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An Exploration of the Adaptive Functions of Dreams and Empirically-Based Methods of Dream Interpretation

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Abstract:

This paper presents a meta-analysis of dream theory within psychology and neuroscience. The questions it attempts to answer are: what is the neuroscientific basis of dreaming? Why do dreams exist (do they have an adaptive function)? Could dreams possibly have no function? And, what is the best way to interpret a dream? The current analysis presents various theories relevant to each of these questions and compares their viability. It also briefly examines the origins of psychological thought on dreams and, towards the end, outlines the steps and empirical support for a well-regarded method of dream interpretation known as the cognitive experiential model. In the end, the analysis finds that a major likely cause of dreaming is the occurrence of different memory processes during REM sleep, whose activity likely also contributes to dream content. As for adaptive functions, the existing neuroscientific evidence suggests that we are almost certainly capable of learning during dreams and that learning may therefore be one of dreams' primary adaptive functions. However, due to the scarcity of research on dreams, few of these conclusions can be drawn with overwhelming confidence. Lastly, in regards to dream interpretation, the cognitive experiential model seems to provides a framework for dream interpretation which clients and therapists alike find satisfying and useful.

Introduction

Dreams are undeniably mystifying events. Just think of the reality that every night, each one of us seemingly goes unconscious only to suddenly hallucinate astonishingly fantastical events that despite our best selves we often believe in the moment are truly real! Naturally, the profound feelings inspired by dreams have led ancient civilizations to view dreams as events of spiritual and religious significance (Crisp, n.d.). Even in the modern age, many individuals see dreams as capable of having spiritual significance, although this perspecive tends to be pushed by society less and less. In the last hundred years, however, humans have invented the field of psychology, whose sole intent is to investigate the phenomena of the human mind. Given that such a discipline exists, one might naturally wonder about the scientific perspective on the mystical events we call dreams. The present paper offers an in-depth psychological and neuroscientific overview of the existing literature on dreams in an attempt to provide that perspective. What are dreams? Why do they sometimes feel so significant? And, how can I reliablyinterpret my dreams to derive meaningful conclusions from them? The present paper tackles all of these questions in the hopes of providing a satisfactory view of the current state of dream science.

The first major theoretical perspective on dream functions came from Sigmund Freud in the year 1900. Forty years later, Carl Jung contributed a theory which significantly departed from Freud's views. But since then, no single theory has dominated psychological thought on the subject. The field of study of dream function may also be described as rather nascent compared to other topics in psychology. Nevertheless, a number of functional theories do exist on dreams. Furthermore, recent advances in neuroimaging technology have spurred a number of neurologically based theories on the causes of dreams. These findings have in turn been used to strengthen and discredit previously proposed theories. In the end, one might say that dream research is currently in the midst of a steep learning phase. In the ensuing analysis, I will illuminate some of the major theories of dreams that have withstood the onslaught of recent neuroscientific evidence or significantly impacted the discussion about dreams. I will also briefly pay homage to the origins of dream theory through a distillation of Freud and Jung's theories on dreaming, some of which stand strong in the face of recent neuroscientific evidence. Finally, I close out the discussion by outlining an empirically tested method which can be used to interpret one's dreams.

Dream Theories

Freud

The first psychologist to make a major attempt at deciphering the meaning and psychological function of dreams was Sigmund Freud. In honor of Freud's contributions to the world of psychology, I will briefly mention Freud's major points on the psychological function of dreams. In short, Freud believed that dream content was partially comprised of imagery which symbolically represented an individual's unconscious desires or wishes. He referred to this component of his dream theory as "wish-fulfillment" (Domhoff, 2009). Freud further believed that these wishes were often primitive bodily desires for raw actions like sex and violence (Domhoff, 2009). Another major component of Freud's beliefs on dreams is that the visuals we see in dreams are not only symbolically representative of "body-based" desire, but that the symbolic or obscured representation of these desires served another role. Because of the shocking and primitive nature of these body-based desires, Freud believed dreams obscure their depiction to prevent the dreamer from awakening in shock mid-sleep and thus disrupting the sleep process (Hoss, 2013). These two points consitute Freud's most important claims on the function of dreams. Thus, in short, Freud believed that dreams represent unconscious bodily wishes of the dreamer, and that this content is intentionally obscured by the mind to preserve the process of sleep. This obscurity, in turn, causes the unusual fantasy-like visual aspects of dreams.

Owing as we are to Sigmund Freud for helping establish psychology as a legitimate field of scientific study, our duty nevertheless requires us to examine all proposed theories with a critical eye. Under a critical evaluation based on research conducted after Freud's time, Freud's assertions appear scantly supported. Although researchers agree that dream content is consistently strange or obscure in appearance and that dreams generally carry a sense of personal psychological meaning to the dreamer, little to no research supports either the idea that dream imagery embodies subconscious bodily desires, or that the obscure nature of the dream content is designed to protect dreamers from "too directly" observing their subconscious desires and waking up due to shock, thus disturbing the sleep cycle (Hoss, 2013; Wamsley & Stickgold, 2010). Certain evidence even seems to outright refute the claim that dream imagery is always of an obscure symbolic nature, such as the observation by Wamsley and Stickgold (2010) that contrary to dreams as an obscure and symbolic language, dreams are "transparently centered on people, activities, and ideas experienced in daily life" (Wamsley & Stickgold, 2010). Thus, Freud's views on dreams remain, in light of recent research, tenuous at best.

Jung

Another major historical perspective on dreams worthy of consideration comes from Carl Jung. Jung, whose conception of dreams is perhaps more well-known than Freud's, proposes that dreams help balance the misconceptions created by the ego in waking life and that in doing so, they integrate the conscious mind with the unconscious mind and, in a sense, perform a "maintenance of the self" (Hoss 2013). According to Jung, our unconscious mind recognizes misconceptions in our ego by identifying responses in waking life which are novel or produce strong negative emotion: these situations become candidates for possible misconceptions generated by the ego (Hoss, 2013). These situations are then reproduced within our dreams, wherein the dreamer, who is often urged on by a guide which represents the unconscious mind, tests out different reactions to the scenario in an attempt to find a more positive resolution. In this way, Jung claims that dreams "restore our psychological balance" by "compensating" for misconceptions in the ego in order to "bring our awareness back to reality, and warn of dangers of our present course" (Hoss, 2013). Jung describes this function of dreams as"transcendent" and concludes that dreams "bring about. . . a new awareness and a more integrated personality" (Hoss 2013). This view has come to be known as the compensatory theory of dreams.

