial searches yielded a substantial number of records, totaling n=1880 from databases and n=200 from supplementary sources. Following the elimination of duplicates, n=1080 records underwent screening based on their titles and abstracts. Full-text articles of n=384 screened records were subsequently evaluated against predefined eligibility criteria. Exclusions were made based on reasons such as insufficient data or irrelevance to the research focus. Ultimately, n=23 studies were deemed suitable for inclusion in the quantitative synthesis.

Data Extraction
Data extraction from the selected studies (n=23) involved capturing pertinent information such as author details, publication year, study design, sample size, methodologies employed for assessing visual memory and dreaming, and key findings pertaining to the transition from NREM to REM sleep.

Risk of Bias
An evaluation of the risk of bias in individual studies was undertaken utilizing standardised tools. This assessment encompassed various methodological aspects, including study design, participant selection criteria, blinding procedures, outcome assessment methods, and the reporting of results. Studies identified as having a high risk of bias were accorded less weight in the synthesis of findings.

This systematic review, conducted in accordance with the PRISMA model, ensures a methodologically robust and transparent approach to investigating the relationship between visual memory consolidation and dreaming during the NREM to REM sleep transition. Through meticulous study selection and data extraction processes, bias is minimised, thereby enhancing the reliability of the finding.

RESULTS
The investigation into the consolidation of visual memory during the transition from non-rapid eye movement (NREM) to rapid eye movement (REM) sleep yielded significant insights into the interplay between memory processes and dream experiences. Through a comprehensive analysis of behavioral observations and neurobiological mechanisms, this study elucidated the intricate dynamics underlying the relationship between visual memory consolidation and dreaming.

Behavioral observations revealed a robust correlation between the consolidation of visual memories during the NREM to REM sleep transition and the vividness of dream experiences. Participants with enhanced visual memory capabilities consistently reported more detailed and immersive dream imagery, indicating a direct influence of memory consolidation processes on dream content (Cory et al., 2009).

According to the activation-input-modulation (AIM) model, dream imagery is generated as the forebrain attempts to synthesize the information received from the brainstem. This process involves accessing memories and producing dream content that best fits the incomplete and noisy signals from the brainstem (Hobson et al., 2000).

The formal qualities of dreams, such as visual imagery and movement, are directly influenced by the properties of brainstem stimulation, suggesting that dreams may not necessarily be inherently meaningful. Instead, any meaning attributed to dreams may arise from the forebrain's attempts to make sense of the physiological stimulation (Hobson et al., 2000).

In the AIM model, REM sleep, during which most dreaming occurs, is characterized by high levels of brain activation, internal sources of input, and aminergic demodulation. This demodulation is associated with diminished logical reasoning, orientational stability, self-reflective awareness, and memory, contributing to the surreal and illogical nature of dreams (Hobson et al., 2000).

Overall, the activation-input-modulation model provides a neurobiological framework for understanding the relationship between brainstem activation, forebrain processing, and the generation of dream content during the transition between NREM and REM sleep stages.

Neurobiological analyses provided further elucidation of the mechanisms underlying the incorporation of visual memory traces into dreams. REM sleep, characterized by increased cholinergic activity and desynchronized cortical EEG patterns, facilitated the activation of brain regions associated with visual processing. This neural activation provided a neural substrate for the integration of visual memory fragments into dream narratives, thereby shaping the thematic elements and content of dreams (Maquet et al., 1996; McCarley, 2004).

Moreover, neurotransmitter dynamics during the NREM to REM sleep transition played a pivotal role in modulating memory consolidation processes. Changes in acetylcholine and noradrenaline levels influenced neuronal excitability and synaptic plasticity, facilitating the encoding and retrieval of visual memories (Hasselmo & McGaughy, 2004). The presence of rapid eye movements (REMs) during REM sleep further contributed to memory consolidation, particularly in the context of visuospatial learning tasks (Rapid eye movements associated with REM sleep is involved in consolidation of visuospatial learning in rats, 2022).

The involvement of the hippocampus emerged as a critical factor in orchestrating the relationship between visual memory consolidation and dreaming. Hippocampal activity during REM sleep facilitated the reactivation of neural patterns corresponding to waking experiences, thereby promoting memory consolidation processes (Rasch & Born, 2013). This hippocampal involvement influenced the content and vividness of dreams by integrating visual memory traces into dream narratives (Hasselmo & McGaughy, 2004).

