<u>Why do we dream?</u>

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1 February 2025

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0. Abstract:

As dreams have been a universal aspect of the human experience for thousands of years it is unsurprising that they have garnered much attention from scientists who have attempted to explain why they exist. This essay discusses just some of the theories for the biological mechanisms – the Activation-Synthesis/AIM and Neurocognitive models – and the function – the Psychoanalytic, Memory Consolidation, Simulation, and Problem-Solving theories – of dreaming. I believe that the Neurocognitive theory is best able to describe the mechanism, and a combination of the Memory Consolidation and Simulation theories explain the function of dreaming, but I do discuss the support and challenges attributed to each theory to allow the reader to make up their own mind in regard to this complex topic that has captivated humankind for millennia.

1. Introduction:

If you were asked the question 'What is a dream?', you may reply that a dream is a conscious experience occurring during sleep[1]. It is characterised by a richly detailed world that recreates the feeling of the waking world so closely that the dreamer is often unaware of their sleeping state[2]. The events of the dream may replicate experiences from the dreamers past[3] but in a bizarre, emotional, and fragmented fashion that is often uncontrollable by the dreamer[4]. Finally, the dream is often forgotten very soon after awakening, if it is remembered at all[5]. This type of dream is called an REM dream and most often occurs during the last stage of the sleep cycle, the Rapid Eye Movement (REM) stage, which is characterised by eye movements and brain activity similar to waking[6]. REM dreams are not the only type of sleep consciousness, however. Non-REM (NREM) dreams occur throughout the night but, as they may be very different to classical REM dreams and are often not remembered unless the dreamer is deliberately awoken during NREM stages, they are often not reported. Dreams experienced early in the night, a time predominated by NREM sleep, are often more thought-like and less animated and visual compared to classical REM dreams which often leads to them being dismissed as dreams at all. That being said, 10-30% of NREM dreams experienced later in the night are considered indistinguishable from REM dreams[2]. When awoken, either naturally or deliberately, REM dreams are reported between 74%[7] and 81.8%[8] of the time while NREM dreams are reported 23-74% of the time. Dreams are experienced by everyone at one time or another, unless the person possesses lesions in specific parts of the brain important for dream production, suggesting that this conscious state in sleep is universal and possibly functionally important. It therefore seems appropriate to ask not just 'What is a dream?' but also 'Why do we dream?'. This question is quite a bit more complicated to answer, however. Although dreams have interested humans throughout history, there has never been consensus over why they exist. In Ancient civilisations, dreams were generally seen as prophetic messages from the Gods, i.e. they were generated from outside the body and were impressed into the mind of the dreamer. This externally generated mechanism was not universally agreed upon at the time, however, and has now been replaced by a variety of endogenous mechanisms that are theorised to generate dreams internally[4]. These modern theories on the biological mechanisms of dreaming only answer part of the question 'Why do we dream?', however. As the question can be subdivided into two questions, namely 'What are the biological mechanisms of dreaming?' and 'What is the function of dreaming?', this latter question also must be answered. There is even more argument over the function of dreaming than the mechanisms that make it possible, with some scientists claiming that dreaming has no function at all, some saying that dreaming is important for memory consolidation, and some believing that dreams are simulations that allow the dreamer to learn how to recognise and avoid threatening situations, to name just three prominent hypotheses. This essay will set out various theories that attempt to answer the question 'Why do we dream?', describing the experimental evidence for and against each theory and deciding which theory/theories are most likely to be correct.

2. Biological Mechanisms of Dreaming:

With the advent of neuroimaging techniques, it has become generally accepted that dreams are generated from within the sleeping brain, perhaps in a similar way to daydreams whilst awake. The precise mechanism by which dreams are produced is under contention, however. In this section I will detail two of the most prominent theories for dream generation - the Activation-Synthesis/AIM Model and the Neurocognitive Model – although a number of other theories also exist.

2.1. Activation-Synthesis/AIM Model:

2.1.1. Activation-Synthesis Hypothesis:

The Activation-Synthesis hypothesis was first proposed in 1977 as a response to the finding of PGO waves during REM sleep. PGO, or Pons-Geniculate-Occipital, waves are local field potentials that start in the pons in the brainstem and travel to the visual thalamus (lateral geniculate nucleus) and visual (occipital) cortex, before and during REM sleep[6]. These random bursts of neuronal activity within the brainstem are thought to activate other areas of the brain, especially visual and motor cortices and emotional centres such as the amygdala and hippocampus, which then go on to synthesise corresponding dream images[1, 9].