Several pieces of evidence from modern dream research actually support many of the functions proposed by Jung's compensatory view. In a sense, Jung's theory can be construed as one of the many learning theories of dreams. While these theories will be discussed in more detail in the proceeding sections, in short, this group of theories claim that dreams new information or skills through dream events such as such as rehearsing specific tasks, creative problem solving, practicing basic survival mechanisms, and practicing social skills, among other things (McNamara and Butler, 2009; Ribeiro, 2014; Hoss, 2013; Wagner, U., Gals, S., Haider, H., Verleger, R., Born, J., 2004). In this context, Jung's compensatory view may be seen as learning better ways to approach the situations in which one's ego has created a potential misconception, whether it involves a belief related to other humans or some other aspect of the natural world. Furthermore, extensive neurological research of brain activity during REM dream states seems to support various learning theories of dreaming (Hoss, 2013; Wamsley, 2014; Wamsley & Stickgold, 2013). This means that Jung's compensatory view on dreams may be tenable within the current landscape of psychological dream research (a surprising and exciting conclusion given the lack of neuroscientific knowledge available during the time when Jung proposed the theories).

Theories of Learning

A large number of the modern theories on dreaming view dreams as learning tools. Thus, for the sake of simplicity, I haved group these theories together under an umbrella which I call "theories of learning." It should be noted, however, that the authors themselves do not all describe their findings in these explicit terms.

The first major theory of learning is threat simulation theory. One of the strongest arguments for this theory comes from neurobiologist Sidarta Ribeiro. In a unique approach to dream theory, Ribeiro (2004) attempts to shed light on the mystery of dream function by tackling the phenomenon from an evolutionary perspective. Ribeiro believes that a complete answer to the mystery of dream function will never be found without an analysis that incorporates the theory of evolution. As such, in his 2004 paper, Ribeiro makes a significant contribution to the work of dream function analysis by tracing the evolutionary history of dreaming. This approach inevitably led Ribeiro to trace not only the trait of dreaming, but also instances of the sleep state most strongly associated with dreaming, namely, the sleep state known as rapid-eye-movement, or REM, sleep (Ribeiro, 2004; Hoss, 2013; Wamsley, 2014; McNamara and Butler, 2009).

In sleep research, researchers have divided sleep into at least three different categories or stages during which the brain emits identifiably distinct wavelengths of energy (Ribeiro, 2004). Among these phases, REM sleep, which is also the deepest phase of sleep, is particularly distinctive due to its accompanying phenomenon which gives the sleep state its name: during REM sleep, activation of certain parts of the brain cause the eyes to rapidly move back and forth while the eyelids are still shut (McNamara and Butler, 2009). Other distinctive aspects of REM sleep include greater cerebral activity compared to other sleep states and near-paralysis of our motor capabilities (Ribeiro, 2004; McNamara and Butler, 2009). During REM, we also have more intense and memorable dreams. In a review of REM and non-REM (NREM) dream reports, McNamara and Butler (2009) found that dreams experienced during REM are reported as longer, more emotional, and more visually vivid than non-REM state dreams. Convergent findings from other studies further suggest that REM dreams are the ones which exhibit the "strangeness" and obscurity which we typically associate with dreaming (Ribeiro, 2004; Domhoff, 2017). In other words, our most memorable and fantastical dreams seem to occur exclusively during REM sleep.

Given this demonstrated association, many researchers, including Ribeiro (2004), have attempted to understand the mystifying phenomenon of dreams by studying REM from various angles of interpretation. Returning to the paper at hand, Ribeiro (2004) begins his exploration of dreams by considering the evolution of REM sleep. REM sleep first appeared in various species of birds, whose most intelligent relatives, the reptiles, had only reached slow-wave sleep, the stage just one level below REM sleep in terms of depth (Ribeiro, 2004). After appearing in birds, a more developed version of REM sleep presented itself within marsupials. Finally, the most developed version of REM sleep appeared in terrestrial mammals and eventually in humans (Ribeiro, 2004). A brief comparison between human and animal REM sleep may help explain how REM in one species can be "more developed" than in another. In an ideal night's sleep, humans repeat a cycle of four stages of sleep approximately three to five times, depending on how long one stays asleep. Each stage in the cycle indicates a deeper level of sleep, with REM being the deepest, and in each repetition of the cycle, the stage of REM sleep lasts longer than in previous cycles; the length of REM therefore varies in duration from as short as ten minutes in the first occurrence to longer than thirty minutes in subsequent occurrences during a given night's sleep (Ribeiro, 2004). Ribeiro's description of one species' REM sleep being "more developed" than another species' thus directly refers to the quantifiable measurements of the number of times REM sleep occurs within a single night's sleep and how long these stages last (Ribeiro, 2004). Ultimately, the main conclusion is that humans have achieved the most developed form of REM sleep among all species who exhibit REM sleep,

Such a quantifiably sequential development of the particular trait of REM sleep begs the question of why birds developed REM sleep while reptiles did not, and why subsequent species developed more intense versions of REM than the birds. The best way to answer this question is to examine the benefits that REM provides to an organism compared to less deep levels of sleep. A substantial amount of research exists on the topic of the functions of REM sleep: by far, the most common recurring finding is that REM sleep likely plays an integral role in the processing of memories (McNamara and Butler, 2009; Schredl, 2017; Wamsley & Stickgold, 2010; Wamsley, 2014; Hoss, 2013). Specifically, Ribeiro (2004) states that during the REM stage of sleep, there is intense "non-stationary memory reverberation," or in other words, during REM sleep there is an increased amount of neuronal activity across many distant regions of the brain, but regions related to memory show especially heightened activity (Ribeiro, 2004). Ribeiro further states that these activated memories are in part responsible for the content which comprises dreams, and that the high levels of excitation during REM accounts for our bright and vivid perceptions of dreams (Ribeiro 2004). Evidence of mental activity during slow-wave sleep, the stage just before REM, further supports this claim. Studies on slow-wave sleep dreams have shown that these dreams possess less intense or vivid imagery, is more "ordinary" in nature, and often includes realistic replications of activities completed during the day (Ribeiro, 2004; McNamara and Butler, 2010; Wamsley & Stickgold, 2010).