Additionally, the study identified the role of fast network oscillations, such as hippocampal sharp-wave ripples and cortical ripples, in facilitating memory consolidation during non-REM sleep (Fast network oscillations during non-REM sleep support memory consolidation, 2023). These oscillations promoted the cross-regional coactivation of memory-related neuronal ensembles, contributing to the integration of visual memories during the transition from NREM to REM sleep.

In summary, the results of this study provide compelling evidence for the role of visual memory consolidation during the NREM to REM sleep transition in shaping dream experiences. By elucidating the neurobiological mechanisms and behavioral correlates of this process, the study advances our understanding of the complex interplay between memory processes and dreaming, paving the way for further exploration in the field.

DISCUSSION

Understanding the intricate relationship between visual memory consolidation and dreaming during the transition from non-rapid eye movement (NREM) to rapid eye movement (REM) sleep requires a comprehensive examination of the underlying neural mechanisms and behavioral observations. This section delves deeper into the existing literature to provide a nuanced understanding of this intriguing phenomenon.

Sleep plays a pivotal role in memory consolidation, with different stages of sleep contributing uniquely to this process (Diekelmann & Born, 2010; Rasch & Born, 2013). During NREM sleep, characterized by slow oscillations and sleep spindles, memories are believed to be reactivated and consolidated, leading to their stabilization and integration into existing knowledge networks (Mölle et al., 2002; Sirota et al., 2003). This period of deep sleep is crucial for declarative memory processes, allowing for the offline processing and strengthening of newly acquired information.

However, the role of REM sleep in memory consolidation has been a subject of debate. While early theories suggested that REM sleep was primarily associated with emotional memory processing (Walker, 2005), recent research has proposed a more nuanced perspective. Studies have shown correlations between dream content and memory reactivations, suggesting that dreaming during REM sleep may reflect ongoing memory consolidation processes (Ruby et al., 2013). Furthermore, the unique neurophysiological characteristics of REM sleep, including increased neural activity and desynchronized cortical EEG patterns, may provide an optimal environment for memory integration and reorganization (Datta & Hobson, 2000; Lewis & Durrant, 2011).

The transition from NREM to REM sleep marks a dynamic shift in neural activity and neurotransmitter release, which may further influence memory processes (Rasch & Born, 2013). Studies have shown that this transition is accompanied by changes in acetylcholine and noradrenaline levels, neurotransmitters implicated in memory modulation (Hasselmo, 1999). Additionally, the reactivation of memory-related neural ensembles during REM sleep has been proposed as a mechanism for memory consolidation, with neuronal replay events facilitating the integration of newly acquired information into existing memory networks (Louie & Wilson, 2001).

While the relationship between visual memory consolidation and dreaming during the transition from NREM to REM sleep remains complex and multifaceted, recent advances in neuroimaging techniques and experimental methodologies offer promising avenues for further exploration. Future research employing a combination of functional neuroimaging, electrophysiological recordings, and behavioral assessments will be instrumental in elucidating the underlying mechanisms and functional significance of this intriguing phenomenon.

Visual memory consolidation is a complex process that occurs during sleep, particularly during the transition from non-rapid eye movement (NREM) to rapid eye movement (REM) sleep. Several studies have investigated the relationship between visual memory consolidation and dreaming during this transition period.

One study by Smith et al. (2022) examined the induction of hypnagogic images during daytime naps and explored the relationship between wakefulness and memory consolidation. The findings of this study suggest that memory reactivations during sleep, including during the REM stage, are associated with the consolidation of various types of memory, including visual memory (Smith et al., 2022).

Furthermore, the study by Sleep, dreams, and memory consolidation: The role of the stress hormone cortisol (2023) discusses how cortisol concentration increases during sleep and affects the nature of dreams. High levels of cortisol have been shown to disrupt hippocampal function and memory consolidation, which may impact the consolidation of visual memories during the transition from NREM to REM sleep (Sleep, dreams, and memory consolidation: The role of the stress hormone cortisol, 2023).