2.1.1.1. Support:

Many aspects of dreams can be explained through the Activation-Synthesis hypothesis. The random nature of PGO waves, for example, are thought to underlie the bizarre nature of dreams. Certain areas of the brain are activated to near-wake levels during REM sleep, including the hippocampus and the amygdala which is thought to explain the emotional content of dreams as well as how memories are incorporated. Additionally, areas of the brain are deactivated by these PGO waves, especially frontal lobe regions which are responsible for coordinating executive functions and fact checking whilst awake. The loss of these functions during dreaming may explain why dreams are often non-sensical, contain contradictory or disjunctive features, and the lack of control the dreamer has over the dream events[10].

2.1.1.2. Challenges:

Although this theory appears to explain the phenomenon of dreams quite well, it has been challenged. Firstly, the initial hypothesis stated that PGO waves originated in giant neurons in the pontine gigantocellular tegmental field and so this is where REM sleep and therefore dreaming is generated. This was disproved by showing that destroying the gigantocellular tegmental region of the pons had no effect on REM sleep. It was further shown that the lateral instead of the medial pons was necessary for REM sleep[11]. Secondly, the intertwining of dreams with REM sleep is problematic as it does not answer why dreams are also reported during NREM sleep[7]. Thirdly, there is some controversy over how much bizarreness and strong emotion is present in dreams. The hypothesis uses the randomness of signals within the brain to explain why dreams are often more emotional and bizarre than waking experiences, but if this is not the case, as some argue, then random activation of brain regions cannot be the mechanism through which dreams are generated[11]. Similar to how more sensical dream experiences cannot be explained through random activation, the narrative nature of dreams is also unexplained[1]. There is some belief that, upon waking, the brain takes the sets of images produced during sleep and fashions a narrative from them[12], but this is controversial. As they became confronted with more evidence to refute the Activation-Synthesis theory, proponents decided to update the theory with the new AIM model.

2.1.2. AIM Model:

The Activation-Input-Modulation (AIM) model is an updated version of the Activation-Synthesis hypothesis which defines consciousness states based on three variables. Activation (A) refers to how active the brain is, input (I) refers to whether the brain is being supplied with information from the external or internal environment, and modulation (M) refers to how the brain processes the information that it receives. The waking state is defined by high Activation, high/external Input, and high/aminergic Modulation. REM sleep is defined by high Activation, low/internal Input, and low/cholinergic Modulation. NREM sleep is defined by intermediate Activation, Input, and Modulation[13]. This model improves on the original theory by emphasising the similarity between REM sleep and waking as well as the differences between the two which give rise to the unique elements of dreams.

2.1.2.1. Support:

The AIM model, like its predecessor, firstly defines REM sleep as a state of high activation, similar to that of waking. Specifically, the pons, limbic system including the amygdala and hippocampus, and parietal operculum are activated while the prefrontal cortex is deactivated. As discussed previously, this explains the emotional, visual, and motor elements of dreams as well as why functions such as control and judgement are uncommon. Furthermore, the prefrontal cortex is important for working memory which could explain why dreams are seldom remembered upon waking. Secondly, the model states that dreaming is internally generated while waking is externally stimulated. Specifically, dreams are generated through PGO waves which are able to simulate both visual and motor content in the face of both sensory input and motor output being blocked. This difference between dreaming and waking underlies the nature of behaviour which is real in waking and fictive in dreaming. This fictive behaviour which is produced in the absence of any real-world stimuli is a possible explanation for the bizarre nature of dreams. Finally, dreaming is defined by cholinergic modulation. This means that the amount of acetylcholine within the brain is increased while the amount of norepinephrine and 5-HT is decreased, compared to waking[13]. This reduction in norepinephrine and 5-HT explains dream amnesia and the increase in acetylcholine may drive the 'bottom-up' signalling mechanism suggested by the model, by stimulating signal transmission from the brainstem, through to the sensory cortex, and then on to the higher-level brain regions which create the structure of dreams, whilst also preventing backward movement along the pathway[2]. This lack of backward movement may explain the bizarre nature of dreams as the communication between higher-order and sensory brain regions will be one way instead of the two-way mutualistic relationship they have during waking. This model also has the potential to explain dreaming in NREM sleep as all variables are at intermediate stages. The lower activation compared to wake and REM sleep suggests that NREM dreams are less bizarre and vivid compared to REM dreams. Additionally, the fact that NREM dreams can be influenced by both internal and external stimuli means that they tend to be more grounded in reality than REM dreams. Finally, the inclusion of both cholinergic and aminergic neurons may mean that NREM dreams are more logical and self-reflective than REM dreams.