From all of the above, Ribeiro's final conclusion about the function of dreams is that they seem to provide "probabilistic simulations of past events and future expectations;" within these simulations, we test out novel behaviors, and ultimately, we learn from them (Ribeiro, 2004). Thus, Ribeiro believes that dreams serve as tools for learning. This claim can be seen as a general form of the threat simulation theory of dreaming, which claims that we use dreams to simulate potential threats and test different potential reactions to those threats (Ribeiro, 2004). The theory is supported by a significant amount of evidence. Firstly, it seems to account for two established and highly relatable aspects of dreams, which is first, that dreams tend to carry more negative emotions than positive emotions (one might interpret this as a disproportionate portrayal of threating as opposed to felicitous situations, and that during these situations, individuals often feel compelled to act in reaction to these threats, in a way similar to Ribeiro's theory (McNamara and Butler, 2009; Hoss, 2013; Domhoff, 2017). Secondly, the theory seems to account for the various types of positive and negative dreams which do exist. For instance, the occurrence of highly negative dreams or nightmares might be seen as didactic simulations which encourage learning through negative reinforcement, whereas dreams about positive scenarios might foster learning through positive reinforcement of adaptive behaviors such as finding food and mates (Ribeiro, 2004). Though modern dreams tend to be centered on social conflict rather than lethal conflicts, social conflicts may simply be the most important threats we encounter in the modern world (Wamsley & Stickgold, 2010). One final piece of supportive evidence for dreams as adaptive simulations comes from research on REM sleep in animals. Interestingly enough, in all animal species that have been studied so far, REM sleep occurs more often in juveniles than in adults (Ribeiro, 2004). This finding could very well suggest that the memory activation which occurs during REM sleep indeed evolved to help species learn from their past experiences (Ribeiro, 2004).

McNamara and Butler (2009) propose a slightly different evolutionary theory of dreams. In their paper, the two researchers offer an evolutionary perspective on dreams which is heavily based on Ribeiro's previous work, but which offers a novel and worthwhile insight culminating in a unique conclusion. Namely, McNamara and Butler bring to light an aspect of evolutionary dream phenomenology which Ribeiro largely ignores. This phenomenon is the bihemispheric activation observed in REM sleep. McNamara and Butler stress that the bihemispheric activation in REM sleep is a development worth examining in the evolution of REM sleep and dreams. The researchers claim that this bihemispheric activation is a major source of the "mentation" experiencd during sleep. This mentation inspired by bihemispheric activation thus constitutes our experience of dreams (McNamara & Butler, 2009). So, why might have sleep evolved into a bihemspheric rather than a unihemispheric event? Unfortunately, McNamara and Butler offer less on this question than Ribeiro on his similar question. Nevertheless, one could infer that the evolution of this trait reflects the greater capacity for intelligence within post-reptilian species. Greater intelligence would entail a more abundant and complex process of memory consolidation during sleep, thus resulting in the eventual development of bihemispheric communication duinrg sleep states. Contrary to Ribeiro (2004), however, McNamara and Butler (2009) do not believe that REM processes are a primary cause for the experience of dreaming. Their evidence for this statement lies in the finding that young children do not seem to report dreams until they have reached certain developmental stages despite experiencing REM sleep prior to those stages (McNamara & Butler, 2009). The particular mental capacities necessary for dream reports are sufficient development within the visuospatial and cognitive areas of the brain. The researchers claim these areas must be well-enough developed to support the narrative nature of dreams (McNamara and Butler, 2009). The claim ultimately feels weak, however, due to the clear possibility that young children may experience dreams but may not be scapable of reporting the content of their dreams.

Despite this weak claim, McNamara and Butler (2009) do make a noteworthy conclusion from their evolutionary overview. In essence, the researchers claim that the process of dreaming costs too much energy to not have an adaptive function. And so, based on their finding that dream content tends to focus heavily on social interactions, the researchers conclude that perhaps dreams serve as simulation spaces in which to test potentially risky forms of social interactions. The high value of social activity in primitive existence seems to support this theory. It has been hypothesized that in primitive times, social belonging was a crucial aspect of not just happiness, , but of survival. This essentialness was due to the fact that humans originated as a tribal species which survived through collaboration and teamwork in various arenas of life from hunting prey, to planting crops, to violent altercations with other tribes. Therefore, dreams evolved as a method of testing new types of human interactions which could have severe negative consequences if attempted in real life (McNamara and Butler, 2009). The potential negative consequences of these behaviors make them "costly" actions and the interactions themselves are social "signals;" hence, McNamara and Butler (2009) dubbed their theory costly signaling theory. Therefore, McNamara and Butler make, in a sense, the profound conclusion that dreams help promote social cohesion within human societies (McNamara and Butler, 2009). Admittedly, costly signaling theory does not differ drastically from Ribeiro (2004)'s threat simulation theory. However, it is distinct in that it stresses more heavily the role of dreams in promoting social cohesion as opposed to lethal threats. As previously mentioned, this focus on social interactions seen in modern dreams may reflect that negative social interactions are the biggest threats most individuals in Western countries face on a regular basis.

A third and final theory of learning exists which differs more dramatically from threat simulation. This final theory asserts that the primary function of dreams may be to produce insight and offer the dreamer a unique state in which we can creatively solve problems we face in waking life. It is well documented that sleeping can help improve performance on tasks which measure semantic memory and procedural memory (Wamsley and Stickgold, 2010; Wamsley, 2014). While these findings are more about sleep in general than dreams specifically, one question researchers have asked which is relevant to insight theory is what role, if any, do dreams play in these memory enhancements? This question has proven difficult to answer due to the difficulty of separating the effects of dreams from the effects of the sleep in which dreams embed themselves (Domhoff, 2009; Domhoff, 2017). Few studies exist on this particular question in dream research, likely due to the difficulty mentioned above.

While research is scarce, one study by Wagner and colleauges (2004) examines the role of sleep, albeit not specifically dreams, in providing insight. The concept of insight is distinguished from the more simplistic processes of semantic memory and procedural memory rehearsal. Wagner and colleagues describe insight as "a mental restructuring that leads to a sudden gain of explicit knowledge allowing qualitatively changed behavior" (Wagner, U., Gais, S., Haider, H., Verleger, R., & Born, J., 2004). Although not specific to dreams, Wagner and colleagues examined the power of sleep to produce insight in a unique experiment. The researchers created a game wherein understanding the basic rules of the game was sufficient to lead players to be successful. However, the researchers cleverly designed the game such that there existed a particular unorthodox tactic which if utilized led greater success than the conventional method of play. Researchers divided participants into three groups: a waking group, a daytime sleeping group, and a nocturnal sleeping group, where these distinctions described the way in which participants rested after an initial learning session and practice session of the game. Researchers then examined which participants managed to discover the hidden tactic within the game, which represented gaining insight. Importantly, this tactic was meticulously created to only be discoverable through creative insight and not through unthoughtful practice, thus distinguishing it from the processes of semantic or procedural memory. The findings were that participants who slept, whether in the daytime or during nocturnal sleep, were more than twice as likely to discover the insight (Wagner et al., 2004). The researchers concluded from this that the processes of sleep most likely promote insight and creative problem-solving within individuals (Wagner et al., 2004).