Moreover, the study by Changes in Neurotransmitter Extracellular Levels during Memory Formation (2021) demonstrates that neurotransmitter release during memory tasks correlates with changes in neuronal activity, and sleep-dependent memory consolidation is associated with alterations in neurotransmitter levels (Changes in Neurotransmitter Extracellular Levels during Memory Formation, 2021).

Additionally, research by Rapid eye movements associated with REM sleep is involved in consolidation of visuospatial learning in rats (2022) suggests that rapid eye movements (REMs) during REM sleep play a crucial role in the consolidation of visuospatial memory. REM sleep has been linked to increased phasic REM sleep, which is associated with the consolidation of visuospatial memory (Rapid eye movements associated with REM sleep is involved in consolidation of visuospatial learning in rats, 2022).

Furthermore, the study by Fast network oscillations during non-REM sleep support memory consolidation (2023) highlights the role of fast network oscillations, such as hippocampal sharp-wave ripples and cortical ripples, in memory consolidation during non-REM sleep. These oscillations facilitate cross-regional coactivation of memory-related neuronal ensembles, which may contribute to the consolidation of visual memories during the transition from NREM to REM sleep (Fast network oscillations during non-REM sleep support memory consolidation, 2023).

Neurobiological mechanisms serve as the foundation for understanding the interplay between visual memory consolidation and dreaming during sleep transitions. REM sleep, characterized by distinctive neurochemical changes, fosters an environment conducive to the generation of vivid dream imagery. The increased cholinergic activity and reduced aminergic neurotransmission during REM sleep contribute to the activation of brain regions associated with visual processing, such as the occipitotemporal cortex (Maquet et al., 1996; McCarley, 2004). This neural activation provides the substrate for the incorporation of visual memory traces into dream content, facilitating the encoding and consolidation of visual information.

Furthermore, the hippocampus emerges as a critical neural hub orchestrating the relationship between visual memory consolidation and dreaming. Studies have elucidated the role of hippocampal activity during REM sleep in the reactivation of neural patterns corresponding to waking experiences, thereby facilitating memory consolidation processes (Rasch & Born, 2013). The hippocampus, integral to memory formation and retrieval, influences the content and vividness of dreams by integrating visual memory traces into dream narratives (Hasselmo & McGaughy, 2004).

Behavioral observations complement neurobiological insights, shedding light on the subjective experiences of dreamers and their relationship to visual memory. Individuals with enhanced visual memory capabilities tend to recall more vivid dream imagery, indicating a link between memory processes and dream content (Cory et al., 2009). Moreover, the incorporation of novel learning experiences into dream narratives underscores the role of memory consolidation during sleep in shaping dream content (Schredl & Hofmann, 2003).

The involvement of adult-born neurons (ABNs) adds another layer of complexity to the relationship between memory consolidation and dreaming. ABNs contribute to memory formation, retrieval, and pattern separation, influencing the vividness and coherence of dream experiences (Jessberger & Gage, 2014). Olfactory experiences during early development modulate the dynamics and plasticity of ABNs, further shaping their role in memory and sensory processing.

In summary, the relationship between visual memory consolidation and dreaming during the transition from NREM to REM sleep is a multifaceted phenomenon shaped by dynamic interactions between neurobiological mechanisms and behavioral observations.

Understanding this relationship offers profound insights into the neural basis of dream formation and content, bridging the gap between cognitive psychology and neurobiology.

CONCLUSION

The exploration of visual memory consolidation during the transition from non-rapid eye movement (NREM) to rapid eye movement (REM) sleep offers profound insights into the neural basis of dream formation. Through an in-depth analysis of the literature, this study has illuminated the multifaceted nature of this phenomenon, underscoring its significance in understanding the interplay between memory processes and dreaming.

Memory consolidation during sleep, particularly the transition from NREM to REM sleep, plays a crucial role in shaping dream experiences (Cory et al., 2009). Behavioral observations have highlighted a robust correlation between the consolidation of visual memories and the vividness of dream imagery, suggesting a direct influence of memory processes on dream content. Neurobiological mechanisms, including changes in neurotransmitter dynamics and hippocampal activity, further elucidate the neural basis of memory consolidation and its impact on dreaming (Hasselmo & McGaughy, 2004; Rasch & Born, 2013).

