Dreaming and Waking Cognition

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Dreams are often believed to be “symbolic” and thus categorically distinct from the “ordinary” thoughts of waking cognition. But to the contrary, emerging evidence suggests that dreams and waking cognition share a common origin at the neurobiological level, which is reflected in similarity of form, content, and function at the phenomenological level. In both dreams and daydreams, memories of the past form the basis of novel imaginary scenarios. Neural networks that support remembering the past, imagining the future, and creating fictitious scenes remain active across conscious states of wake and sleep. Taken together, this evidence suggests that dreaming is a natural extension of waking conscious experience. This empirically supported conception of dreaming has important clinical applications concerning the “interpretability” of dreams in the therapeutic setting.

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The idea that dreams are distinct from waking cognition has been expressed in myriad forms throughout history. In ancient times, dreams were considered to be symbolic messages from the gods. In the early 20th century, Freudian and Jungian approaches considered dreams to be symbolic messages from an equally powerful and enigmatic unconscious. In each of these historical views of dreaming, dream images are elevated to a more “profound” and “meaningful” level than waking cognition. But is this assumption justified?

Even some more modern dream theories have presumed that dreams require special treatment relative to waking thought. In direct opposition to Freudian dream analysis is Alan Hobson’s highly influential “activation synthesis” model of dreaming (Hobson & McCarley, 1977). In this view, dreams are “hallucinations” produced from random neural firings in the brainstem during REM sleep. The cortex then “interprets” these random neural firings after the fact, as best as it can. Although still highly influential, this model has largely fallen out of favor as a result of evidence that dreams are also experienced throughout all stages of sleep, including the deepest stages of non-REM (NREM) sleep (Foulkes, 1962; Wamsley, 2014). But it is worth noting that activation synthesis maintained the assumption that dreams are unique from waking cognition. Here, dreams are considered to be highly chaotic, emotional, and bizarre, relative to waking thought (Hobson, Pace-Schott, & Stickgold, 2000). Thus, even in the first neurobiological theories of dreaming, dream content is considered to be categorically unique from waking cognition.

Yet recent research highlights fundamental similarities between dreaming and waking cognition at the phenomenological and neurobiological levels (Fox, Nijeboer, Solomonova, Domhoff, & Christoff, 2013; Wamsley, 2014; Wamsley & Stickgold, 2010, 2011). At the phenomenological level, memories of waking experience are incorporated into dream content (Stickgold et al., 2000; Wamsley, Perry, et al., 2010; Wamsley, Tucker, et al., 2010). But dreams do not merely “replay” past experiences in original form. In both dreams and waking daydreams, recent and remote memory fragments combine to form novel imaginary scenar-
ios, never before experienced by the dreamer (Stenstrom, Fox, Solomonova, & Nielsen, 2012; Wamsley, Perry, Djonlagic, Reaven, et al., 2010). As we will argue below, this spontaneous combining of recent and remote memory fragments into novel dream scenarios could be a direct reflection of ongoing memory processing during sleep (Wamsley, 2014; Wamsley & Stickgold, 2010, 2011).

There is also overlap between wake and sleep at the neurobiological level. Patterns of regional brain activity are strongly similar during waking rest and sleep. In wake and sleep, the activity of medial temporal and medial frontal memory networks, in concert with reduced executive control, allows the reactivation of past memory, as well as the creation of novel imaginative scenarios (Fox et al., 2013; Nir & Tononi, 2010; Wamsley, 2014; Wamsley & Stickgold, 2010). Such activity extends into sleep, and is therefore hypothesized to form the neural basis of novel dream scenarios (Domhoff, 2011; Fox et al., 2013; Nir & Tononi, 2010; Pace-Schott, 2013; Wamsley, 2014; Wamsley & Stickgold, 2010, 2011).

Importantly, there is a major difference between the “spontaneous” neural activity that is part of our conception of dreaming and the “random” neural activity of Hobson & McCarley’s model (1977). The spontaneous neural activity that we refer to extends across sleep as well as wake, rather than just sleep alone. In addition, such activity is expressed at the level of large-scale brain networks rather than a single region such as the brainstem. Lastly, whereas Hobson and McCarley (1977) view dream imagery as a mere byproduct of random brain signals, we propose a tight functional link between dream imagery and neural activation linked to memory consolidation during sleep. Overall, we suggest that the spontaneously arising content of our waking thoughts and dreams may be a direct reflection of ongoing information processing at the neurobiological level, across wake and sleep (Wamsley, 2014; Wamsley & Stickgold, 2011).