Although the study did not focus on the particular role of dreams in insight, researchers nevertheless did ask participants if they dreamt about the task in any way during the resting period. But disappointingly, none of the participants reported having any dreams related to the task (Wagner et al., 2004). This type of questionnaire represents one way researchers could potentially distinguish between outcomes of dreams and outcomes of underlying sleep processes (Domhoff, 2017; Domhoff, 2007). Another way researchers can distinguish between the two is through the combined use of either fMRI or EEG scans and follow-up dream questionnaires (Hoss, 2013; Dresler, M., Wehrle, R., Spoormaker, V. I., Koch, S. P., Holsboer, F., Steiger, A., ... & Czisch, M., 2012). The expensive and cumbersome nature of these research tools inevitably prevent numerous large-scale studies from being conducted, however. But, nevertheless, perhaps a smaller-scale replication of Wagner and colleagues' study which focused on dreams instead of sleep and incorporated these measures would yield enlightening results, assuming the participants had dreams this time around.

Aside from Wagner and colleagues, few other studies exist exploring the specific correlation of dreaming and insight. If we turn to anecdotal evidence, however, myriad famous and ordinary individuals claim to have received important insight from their dreams. Dmitri Mendeleev, the man who invented the periodic table of the elements, claimed that his idea for his invention was revealed to him in a dream (Ribeiro, 2004); chemist Kekulé, who discovered the strcture of benzene, claimed that the idea for the structure came to him in a dream in which he watched a snake eating its own tail, which apparently resembled his subsequent discovery (Ribeiro, 2004); Albert Einstein claimed that his idea for the theory of relativity was inspired by a dream (Ribeiro, 2004). Aside from science, in the realm of art, both John Lennon and the Beatles have claimed to have written songs based on lyrics or melodies witnessed inside a dream (Gregoire, 2017), and in the realm of literature, renowned horror novelist Stephen King claims that many of his stories have been inspired by vivid dreams (Gregoire, 2017). These testimonies seem to suggest a clear ability for dreams to portray creative insights to problems as well as to fuel artistic creativity and even directly create works of art. More research into the role of creative problem-solving in dreams would therefore likely be fruitful, if done properly. This topic may be particularly difficult to study, however, given the unpredictable nature of receiving insight through dreams. Nevertheless, there would be little harm in attempting an experiment to test for dream-induced insight, especially given the high probability of finding fruitful results.

To conclude, there are two major varieties of learning-oriented theories: realistic threat simulation theories and insight/problem-solving theories. Theories based on threat simulation seem to have more consistent empirical support than theories of insight, but this may be due in part to the difficulty of studying the process of insight within dreams. Furthermore, anecdotal evidence suggests that dreams do possess the capability to provide unique creative insights, and to fuel artistic creativity as well as to generate entire miniature works of art within the dream state. Lastly, in terms of Freud and Jung, Freud's theory of wish-fulfillment appears scantly supported by modern evidence and even refuted by it in some cases. On the other hand, Jung's compensatory theory of dreams seems to be largely unscathed and even supported by neurological findings.

Adaptive Functions from a Neuroscience Perspective

One of the great advances of modern psychological study is the introduction of techniques which allow us to directly observes the neurological activity of the brain. No longer must we rely on observation and inference to predict one's psychological states; instead, an increasing body of knowledge about the functions of particular brain regions allows us to make inferences about one's brain state, one's subjective experiences, and one's other internally ocurring phenomena based on neurobiological information alone. While the previous section incorporates some neurological evidence in its analysis of dream theories, the current section delves more deeply into neuroscientific findings of dream phenomenology. Ultimately, I hope to portray a clear picture of what is actually happening in the brain when we dream at a neuronal level.

In "The Neuropsychology of Dreaming: Studies and Observations," Robert Hoss provides an extensive account of the neuroscientific findings on dreams and the implications of this evidence for theories of dreaming. In a general overview of dream state brain activity, Hoss argues that the dream state can be seen as "a state of generalized brain activity with the specific exclusion of executive systems" (Hoss, 2013). Figure 1 in the appendix depicts a diagram of the active brain regions observed during REM sleep which represents an eggregation of information from a breadth of neuroimaging studie. The active brain regions during REM sleep include, in general terms: the visual association cortex (note: not the visual cortex, which is inactive), which organizes imagery into a visual space; motor and sensory regions; the temporal areas used in facial recognition, auditory processing, and episodic recall; association regions of the cortex, which may account for the metaphorical nature of dream imagery; primal regions which regulate sleep, consciousness, alertness, and metabolic function; the limbic region, involved in emotional processing, especially in the amygdala and hypothalamus, both of which are active, as well as short- to long-term memory consolidation; and finally, regions involved in emotional control, fear extinction and reward-based adaptive action planning and learning functions (Hoss, 2013).

Based on these active regions, Hoss draws three major conclusions about the nature of dreams. First, dreams seem to in a sense express the unconscious. Dreams have been considered paths to the unconscious since as long as they have been studied. Freud famously noted that dreams are the "royal road to the unconscious (Freud, 2013). Jung, too, similarly also described dreams, claiming that they are "the most readily accessible expression of the unconscious" (Jung, 1971). Certain neurological evidence seems to support this idea the dreams depict the world from the perspective of the unconscious. Particularly, areas which are associated with episodic memory, working memory, and conscious reflection, such as the precuneus and the posterior cingulate cortex, remain relatively *inactive* during REM sleep while various limbic regions and the hippocampus, which are associated with emotions and memory consolidation, remain highly *active* (Hoss, 2013). This pattern of activation suggests that while dreaming, we might have, in a sense, "easy access" to the emotional aspects of memories but lack access to the specific episodic nature of memories (Hoss, 2013). From this perspective, dreams may be able to project the emotional impact that various events have on us, while rarely, if ever, depicting those effects in obvious ways. This interpretation would explain the common notion of "symbolic meaning" many people sense in their dreams. Therefore, dreams may very well show us our unconscious and suppressed emotions (Hoss, 2013; Hill & Knox, 2010).