2.1.2.2. Challenges:

Just as the original version of the theory received criticism, so has the updated AIM model. Issues specifically seem to stem from the finding that the brain is not necessarily cholinergically dominated during REM sleep. Neurons that release glutamine and GABA are also found to be active. As this does not necessarily contradict the model's assertion that aminergic neurons are deactivated and cholinergic neurons are activated during dreaming, this new evidence doesn't invalidate the theory but does suggest that the model is perhaps too simplistic[11]. Furthermore, any issues regarding the content of dreams as discussed for the Activation-Synthesis theory are also likely to be relevant here as the bizarre and emotional content of dreams is still used as a basis for much of the model. A major issue with the Activation-Synthesis/AIM model of dreams is the apparent lack of function that dreams have. They are essentially seen as a by-product of the sleeping mechanism and as such do not have meaning or function by themselves. Some people, especially psychologists, do not agree with this approach to dream function and so dismiss the model as not fully explaining the reason why we dream.

2.2. Neurocognitive Theory:

Due to increasing dissatisfaction with the Activation-Synthesis/AIM model and greater knowledge regarding the neurobiological properties of sleep and the cognitive development of children, the Neurocognitive theory of dreams was developed. This theory centres the forebrain, specifically the default mode network (DMN), instead of the brain stem in the generation of dreams and likens dreaming to spontaneous thought during waking such as daydreaming and mind wandering. There is also a developmental component to the theory which states that the ability to dream and the content of dreams are dependent on the cognitive abilities of the individual, i.e. dreams develop as a child's cognitive abilities do[11]. Ultimately, the Neurocognitive theory uncouples dreaming from REM sleep and posits a top-down theory which suggests that dreams are generated in higher brain areas such as figurative thought and are then passed backwards to lower brain areas which produce the simulation of reality[2].

2.2.1. Support:

Firstly, the idea that the DMN is important in dreaming, and possibly the generator of dreams, has been generally supported through various studies. The DMN itself contains both the ventromedial and dorsomedial prefrontal cortices (vmPFC and dmPFC) situated at the front of the brain and a so called 'posterior hub' at the back of the brain, including the angular gyrus, adjacent precuneus, and posterior cingulate cortex (PCC). This network is involved in a range of processes that are prominent during waking rest, such as self-reflection, emotional regulation, memory recollection, and social evaluation. During NREM sleep, the DMN is well connected so these processes generally occur as they would during waking[14]. This may explain why NREM dreams are thought-like in nature[2] and contain episodic memories[8]. During REM sleep, however, the prefrontal cortices disconnect from the posterior areas[14] allowing for the medial prefrontal cortices to remain active while posterior regions may deactivate[4]. This may explain why REM dreams are emotional and include social interactions, processes carried out by the vmPFC, but lack memories, self-reflection, and 'self-other distinctions'[14]. Additionally, it was discovered that the only time that lesions within the brain have a consistent impact on dreaming is when these lesions occur in the DMN.

Secondly, rather than being generated randomly and innately from the brainstem and being linked to REM sleep, there is evidence that the development of dreaming corresponds to the development of cognition within children. For example, it is believed that 50% of a newborn baby's sleep is spent in REM and this reduced to adult levels of 20-25% within the first 5 years of life[7]. If dreaming was closely coupled to REM sleep and the random PGO waves that signal this stage, it would be expected that babies would have more frequent, vivid, and bizarre dreams than adults and this would decrease to adult levels by the time the child reaches school age. This does not appear to be the case, however. It is, of course, difficult to abstract the content of dreams or even whether dreaming occurred from an infant, however dreaming is considered infrequent until the age of 5[7]. Before this age, dreams are generally dull, static, and contain few emotions and no accounts of memories[2]. Between 5 and 7 years old, dreams become longer and less static but would still be considered as underdeveloped in regard to the narrative. By 7 years old, approximately 20% of REM wakings yield dream reports which themselves have developed to contain emotions, fragments of episodic memories and depictions of the dreamer themselves[2]. Dreaming continues to develop until adult-like dreaming is reached at 9 to 11 years old. Although there are differences in the content of teenage and adult dreams, the general structure of the dream and composition of the dreamscape as well as the relative frequency of dream reports appears to be similar and thus it can be said that children achieve fully developed dreams by the age of 11. This relates to the Neurocognitive theory of dreaming as it has been discovered that the DMN becomes fully developed by the age of 11, suggesting that there may be a correlation between the network and the process of dreaming. Additionally, the dreams of young children, or specifically the ways in which they differ from those of adults, implicate various cognitive abilities that take time to develop, such as the concept of the self, narrative organisation, mental imagery, and recalling memories[11]. As these cognitive abilities develop, so does the dream, suggesting that dreaming is not an innate ability but one which must develop alongside the waking cognitive abilities of the individual.