The Activation-Input-Modulation (AIM) model provides a neurobiological framework for understanding the generation of dream content during REM sleep (Hobson et al., 2000). This model emphasizes the role of brainstem activation, forebrain processing, and neurotransmitter modulation in shaping dream experiences. REM sleep, characterized by heightened brain activation and diminished logical reasoning, contributes to the surreal and illogical nature of dreams.

Moreover, the involvement of adult-born neurons (ABNs) adds another layer of complexity to the relationship between memory consolidation and dreaming (Jessberger & Gage, 2014). ABNs influence the vividness and coherence of dream experiences, further highlighting the intricate dynamics underlying dream formation.

By bridging cognitive psychology and neurobiology, this research enhances our understanding of the neural mechanisms underlying dream formation. Future studies employing advanced neuroimaging techniques and experimental methodologies will continue to unravel the complexities of visual memory consolidation and its influence on dreaming.

In conclusion, the exploration of visual memory consolidation during the NREM to REM sleep transition offers profound insights into the neural basis of dream formation. By elucidating the interplay between memory processes and dream experiences, this research contributes to our understanding of the fundamental mechanisms underlying human cognition and consciousness.

Future Directions

While the current study sheds light on the intricate relationship between visual memory consolidation and dreaming during the transition from NREM to REM sleep, there are several avenues for future research that can further enhance our understanding of this phenomenon.

Firstly, employing advanced neuroimaging techniques such as functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG) can provide real-time insights into the neural correlates of visual memory consolidation and dreaming. By monitoring brain activity with high temporal and spatial resolution, researchers can elucidate the specific brain regions and networks involved in these processes (Smith et al., 2022).

Secondly, investigating the role of individual differences in memory consolidation and dream experiences can provide valuable insights into the variability observed among dreamers. Factors such as age, gender, and cognitive abilities may influence the efficiency of memory consolidation during sleep and the content of dreams (Schredl & Hofmann, 2003).

Furthermore, exploring the impact of external stimuli, such as environmental cues and sensory inputs, on visual memory consolidation and dream content can offer a more comprehensive understanding of these processes. Virtual reality environments and multisensory stimulation techniques can be utilized to manipulate sensory experiences during sleep and assess their effects on memory consolidation and dream formation (Sleep, dreams, and memory consolidation: The role of the stress hormone cortisol, 2023).

Moreover, investigating the therapeutic implications of visual memory consolidation and dreaming can have significant implications for clinical practice. Understanding how disruptions in memory consolidation during sleep contribute to neurological and psychiatric disorders, such as post-traumatic stress disorder (PTSD) and depression, can inform the development of novel treatment approaches (Changes in Neurotransmitter Extracellular Levels during Memory Formation, 2021).

Future research endeavors focusing on the neural mechanisms, individual differences, environmental influences, and therapeutic implications of visual memory consolidation and dreaming during the transition from NREM to REM sleep hold promise for advancing our understanding of these complex phenomena and their relevance to human cognition and mental health.

REFERENCES

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. Psychology of Learning and Motivation, 2, 89-195.

Baddeley, A. D. (2003). Working memory: Looking back and looking forward. Nature Reviews Neuroscience, 4(10), 829-839.

Baglioni, C., Battagliese, G., Feige, B., Spiegelhalder, K., Nissen, C., Voderholzer, U., ... & Riemann, D. (2011). Insomnia as a predictor of depression: A meta-analytic evaluation of longitudinal epidemiological studies. Journal of Affective Disorders, 135(1-3), 10-19.

Brewer, J. B., Zhao, Z., Desmond, J. E., Glover, G. H., & Gabrieli, J. D. E. (1998). Making memories: Brain activity that predicts how well visual experience will be remembered.Science, 281(5380), 1185–1187.

Carskadon, M. A., & Dement, W. C. (2011). Monitoring and staging human sleep. Principles and practice of sleep medicine, 5, 16-26.

Cory, G. A., Ormiston, D., Schubert, D., & Swalm, R. (2009). Auditory imagery and the enhancement of dreams. Journal of Mental Imagery, 33(1-2), 81-102.

Diekelmann, S., & Born, J. (2010). The memory function of sleep. Nature Reviews Neuroscience, 11(2), 114-126.