The second major conclusion Hoss (2013) draws from neurological findings is that dreams seem to operate in a highly associative way. Hoss (2013) notes that dream images are like a picture-metaphor form of communication: while the images may not make immediate sense, they are not meant to. Instead, they are symbolic, almost like each image is itself a word or a phrase in a foreign language (Hoss 2013). Mostly, Hoss draws this claim from observing activity in what he calls "the association cortex," presumably a part of the brain which aids in the creation of associations between concepts, as well as the inferior parietal cortex, which helps us to create a meaningful perception of our visual space (Hoss, 2013). This conclusion inevitably resonates with those of us who are capable of remembering our dreams.

Hoss's third and final conclusion about the nature of dreams is that dreams picture emotion. As most know from personal experience, dreams undeniably can be highly emotional events. Evidence from brain imaging studies now supports this claim by revealing brain activity in regions associated with emotional activation during the dream state. Most crucially, evidence for this claim can be seen in the high activation of the limbic system, which is known to regulate emotion, and the amygdala, which is known for being the house of negative emotions such as fear, during REM sleep (Hoss, 2013).

A number of theories have been proposed which account for Hoss' neurological findings. One theory based on the idea that dreams express the unconscious has been proposed by Hobson (2009), who asserts the theory of protoconsciousness. Under this theory, dreams may possess the adaptive function of encouraging conscious personal development during wakefulness by encouraging individuals to self-reflect on their dreams, which depict meaningful unconscious processes (Hoss, 2013). Another theory based on dreams' pension for excessive association comes from Zhang. Zhang asserts that the primary function of dreams is encoding, processing, and transfer of data from temporary memory to long-term memory (Hoss, 2013). During this process of memory consolidation, short-term memories are activated and "sent" to the conscious part of the brain. Once there, these memories are then "self-maintained" by the dreamer's associative thinking system (Hoss, 2013). This theory, which Zhang calls the continual-activation theory accounts for the tendency of dreams to be both continuous and capricious in their setting: a dream's broader setting thus reflects a certain memory being activated, while the strange and unpredictable mutations therein reflect the work of associative regions of the brain "maintaining" the memory; the sudden shifting of dream setting, which commonly occurs in our dreams, reflects the activation of a different memory (Hoss, 2013). Two final theories based on dreams' pension for depicting emotions come from Hartmann and Hoss. Hartmann subtly expands the claim that dreams depict emotion by claiming not only that the central images of a dream picture the emotions of the dreamer, but also that "the intensity of the image is a measure of the strength of the emotion" (Hartmann, 1995). In a separate theory, Hoss comments on the role of color in dream imagery. Based on previous findings that colors seem to invoke different emotions in waking life, Hoss (2010) proposes that in a similar manner, the colors we perceive in dreams symbolize the same emotions they have been shown to evoke in waking life.

A special note should be placed on the role of memory in REM dreams. As previously mentioned, various neurological studies suggest that some form of memory activation, consolidation, or trimming likely occurs during REM sleep (Hoss, 2013; McNamara & Butler, 2009; Domhoff, 2009; Wamsley & Stickgold, 2010; Wamsley, 2014). The following findings illustrate the strength of this evidence for a role of memory in REM sleep processes: Zhang proposes that the main function of dreaming is the processing, encoding, and transfer of short-term memories to long-term memories; Tarnow (2003) has found evidence to suggest that dreams strengthen consolidation of semantic memories, or memories related to the meaning of information; Payne and Nadal (2004) have made a similar finding, which is that dreams help strengthen semantic memories and consolidate them into a smooth narrative; finally, Hoss's aggregated list of active brain regions reveal high activity in regions commonly associated with memory processing, such as regions within the limbic system, including the hippocampus and amygdala (Hoss, 2013). Suffice it to say, there is convincing evidence that memory processes occur during REM sleep. These processes, in turn, likely influence the content which we perceive and feel emotionally during dreams.

Neuroscientific Evidence For and Against Theories of Learning

A significant amount of brain imaging data exists on the state of dreaming. If we are to abide by a conservative view of empirical validity, perhaps we might wish to see brain imaging studies as limitations of what is neurologically or psychologically possible within dreams, or at least of indicators of what is likely to be possible. In this very frame of mind, Hoss (2013) offers a succinct analysis of what is possible within the phenomenon of dreams based on neuroscientific findings of REM sleep brain activity. Beore summarizing Hoss's findings, a moment 'ought to be taken to acknowledge the extensive research which Hoss (2013) conducted in order to produce the article upon which the present paper quite consistently relies. If it were not for Hoss's work, a large portion of the present paper would have been far more difficult to successfully and rigorously produce.

To test learning theories of dreaming, Hoss (2013) assessed five questions which lie at the heart of a common attempt at explaining how we can learn from dreams. The first question Hoss asks is, during REM sleep, is the brain capable of detecting norm violations or interating novel reactions experienced in waking life into a larger internal belief system or world understanding? The answer to this question seems to be: "yes," given observed activity in brain regions which allow us to detect when things are wrong and initiate action (Hoss, 2013). The second question Hoss asks is, can we devise compensating behaviors, or adaptive new behaviors, and initiate them while in REM sleep? The answer to this question is also "yes." Active regions which lead to this conclusion include the anterior cingulate, medial prefrontal cortex, and the basal ganglia, which are all associated with experimenting with new behaviors and/or initiating action (Hoss, 2013). Hoss's third question was quite similar to the last and asked, can the dreaming brain provide cues to guide and influence action? Once again, the active brain regions observed suggest that we probably can. In particular, the following regions contribute to this potential capability: the antieror cingulate, which provides cues to influence and monitor performance in order to select appropriate responses; the insula, which is involvd in possessing a sense of self, receiving sudden insight, and guiding perceptual decision-making; the basal ganglia, which motivates the seeking of long-term as opposed to immediate rewards; the medial prefrontal cortex (mPFC), which monitors learning, provides a "sense of knowing" and aids in forming judgements of confidence (Hoss, 2013). In particular, the mPFC may be responsible for the "guiding forces" often experienced in dreams either through an encouraging other or an internal instinct of what to do next in dream scenarios.