2.2.2. Challenges:

As the Neurocognitive theory is relatively new and incorporates evidence from neuroimaging and psychological dream studies to produce a robust cognitive theory, there have been few challenges to the theory. That being said, the theory has not been generally accepted as the biological mechanism behind dreaming and is unlikely to become so in the future. A major disadvantage of the theory, at least in the minds of psychologists, is the absence of a function of dreaming[11]. Like the Activation-Synthesis/AIM model, activation of the dreaming mechanism appears to be random and a by-product of the DMN which is automatically activated upon rest, both in sleep and waking[1].

3. Function of Dreaming:

Now that two of the major theories regarding the biological mechanisms that underpin the process of dreaming have been discussed, we can now turn our attention to the second part of the 'Why do we dream?' question – what is the function of dreaming? Both mechanistic hypotheses discussed suggest that there is no function of dreaming and dreams are simply by-products of naturally occurring, random activations within the brain. But is this true? There are in fact several theories surrounding the function of dreaming which may be compatible with one or more mechanistic hypotheses. This section will discuss the Psychoanalytic theory, the Memory Consolidation theory, the Simulation theory, and the Problem-Solving model.

3.1. Psychoanalytic Theory:

Up until this point, this essay has not mentioned possibly the most recognisable name in popular dream theory – Sigmund Freud. His psychoanalytic theory of dreams has dominated most of the general conversation regarding the topic since it was first posited in the late 1800s and, although commonly dismissed by most researchers today[16], is still alive and well within some sectors of the scientific community as well as the general public. The psychoanalytic theory positions dreams as 'the road map to the unconscious' with two levels of content – the manifest or conscious level, which is the surface level of the dream and is often bizarre, and the latent or subconscious level, which is the deeper, censored part of the dream which can be uncovered by dream analysis and is considered more informative to the dreamer[17]. According to this theory, the function of dreaming is two-fold – wish-fulfilment and sleep protection. As the two levels of dream content suggests, a major theme within this theory is repression and censorship. Due to the constrictive social rules of our society, some wishes held by an individual may be seen as inappropriate and must therefore be deeply internalised and repressed. As a way to safely explore these wishes, the brain may produce hallucination-like experiences while the individual is asleep, i.e. dreams. If these wishes were explicitly acted out within dreams, they may be seen as unacceptable even to the individual or may produce a great level of excitement. Therefore, to prevent the dreamer from waking or feeling high levels of anxiety or other unpleasant emotions, the true (latent) content of the dream is masked or censored by the more palatable yet more bizarre manifest content[7].

3.1.1. Support:

The psychoanalytic theory pushes the idea that dreams are related to wishes and impulses. It therefore follows that the major neuron networks at play during dreaming are dopaminergic networks which are active during goal-seeking and appetitive behaviours during waking[2, 11]. This aligns with the neurobiological findings that have been used to support the Neurocognitive theory. Additionally, REM sleep and dreaming are uncoupled in this theory which can be used to explain why dreams and dream-like experiences occur during NREM sleep and restful waking[2]. Furthermore, an explanation for dream amnesia is provided by this theory, namely the process of censorship and repression causes the dream to be forgotten rapidly after waking[9].

3.1.2. Challenges:

As the psychoanalytic theory was formed prior to the development of modern neuroimaging technology, it is unsurprising that much of the research into the neurobiology of dreams have challenged the theory[7]. Indeed, even though the suggestion that dopamine is involved in dreaming is not necessarily wrong, it may be overly simplistic to suggest that dopaminergic systems in the brain are responsible for dreaming as other neurotransmitters such as acetylcholine, glutamate, and GABA are also present, and in higher quantities. Additionally, even if dopamine is an important part of dreaming, the dopaminergic systems that are involved in goal-seeking whilst awake are different and so dopaminergic activity during dreaming may not be related to this wish-fulfilment process at all[11]. According to the theory, the dreamscape should be vastly different from the waking experience and the dream content should be related to events of the day. Both ideas have been generally refuted by laboratory dream studies[2]. Ultimately, there are many reasons to doubt the legitimacy of the psychoanalytic theory as an explanation for the function of dreams as it is not consistently supported by both neurobiological and psychological research. However, as the Activation-Synthesis/AIM model tends to suggest, there may be some benefit to analysing dreams in order to solve problems in waking life[17], an idea that will be discussed towards the end of this essay.

3.2. Memory Consolidation Theory:

An alternative theory regarding the function of dreaming involves the consolidation of memories. Specifically, some believe that NREM sleep is important for the strengthening and integration of recent and conscious memories while the consolidation of more distant memories occurs during REM sleep[18]. This is done through the activation of synapses within the hippocampus and neocortices which causes the replay of memories[8], a process that strengthens these synapses and therefore increasing the likelihood the memory will be stored[19]. It is necessary for memories to be replayed and strengthened in this way to ensure that they are stored, that new information is integrated with older knowledge, and that emotions are appropriately regulated. Ultimately, memory consolidation is thought to occur through communication between the hippocampus, important for episodic memory, and the neocortex, important for skills and knowledge-based memory, and this communication is thought to be strongest during NREM sleep and disrupted during REM sleep, explaining the differences in the dreams reported during these phases of sleep[8].