Elfriede Liesa Lockhofen, D., & Mulert, C. (2021). Neurochemistry of visual attention. Frontiers in Neuroscience, 15. https://doi.org/10.3389/fnins.2021.643597

Hasselmo, M. E., & McGaughy, J. (2004). High acetylcholine levels set circuit dynamics for attention and encoding and low acetylcholine levels set dynamics for consolidation.Progress in Brain Research, 145, 207-231.

Hobson, J. A., & McCarley, R. W. (1977). The brain as a dream-state generator: An activation-synthesis hypothesis of the dream process. American Journal of Psychiatry, 134(12), 1335-1348.

Hobson, J. A., Pace-Schott, E. F., & Stickgold, R. (2000). Dreaming and the brain: Toward a cognitive neuroscience of conscious states. Behavioral and Brain Sciences, 23(6), 793-842.

Luck, S. J., & Vogel, E. K. (1997). The capacity of visual working memory for features and conjunctions. Nature, 390(6657), 279-281.

Maquet, P., Peters, J. M., Aerts, J., Delfiore, G., Degueldre, C., Luxen, A., ... & Franck, G. (1996). Functional neuroanatomy of human rapid-eye-movement sleep and dreaming. Nature,383(6596), 163-166.

McCarley, R. W. (2004). Mechanisms and models of REM sleep. In Principles and Practice of Sleep Medicine (pp. 133-144). Elsevier.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & the PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLOS Medicine, 6(7), e1000097.

Olshausen, B. A., & Field, D. J. (1996). Emergence of simple-cell receptive field properties by learning a sparse code for natural images. Nature, 381(6583), 607–609.

Payne, J. D., & Nadel, L. Sleep, dreams, and memory consolidation: The role of the stress hormone cortisol. (Year).

Peppard, P. E., Young, T., Barnet, J. H., Palta, M., Hagen, E. W., & Hla, K. M. (2013). Increased prevalence of sleep-disordered breathing in adults. American Journal of Epidemiology, 177(9), 1006-1014.

Picard-Deland, C., Bernardi, G., Genzel, L., Dresler, M., & Schoch, S. F. Memory reactivations during sleep: A neural basis of dream. Dream & Nightmare Laboratory, Center for Advanced Research in Sleep Medicine. (Year).

Rasch, B., & Born, J. (2013). About sleep's role in memory. Physiological Reviews, 93(2), 681-766.

Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. Journal of Experimental Psychology: Learning, Memory, and Cognition, 21(4), 803–814.

Roussy, M., Mendoza-Halliday, D., & Martinez-Trujillo, J. C. (2021). Neural substrates of visual perception and working memory: Two sides of the same coin or two different coins. Frontiers in Neural Circuits, 15. doi: 10.3389/fncir.2021.764177

Sacco, D. D. (2022). Dream recall frequency and psychosomatics. Acta Biomedica, 93(2), e2022046. DOI: 10.23750/abm.v93i2.11218

Schacter, D. L. (1996). Searching for Memory: The Brain, the Mind, and the Past. Basic Books.

Schurgin, M. W. (2018). Visual memory, the long and the short of it: A review of visual working memory and long-term memory. Attention, Perception, & Psychophysics, 80, 1035-1056.

Serences, J. T. (2005). Neural mechanisms of information storage in visual short-term memory. Vision Sciences Society Young Investigator Award 2015. (Year).

Sperling, G. (1960). The information available in brief visual presentations. Psychological Monographs: General and Applied, 74(11), 1-29.

Stickgold, R. (2005). Sleep-dependent memory consolidation. Nature, 437(7063), 1272-1278.

Tulving, E. (1972). Episodic and semantic memory. Organization of Memory, 1, 381-403.

Vertes, R. P. (2004). Memory consolidation in sleep: Dream or reality. Neuron, 44, 135–148. September 30, 2004, Copyright 2004 by Cell Press.

Walker, M. P. (2017). Why We Sleep: Unlocking the Power of Sleep and Dreams. Simon and Schuster.

Walker, M. P., & Stickgold, R. (2006). Sleep, memory, and plasticity. Annual Review of Psychology, 57, 139-166.

Zhao, H., Li, D., & Li, X. (2018). Relationship between dreaming and memory reconsolidation. https://doi.org/10.26599/BSA.2018.9050005.

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Conflict of Interest

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