The last two questions Hoss examines center around aspects of emotional learning. The first is, is the dreaming brain capable of emotional reinforcement of an anticipated outcome? The pattern of “yes”’s continues with this question. The active region of the anterior cingulate is known to have the function of placing a reward value on expected outcomes in order to facilitate appropriate responses. The basal ganglia has been shown to be involved in “focused, reward-based decision-making and learning and adapting to changing conditions” (Hoss, 2013). Finally, the caudal and ventromedial orbitofrontal cortex (vmPFC) has been associated with expectation and regulating or planning behavior based on reward and punishment and influencing changes in behavior through this process (Hoss, 2013). All three of these regions are shown to be active while we dream. Finally, Hoss examines the question of, is the dreaming brain capable of learning, emotional dampening, or extinction? The answer to this question turns out to be “yes” as well. Particularly, the mPFC has been associated with extinction of conditioned fear, which may explain why we often feel more resolved after confronting deep fears inside our dreams, and the basal ganglia has been associated by some researchers a sessential to the processes of extinction learning and making or inhibiting responses. Lastly, the ventral striatum (VST), another region shown to be active in the dreaming brain, has been associated with inhibitory control and extinction learning via communication with the prefrontal cortex and OFC (Hoss, 2013).

In summary, neuroscientific evidence contributes a unique marker of indication as to what sort of internal processes might be causing dreams as well as what type of things we might be capable of doing while dreaming. On the nature of dreams, we may be able to say three things with some certainty: one, dreams likely reveal our unconscious world-views; two, dreams are highly associative events; and three, dreams undeniably depict real emotions, including those we have either consciously or unconsciously repressed (Hoss, 2013). One theory not mentioned above is that the emotional content of dreams may actually dictate the dream images we see, contrary to the popular notion that our emotions are reactions to what we see in dreams (Hoss, 2013). This belief lends itself well ot the idea of dreamwork which will be discussed in the next section. Another major conclusion from the neurological events of dreaming is that the many forms of learning theories, such as threat simulation theory, costly signaling theory, and even Jung's compensatory integration theory, are directly supported by neurological evidence. Due to the virtual non-existence of contrary evidence to theories of learning, they very well may constitute the most tenable dream theories which have been proposed within the psychological study of dreams.

Could Dreams Not Have an Adaptive Function?

Despite the significantly personal and emotional nature of dreams, not all researchers believe dreams possess an adaptive function. This belief arises from two distinct perspectives on examining dream phenomenology: evolutionary and neurological. While Ribeiro (2004) concluded that we use dreams to simulate threats and learn survival skills, other researchers who have taken the evolutionary approach to dreams remain less convinced of a special functionality within dreams. Domhoff (2009) is one researcher who presents such a view. In a paper proposing a neurocognitive theory of dreams, Domhoff briefly explores the evolutionary history of dreaming, much like Ribeiro (2004) and McNamara and Butler (2009). At the end of this exploration, however, Domhoff concludes the following:

> [Dreams are a by-product of] two great evolutionary developments, sleeping and thinking. Even more specifically, they are a by-product of two specific cognitive abilities that have great adaptive value in the waking world, the ability to generate mental imagery and the ability to generate narratives. They occur, as already noted, when there is

sufficient brain activation in a context where there is little or no guidance for the brain from external stimuli or the self system. (Domhoff, 2009).

In this description, Domhoff seems to portray dreams as an unintentional by-prodcut of other evolutionary functions, namely thinking and sleeping.

The evolutionary considerations proposed by McNamara and Butler (2009) can also be interpreted as supporting this view. To briefly recall some aspects of Ribeiro's findings, Ribeiro (2004) found that the development of REM sleep seems to have coincided with the development of increased intelligence; in the developmental track of REM sleep, which begins with reptiles, then moves to birds, to land mammals, and eventually to humans, each new species seems to have increased capacity for planning, complex strategic instincts, or thought. REM sleep was furthermore thought to have evolved along this track in order to enable a deeper, more complex memory consolidation process, which would ultimately create adaptive behaviors or enable learning which is based on a more complex integration of various types of information than less deep versions of sleep are capable of providing (Ribeiro, 2004). One of the difficult questions from this point becomes differentiating the role of REM sleep from possible roles of dreaming as a phenomenon which is distinct from the REM sleep which underlies it. One way to tackle this conundrum is to ask, what might be the function of animal dreams, if they have them? Brain imaging of animals during REM sleep shows animals' brain activity during sleep to be highly similar to the brain activity seen in human sleep (Domhoff, 2009). One key phenomenon which characterizes animal sleep and is also seen within human sleep is memory reactivation (Wamsley, 2014). In a study on rat dreams, researchers trained a rat to navigate a novel maze, then observed its brain activity during a subsequent period of sleep. Astonishingly, researchers found that the same regions activated during the navigation of the maze were reactivated numerous times during sleep (Wamsley, 2014). From this, it would seem that perhaps animals do in fact "dream." It furthermore seems that the function of such dreams may in fact be some form of threat simulation theory or other learning theory.

But is there another function to dreaming besides purely threat simulation? Or more precicesley, why is it necessary for us to be consciously aware of this mental process when other periods of sleep clearly demonstrate that we could simply maintain a highly reduced level of consciousness? One might say that humans' ability to experience their dreams is merely a consequence of the fact that we are conscious beings. As Wamsley (2014) points out, "beyond this, a "function" for dreaming additionally hinges on the difficult question of whether conscious experience in general serves any function" (Wamsley, 2014). So perhaps the best answer to this question is the question, does consciousness have a function? Of course, this question has been asked by human kind for millennia, and to this day, despite the tools of modern psychological study we possess, neither philosophers nor psychologists have reached any consensus on this topic (Wamsley, 2014; Baars, 1997; Oizumi, 2014; Hobson, 2009; Dresler et al., 2012; Tononi, G., Boly, M., Massimini, M., & Koch, C., 2016). While no one theory will probably perfectly describe the true "biological purpose" of conscious awareness, most theorists would likely agree on at least the idea that consciousness allows us to better understand and respond to that environment using inborn instincts as well as rational cognition. Therefore, perhaps one reason we are conscious of our dreams is that we are meant to ponder their subjective meaning using our instincts and reasoning capabilities, just as the purpose of consciousness in waking life is perhaps to better understand and respond to our external environment.