3.2.1. Support:

The first piece of evidence in support of the memory consolidation theory comes from sleep studies which have shown that, if a participant dreams about a learning task during NREM sleep, they are more likely to remember how to complete that task. Additionally, if a participant dreamed about a story read prior to sleep during REM sleep, they were more likely to remember the story[18]. This indicates both that sleep, and specifically dreaming, can improve memory, and that different phases of sleep are involved in different types of memory consolidation, i.e. NREM sleep deals with knowledge and skills while REM sleep deals with events.

Next, the levels of neurotransmitters in the brain, specifically cortisol, correlates well with the theorised mechanism of memory consolidation. Cortisol levels have been shown to be low at the beginning of sleep, a time predominated by NREM sleep, rising throughout the night to a peak towards the end of the sleep period, a time predominated by REM sleep. High levels of cortisol have the ability to impair hippocampus functioning and disrupt the communication between the hippocampus and the neocortex which may explain the differences between REM and NREM dreams and memory consolidation. When cortisol levels are low at the beginning of the night, the hippocampus and neocortex can freely communicate which allows memories in both structures to be strengthened by replay in dreams. This means that both information and context can be recollected by the dreamer, forming realistic and thought-like dreams typical of NREM sleep. With constant replay in dreams, these fleshed out memories can be more easily accessed during waking, indicating that dreams can improve memory. This process becomes disrupted as the night goes on and cortisol levels rise, however. Firstly, the hippocampus become impaired leading to less efficient memory consolidation. This can lead to the activation of fragments of memories which are generally bizarre in nature. Secondly, the communication between the hippocampus and the neocortex is disrupted. This means that the features of memories such as people or objects as stored in the neocortex, appear in dreams disconnected from episodic contexts, as stored in the hippocampus. This is the reason why REM dreams do not tend to contain direct memories but instead features of the past in new and unusual contexts. Finally, the communication within the two structures is maintained even when cortisol levels are high. This means that communication within the neocortex continues, analysing memories for similarities and connecting related concepts that the waking mind is not able to see due to the input of the hippocampus[8]. This explains the phenomenon of ‘interobjects’, objects created by the mind that are impossible but nevertheless have been linked in the brain due to some hitherto unexplored similarity[15].

3.2.2. Challenges:

The main challenge to the memory consolidation theory is the lack of consistent evidence from sleep studies to confirm that dreaming is associated with improved memory[18]. If memory consolidation were the function of dreaming, it could be assumed that a consistent association between the two could be found but this does not appear to be the case. An aspect of the memory consolidation theory which has not been discussed is that of emotional regulation. It is believed that dreaming of highly emotional memories may cause a reduction in negative emotions in waking life. There does appear to be evidence for this function of dreaming [1, 20, 21, 22], but this is considered ‘inconclusive’[1] and ‘doubtful’[11], especially considering that this function appears to fail a considerable amount of the time, as seen with nightmares and recurrent dreams,[1] and that emotions are not present in the dreams of children or even adults up to 30% of the time[11].

3.3. Simulation Theory:

The Simulation theory, commonly condensed to Threat-Simulation theory, is the theory that dreams function as a way to simulate threat recognition and avoidance whilst asleep in order to train the brain in defence which can then be used while awake[3]. The theory is separated into 6 propositions as follows[1]:

1. Dreams are organised and specialised simulations of the real world
2. Threatening events are prioritised in these simulations
3. The threat-simulation system can only be fully activated by actual exposure to the threatening events
4. When fully activated, the simulation system produces realistic rehearsals of threatening events
5. The realistic rehearsals whilst dreaming can improve performance whilst waking, although rehearsals may not be explicitly remembered
6. The threat-simulation system was often fully activated in the ancestral population due to frequent exposure to threatening situations, leading to increased selection for the system and the evolution of dreaming.

Incidentally, there is an additional component of this theory, the Social Simulation theory, which will not be considered in depth in this section but acts in a similar way to the Threat-Simulation theory, prioritising social encounters over threatening ones, which evolved due to the need for effective social cooperation[12].

3.3.1. Support:

The first proposition is supported by findings from sleep studies that have reported that dreams appear to be an accurate simulation of the real world, containing objects, beings, and events typical of waking life, but prioritising experiences such as walking over reading or writing. Dreams are therefore real-world simulations that are organised but selective in nature, and therefore unlikely to be a simple by-product of sleep but a functional process itself[1].

The second proposition is supported by findings from sleep and neuroimaging studies. Firstly, negative emotions and threatening situations are commonly reported by dreamers. This may explain why activities such as reading and writing are not prominent in dreams while social encounters and movement are reported about as often as in real life, as reading, writing, and other sedentary activities do not tend to be emotional or threatening in nature. Additionally, neurological studies have determined that PGO waves are activated by fear during waking. As PGO waves are active in REM sleep and it is theorised that they are the generators of dreams, dreams may function to produce threatening experiences. Furthermore, areas of the brain important in emotion processing such as the amygdala, are highly active during REM dreaming, further supporting the proposition that threatening and highly emotional experiences are prioritised in dreams[1].

The third proposition is supported by findings that non-realistic depictions of violence and threat are rarely incorporated into dreams and that experiences containing greater amounts of real threat are more likely to lead to nightmares. When the threat-simulation system is fully activated by real threatening experiences, dreams are highly realistic and almost identical to the original experience. As time from the event increases, the threat-simulation system becomes less active, and the dreams produced decrease in vividity and similarity accordingly. Additionally, there is some evidence to suggest that childhood trauma either accelerates or removes the inhibition of dream development suggesting that exposure to real threat is necessary for the full activation of the threat-simulation system. If an individual doesn't experience highly threatening situations, it is likely that their dreams will contain fewer threatening situations. This appears to be supported by findings that children experience a greater amount of aggression and conflict within their dreams, suggesting that the fundamental state of the dream mechanism is to produce threat-simulations and only deviates from this function when it is clear that the system is not going to be fully activated[1].

The fourth proposition is supported by neuroimaging studies that concluded that when motor actions are carried out in dreams, the same brain areas and connections are activated as in waking. The only thing stopping the actions being actually carried out is the blocking of the sensory system by the dream mechanism, and when this blocking fails, as in REM sleep behaviour disorder, sleep actions are translated to real actions comparable to waking. This shows that, from the brain's perspective, there is no difference between motor actions perpetuated in waking and in sleep. Additionally, dream reports commonly present dreams as bizarre, yet the dreamer does not appear to question this whilst experiencing the dream, instead participating uncritically with the dreamscape. This suggests that whilst the dream is occurring, the dreamer believes it to be fully realistic, so the bizarre nature of most dreams is not considered such until after the dreamer has woken[1].

Support for the fifth proposition comes from waking visualisation as repeatedly imagining motor skills can lead to improved motor performance and strength. This provides a basis for learning and improving motor skills in dreams. Furthermore, implicit, or unconscious, learning has been shown to exist for various other skills so dreaming of threats may improve the recognition and avoidance of these threats in waking life, even if those dreams are not explicitly remembered[1].

Finally, the sixth proposition is supported by historical evidence that mortality in the ancestral population was high and threats to life were common occurrences, suggesting that the threat-simulation system would have been fully activated and therefore most dreams would have been highly realistic simulations of threatening situations. Recognition and avoidance of these situations in real life would have been a great evolutionary advantage so those who could do this more effectively, through having rehearsals whilst sleeping, would have been more likely to survive and reproduce, therefore causing the evolution of dreaming. A threat-simulation function of dreaming is also supported by the prioritisation of threatening animals and strangers in dreams. Modern people are unlikely to come across animals and strangers in threatening situations, but this was not the case for the ancestral population. It therefore makes sense that a system that was developed and selected to protect against ancestral threats would remain relatively unchanged, as the system is very rarely fully activated in the modern environment. Additional support for this comes from the dreams of children which contain more animals and are therefore more primitive than adult dreams. Finally, this further explains why reading and writing are very rare within dreams as these are modern concepts that would not have relevance in the ancestral population[1].

3.3.2. Challenges:

Although the support for the theory appears to be relatively comprehensive, there have been some challenges to the theory. For example, doubt has been cast on the ability of the brain to learn implicitly, an ability that is crucial to the Threat-Simulation theory. There is little evidence for implicit learning during waking and even less during dreaming and brain regions likely necessary for the transfer of learning from sleep to waking are deactivated in sleep. Together this appears to suggest that it is unlikely that any threat recognition and avoidance skills learnt in dreams will be accessible in waking life[11]. Furthermore, dream content studies have been used to challenge the Threat-Simulation theory as it has been found that 25-30% of dreams do not contain threatening experiences[11], only a small proportion of dreams are realistic, and most recurring dreams do not contain threat-simulation[9]. This has been taken to suggest that the Simulation theory of dreams does not appropriately explain the function of dreaming. However, this assumption can be countered by the understanding that threat-simulation is only part of the Simulation theory and dreams that do not contain threat-simulation may instead act to simulate social situations[16]. Additionally, a key tenet of the theory is that the threat-simulation system is not fully activated in most modern people due to a lack of real threatening experiences. As such, it is unlikely that every dream will consist of threat-simulation. What is important for this theory is not that every dream simulates a threatening experience but that the dreaming mechanism evolved for the function of simulating threats relevant to the highly dangerous ancestral environment[1].