Wamsley and Stickgold (2010) point out a more neurological account which leads them to another unclear or non-existent objective functionality of dreaming. This explanation relies on the recent discovery of a network of brain regions which researchers call the “default network” (Wamsley and Stickgold, 2010). The default network refers to a group of brain regions which are consistently active across different brain states. The precise amount of activity which the default network exhibits does change, however, depending on one’s brain state and level of arousal (Wamsley & Stickgold, 2010). The major regions which constitute the default network are the medial temporal, medial prefrontal, midline, and parietal regions (Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L., 2008). The state of default network activity which is of particular interest is the state of “resting wakefulness,” during which default network activity strongly overlaps with activity observed during REM sleep. The characteristic of the resting wakefulness state which makes it relevant to the study of dreams is that during resting wakefulness, default network activity increases just as sensory input decreases. Some examples of a resting wakefulness state is the feeling of respite we experience when resting on the train after a long day at work, or closing one’s eyes and relaxing in the tranquility of one’s living room after a stressful day (Wamsley & Stickgold, 2010). These conditions cause an increase in default network activity. Buckner and colleagues (2008) have theorized that one purpose of the default network might be some form of memory consolidation. Interestingly, a study on the thoughts we produce during resting wakefulness reveals that they are highly similar to those we experience when we initially start to fall asleep and experience non-REM dreams (Wamsley & Stickgold, 2010). During both instances, we are likely to experience rehearsal of recently experienced memories which give rise to daydream-like muses that are fanciful while not quite reaching the level of free association or intense surrealism experienced during REM-associated dreams (Wamsley & Stickgold, 2010; Buckner et al., 2008).

This interesting similarity between resting wakefulness and the dream state in both brain activity and reported mentation gives rise to a unique theory of dream function. This "default network theory" is unique in that it identifies dreams as an inevitable consequence of automatic memory consolidation processes that occur during periods of reduced sensory input. Furthermore, this automatic process is not limited to occurring during sleep and instead frequently occurs during wakefulness just as well as sleep. A major conclusion Wamsley and Stickgold (2010) draw from this unique perspective is that the conscious experience of dreaming may not serve a unique function separate from the automatic process of memory consolidation. In a separate article, Wamsley (2014) admits that the activity of the default network does not perfectly overlap with the neural substrate of dreaming, and this difference may indicate that dreams do serve some other purpose. However, the preponderance of evidence regarding brain activity during sleep as well as the comparison of this activity to the activity seen during resting wakefulness suggest that a relatively large portion of neurological dream phenomenology is in fact already known within the scientific community. Therefore, even with the potential for new discoveries in the future, the current analysis of dream functionality, including the theories regarding its lack of functionality, may likely capture a fair portion of the true functional purpose of dreams.

How Should We Interpret our Dreams?

Historical records indicate that dream interpretation is a practice which has existed for thousands of years. Civilizations dating as far back as 1350 b.c.e. have produced written records which explain the meaning of dreams, often through the lens of religion and spirituality (Crisp, n.d.). While modern society has largely abandoned the cultural and spiritual aspects of dream interpretation, some psychologists have embarked on the quest to form scientifically valid methods of dream interpretation (Hill and Rochlen, 1999; Keleman, 2007; Mahrer, 2009). Even casual conversations can be seen as attempts to practice dream interpretation, albeit in a much less structured way. In honor of providing a reliable framework for the pursuit of interpreting one's dreams, the current paper presents an overview and empirical analysis of one of the most well-known methods of modern dream interpretation.

Hill and Rochlen's Cognitive-Experiential Model

Developed by psychologists Hill and Rochlen who published their findings in 1999, the method in question is known as the cognitive-experiential model of dream interpretation. In creating a model of dream work, the two researchers wanted to design a model that was as simple and teachable as possible. The researchers also went to great lengths to empirically test their model through testing sessions with real patients in psychotherapy sessions (although the model can be used by an individual with no outside help). The model itself is comprised of three parts - exploration, insight, and action - and is based on two key assumptions. The first assumption the model makes is that dreams often represent important life experiences, conflicts, and unresolved issues, and because of this, they are personally meaningful and thus deserving of reflection. The second assumption is that dream imagery and content is of an entirely personal nature, and that because of this fact, the dreamer's own interpretation, as opposed to others' input on how to interpret images within the dream, is of the utmost importance to the process of dream work.

Goals of the Three Stages

The first part of the process is known as the exploration phase. The exploration phase is comprised of re-entering the dream, or "bringing it back to life," and has two goals. The first goal is that in re-entering the dream, Hill and Rochlen hope the dreamer will become more open to learning from the dream. Second, in a similar way, re-entering the dream helps to kick-start the process of associating the images in the dream with aspects of the dreamer's waking life. The second phase is called insight. The goal of this phase is to try and figure out what the dream means. Naturally, this phase is where the meat of the interpretation process occurs and where individuals embarking on the process alone are most likely to have their possibilities limited by lack of external input. Finally, the action phase attempts to turn the meaning derived from the dream into executable actions the dreamer can take to improve his or her life.

Applying the Three Stages

Assuming the dreamer is accompanied by a partner, to begin the first phase of exploration, the partner should ask the dreamer to retell their dream in the first-person present. This will help the dreamer re-experience the emotions of the dream as well as recall more details about the dream. Next, the dreamer should choose roughly four to seven images that they wish to explore in a four-part process: description, re-experiencing, associations, and waking-life triggers.

After the dreamer has explored the chosen images, they should then be asked what they believe the greater meaning of the dream is. In this process, dreamers will usually tend toward five common methods of interpretation: the experiential level, which entails what it feels like to do or experience the dream images, the waking-life level, which examines how the dream images relate to waking life activities and thoughts, the parts-of-self level, which considers how different dream images relate to different aspects of the dreamer's personal identity, childhood conflicts level, which relates dream imagery to early childhood struggles and traumas, and finally the spiritual-existential level, which examines how the events in the dream relate to the dreamer's beliefs about the meaning of life or the dreamer's relationship with a higher power. Due to the individual tendency to gravitate more naturally toward one of these levels of interpretation than the others, this phase is where a guide or partner can be most helpful in prodding the dreamer to consider different points of view (Hill and Rochlen, 1999).

Lastly, once the dreamer has attained a satisfactory interpretation of the greater meanings within the dream, the dreamer should decide how they would like to change their waking life through taking specific courses of action. Often, when the dreamer finds a satisfying meaning in the dream, the action stage comes naturally with very little prodding by a partner. However, if the dreamer seems unsure of how to change their waking behavior, their partner can prod the dreamer by first asking the dreamer what they might like to change about the dream, then how this desire for change relates to a desire to change some aspect of their waking life in a similar way. An example Hill and Rochlen provide for this scenario, is in a dream where an elevator won't stop going up and down, the dreamer comments that they would like to stop the elevator from going up and down. Their partner might then ask, what else in your life do you want to stop from going up and down? While life-changing action is often natural, as mentioned, unsure dreamers may like to further consider the types of actions they can take, of which there are two. First, they can think about behavioral changes, which constitutes taking specific actions such as ending a relationship or quitting a job. If these actions seem difficult or implausible, these deep issues might be best tackled through collaboration with a behavioral therapist. The second type of action one can commit to taking is creating a ritual, such as hanging a meaningful picture or burning an object, which somehow honors the meaning the dreamer derived from the dream (Hill and Rochlen, 1999).