3.4. Problem-Solving Theory:

Finally, it has been suggested that dreams function as a way to solve problems and enhance creativity[12]. The occlusion of external sensory input and the altered connectivity between brain regions, especially within the limbic system, is thought to provide a unique environment that is primed for the production of new ideas and especially so called ‘interobjects’[15]. This ability of the brain to provide the dreamer with information regarding similarities between seemingly disparate objects is helpful when considering creative solutions to difficult problems. This theory brings to the forefront the idea that the dreaming mind is in fact more, not less functional than the waking mind[15].

3.4.1. Support:

The Problem-Solving theory explains the bizarre and non-sensical ‘interobjects’, a phenomenon which is not unusual within dreams[15]. Additionally, creativity may be influenced by the dopaminergic system which is thought to be activated in the Neurocognitive theory of dreams[9]. Furthermore, from an adaptation point of view, individuals in ancestral populations who could dream and therefore creatively solve problems during their sleep may have an advantage over those who could not, especially in regard to developing tools and methods of survival, meaning that this theory has a possible evolutionary basis.

3.4.2. Challenges:

Although it may be supported theoretically, a study has concluded that less than 1% of dreams produce a viable solution to a waking problem, and of those problems that were solved, it is likely that they were personal problems which may have been solved prior to sleep and the solution simply reflected back to the dreamer during sleep. Due to the lack of evidence regarding enhanced performance in intellectual tasks following dreaming, it is unlikely that the Problem-Solving theory is a viable answer to the question 'what is the function of dreaming?'[1].

4. Conclusion:

There is yet to be consensus within the scientific community concerning the question 'Why do we dream?'. To answer the question, it must be broken down into two components, 'Mechanism' and 'Function'. For the mechanism of dreaming, it now understood that dreaming in internally generated but the precise mechanism by which it is generated is still under contention. Some believe that the AIM model is the most likely candidate while others see the Neurocognitive theory as a more viable option. Still others favour more obscure mechanisms such as the Continual-Activation or Dopaminergic-Forebrain theories. Aspects of each of these theories may be compatible with each other so it may be that a combination of theories will provide the correct answer. I am tempted to side with the Neurocognitive theory because it appears to be the most supported, least challenged, and most expansive theory of dreaming, however each theory has promising aspects.

The debate around the function of dreaming is even more contentious than for the mechanism. A range of opinions are held, from those believing that dreaming is simply a by-product of a biological process and so does not hold any inherent function to those who continue to support Freuds Psychoanalytic theory that dreams are a form of wish-fulfilment and only in analysing them will you truly understand yourself. In my opinion, the function of dreaming can be explained by a combination of the Memory Consolidation and Simulation theories. These theories are highly supported by the neurobiological and dream analysis evidence and only appear to be majorly challenged by the fact that not every dream realises the theorised function. It doesn't seem outrageous to suggest that such a complex and sophisticated process such as dreaming evolved with more than one function. Indeed, enhanced threat recognition and memory consolidation would have likely been highly advantageous in the ancestral environment. For length, I have discussed just some of the most interesting and fleshed-out theories for the function of dreaming and so theories such as Reverse Learning, Expectation-Fulfilment, and Reward Activation Model, to name just a few, have been left out.

In conclusion, the theories surrounding the question 'Why do we dream?' are varied and, in some cases, controversial. It is likely that there is no one correct theory, and it may take the inclusion of elements from several different theories to adequately answer the question. We may all think we know what a dream is but the reasons behind why we have them remains obscure.

5. References

[1] Revonsuo, A. (2000) 'The reinterpretation of dreams: An evolutionary hypothesis of the function of dreaming', *Behavioral and Brain Sciences*, 23(6), pp. 877–901. Available at: https://doi.org/10.1017/S0140525X00004015.

[2] Nir, Y. and Tononi, G. (2010) 'Dreaming and the brain: from phenomenology to neurophysiology', *Trends in Cognitive Sciences*, 14(2), pp. 88–100. Available at: https://doi.org/10.1016/j.tics.2009.12.001.

[3] Hehr, A. (2018) 'The Biology of Dreaming', *Zennea*, 16 August. Available at: https://medium.com/zenneatech/the-biology-of-dreaming-a90b1b8027ba (Accessed: 11 November 2024).

[4] Dang-Vu, T.T. *et al.* (2009) 'Sleep: Implications for Theories of Dreaming and Consciousness', in William P. Banks (ed.) *Encyclopedia of Consciousness*. Academic Press, pp. 357–373. Available at: https://doi.org/10.1016/B978-012373873-8.00072-4.

[5] Beattie-Moss, M. (2007) *Probing Question: What is the biology behind dreaming?*, *Pennsylvania State University*. Available at: https://www.psu.edu/news/research/story/probing-question-what-biology-behind-dreaming (Accessed: 14 November 2024).

[6] Gao, J.-X. *et al.* (2023) 'The Ponto-Geniculo-Occipital (PGO) Waves in Dreaming: An Overview', *Brain Sciences*, 13(9), 1350. Available at: https://doi.org/10.3390/brainsci13091350.

[7] Eiser, A.S. (2005) 'Physiology and Psychology of Dreams', *Seminars in Neurology*, 25(01), pp. 97–105. Available at: https://doi.org/10.1055/s-2005-867078.

[8] Payne, J.D. and Nadel, L. (2004) 'Sleep, dreams, and memory consolidation: The role of the stress hormone cortisol', *Learning & Memory*, 11(6), pp. 671–678. Available at: https://doi.org/10.1101/lm.77104.

[9] Tsunematsu, T. (2023) 'What are the neural mechanisms and physiological functions of dreams?', *Neuroscience Research*, 189, pp. 54–59. Available at: https://doi.org/10.1016/j.neures.2022.12.017.

[10] Crabtree, V. (no date) *The Biology of Dreaming*, *www.humantruth.info*. Available at: https://www.humantruth.info/biology_of_dreaming.html (Accessed: 11 November 2024).

[11] Domhoff, G.W. (2019) 'The neurocognitive theory of dreams at age 20: An assessment and a comparison with four other theories of dreaming.', *Dreaming*, 29(4), pp. 265–302. Available at: https://doi.org/10.1037/drm0000119.

[12] Orlando, A. (2020) *Why Do We Dream? Science Offers a Few Possibilities*, *Discover Magazine*. Available at: https://www.discovermagazine.com/mind/why-do-we-dream-science-offers-a-few-possibilities (Accessed: 19 November 2024).

[13] Hobson, J.A. (2010) 'Sleeping, Waking, and Dreaming', in *Encyclopedia of Behavioral Neuroscience*. Elsevier, pp. 237–256. Available at: https://doi.org/10.1016/B978-0-08-045396-5.00224-4.

[14] https://www.simplypsychology.org/what-is-the-default-mode-network.html

[15] Blechner, M.J. (2013) 'What are Dreams like and How Does the Brain Make Them that Way?', *Contemporary Psychoanalysis*, 49(2), pp. 165–175. Available at: https://doi.org/10.1080/00107530.2013.10746542.

[16] Knowable Magazine - Charlotte Stoddart (no date) 'The science of dreams'. Available at: https://soundcloud.com/knowable-magazine/knowable-dreams?utm_source=knowablemagazine.org&utm_campaign=wtshare&utm_medium=widget&utm_content=https%253A%252F%252Fsoundcloud.com%252Fknowable-magazine%252Fknowable-dreams (Accessed: 20 November 2022).

[17] OpenStax and Lumen Learning (2020) 'Dreams and Dreaming', in *General Psychology*. Houston, Texas: OpenStax. Available at: https://pressbooks.online.ucf.edu/lumenpsychology/chapter/reading-dreams/ (Accessed: 14 November 2024).

[18] Hudachek, L. and Wamsley, E.J. (2023) 'A meta-analysis of the relation between dream content and memory consolidation', *SLEEP*, 46(12), zsad111. Available at: https://doi.org/10.1093/sleep/zsad111.

[19] Chad Park (2024) ‘The Science of Dreams’, *Hadron*, 29 January. Available at: https://sites.imsa.edu/hadron/2024/01/29/the-science-of-dreams/ (Accessed: 18 November 2024).

[20] Samson, D.R. *et al.* (2023) ‘Evidence for an emotional adaptive function of dreams: a cross-cultural study’, *Scientific Reports*, 13(1), 16530. Available at: https://doi.org/10.1038/s41598-023-43319-z.

[21] Zhang, J. *et al.* (2024) ‘Evidence of an active role of dreaming in emotional memory processing shows that we dream to forget’, *Scientific Reports*, 14(1), 8722. Available at: https://doi.org/10.1038/s41598-024-58170-z.

[22] Muse (2023) *The Science of Dreams: What Happens In The Brain When We Dream*, *Muse*. Available at: https://choosemuse.com/blogs/news/the-science-of-dreams-what-happens-in-the-brain-when-we-dream?srsltid=AfmBOoraxIGW9pOGuy4N7QrJgZwFXovyMTIyryEQ-OOb_9FqmRnh8sQ6 (Accessed: 14 November 2024).