Empirical Support for the Model

A fair amount of empirical evidence suggests that Hill and Rochlen's model is effective. In a review by Hill and Knox (2010), researchers assessed both the model's outcomes and the theoretical basis of its process. Hill and Knox assessed outcomes of the model by examining three elements of its usage in therapy sessions; the perceived quality of the session, achievement of the dreamer's goals in pursuing dream work, and broader indirect outcomes of doing dream work with the model. In results from twelve studies, clients overall perceived therapy sessions which used the cognitive experiential model as higher quality than sessions in which no dream work occurred (Hill and Knox, 2010). With regard to dreamers' goals, a longitudinal 2-week study suggests that clients felt "increased functioning on their target problems [2 weeks] after a dream session" (Hill and Knox, 2010). Other studies show that the insight and action phases are particularly useful in working on these issues and providing greater clarity about them (Hill and Knox, 2010). In terms of broader impacts of the model, evidence is less convincing that the model has substantive effects on tangential or indirectly related aspects of their lives, such as quality or state of relationships (Hill and Knox, 2010). As for the process, the most telling evidence lies in dreamer testimony of the process' elements. In this regard, clients generally do feel that each element of the process is beneficial to the overall process, especially the insight and action phases, as mentioned above. In particular, the insight phase was considered helpful in gaining insight and making links to waking life through its explanation of different methods of interpreting meaning from dream images, which helped in perceiving new meaning (Hill and Knox, 2010).

Given this empirical evidence, the cognitive-experiential model of dream interpretation is perhaps deserving of individual experimentation. For those who may try the method and feel dissatisfied or are otherwise curious in exploring other methods of modern dream interpretation, I would suggest two other methods: the formative method, which focuses on the bodily and muscular elements of dream activity, which has been proposed by Stanley Keleman (2007), and the unnamed method which I call "becoming a whole new person," which is proposed by Alvin Mahrer (2009).

Conclusion

The mystery of the function of dreams and the question of how to accurately interpret them has been pondered by mankind for thousands of years. In summation of the findings discussed in the present paper, there still exists a lack of general consensus on the answer to these questions. However, neurological advances of modern times have shed some light on what might potentially cause dreams to form, as well as what types of theories might be plausible explanations of dream function. Particularly, dreams seem to be caused in part by some neurologically identifiable processes of memory consolidation. More specifically, activation of certain regions of the brain during sleep have led some to conclude that dreams may portray simulations based on real life from which we can learn new adaptive behaviors. In the end, the various theories of learning seem to be somewhat heavily supported by this neurological evidence. Our apparent capability to learn from dreams combined with the extensive findings of memory-related phenomena occurring during the dream state seems to lend psychologically-oriented compensatory theory of Jung some credence. Perhaps we are in fact "learning" about our own misconceptions in dreams and "maintaining the self" by using this information to develop new, more helpful beliefs about our external world.

Finally, while dream interpretation remains a nascent area of study at best, burgeoning research suggests that some models, such as Hill and Rochlen's cognitive-experiential model, may be helpful to those who wish to explore their dreams in more depth.

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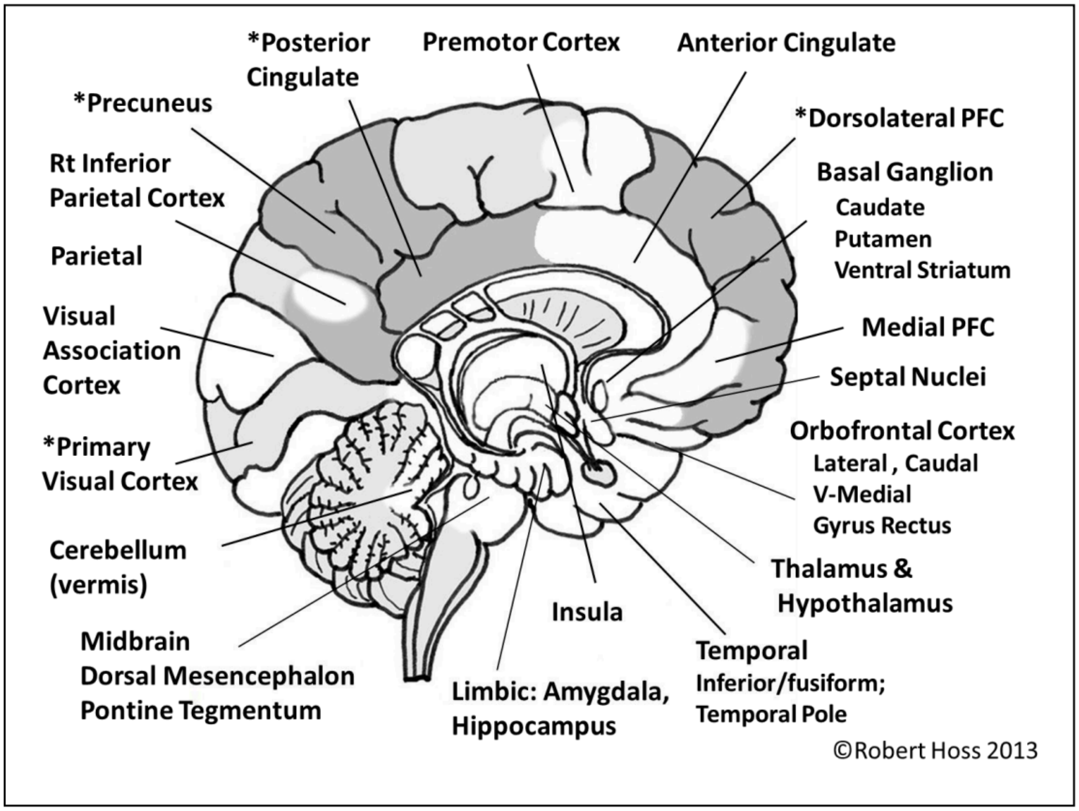
Appendix

Figure 1



Relatively active (white) and *inactive (dark gray) centers of the brain in REM sleep (Hoss, 2013).