Taken together, these findings suggest that our nightly dreams are not categorically distinct from waking cognition. On the contrary, the dreaming process appears to be an extension of our waking conscious experience (Wamsley, 2014; Wamsley & Stickgold, 2010, 2011). This view of dreaming as a natural extension of waking cognition contrasts with psychoanalytic conceptions of dreams as symbolically disguised expressions of unconscious wishes. In fact, we argue below that there is no compelling evidence that dreams can be usefully “interpreted” in clinical practice. Instead, dreaming is best viewed as a transparent reflection of waking thoughts, feelings, and memories.

**Waking Experience, Memory Reactivation, and Dreams**

Although the popular mantra “practice makes perfect” suggests that active rehearsal is the only way to build lasting memories, there is robust evidence that spontaneous activation of experience during sleep offers an important opportunity for memory processing. Human behavioral studies demonstrate that sleep facilitates memory performance across a wide variety of domains—that is, verbal (Tucker et al., 2006), emotional (Payne, Stickgold, Swanberg, & Kensinger, 2008), perceptual (Mednick et al., 2002), motor (Walker et al., 2002), and spatial (Wamsley et al., 2010). Meanwhile, single cell recordings in rodents demonstrate that waking spatial experiences are “replayed” in slow-wave-sleep (SWS) (Ji & Wilson, 2007; Kudrimoti et al., 1999; Lee & Wilson, 2002). Memory reactivation at the neural level has yet to be explored in humans, but memory-related brain regions are reactivated during sleep (and rest) after human learning as well (Laureys et al., 2001; Tambini, Ketz, & Davachi, 2010). This converging evidence suggests that memories are processed during sleep, which has important implications for the origin of dreaming.

There is evidence to suggest that memories of waking experience form the basis of mental imagery in dreams. First, we know that presleep learning experiences are incorporated into dreams. In the 1960s and 1970s, some of the earliest studies of how waking experience is incorporated into dream content found that, while experimental materials like films and images were not often directly incorporated into dream content (Wamsley & Stickgold, 2009), the laboratory experience itself was a powerful influence on dream content. For example, in an analysis combining data from several prior studies, Dement, Kahn, & Roffwarg (1965) found that 22% of dreams incorporated either isolated elements (10%) of the laboratory sce-
nario or more complex representations combining multiple laboratory elements (12%). This could suggest that dreams are influenced by experiences that are especially novel and relevant to the individual. The real-life scenario of being in a novel laboratory setting, wearing electrodes, and being awakened multiple times throughout the night may have been incorporated into dream content because it was more novel, and more important to participants, than the passive viewing of the experimental films and images.

Indeed, a number of subsequent studies demonstrated that novel learning experiences have a particularly powerful effect on dream content. In early studies from Howard Roffwarg’s laboratory (Bowe-Anders, Herman, & Roffwarg, 1974; Tauber, Roffwarg, & Herman, 1968) subjects wore red-tinted goggles for an extended period of time during wakefulness, which led to altered perceptual qualities during dreaming. Similar effects have been seen on the dreams of subjects who wore prism goggles that invert the visual field for an extended period of time during wakefulness (e.g., Corsi-Cabrera et al., 1986).

More recently, Stickgold et al. (2000) have demonstrated an influence of engaging video games on dream content. In one study, participants played the video game Tetris before falling asleep (Stickgold et al., 2000). Multiple dream reports were obtained during early non-REM (NREM) sleep awakenings. Here, it was found that 64% of participants reported Tetris images in their dreams. Kussé et al. (2012) later replicated this same basic effect of Tetris on sleep-onset dream imagery. Virtual navigation tasks and arcade games have also been used to successfully demonstrate the incorporation of a presleep learning experience on dreaming (Wamsley, Perry, et al., 2010; Wamsley, Tucker, et al., 2010). This evidence provides further support for the idea that novel, engaging learning experiences influence dream content.

Home-collected dream reports also demonstrate a clear effect of waking experience on dream content. In a study by Fosse et al. (Fosse, Fosse, Hobson, & Stickgold, 2003) subjects were asked to identify waking sources of dream elements from 299 home-collected dream reports. Fragments of recent experience frequently appeared in these types of dream reports. Of the 299 dream reports, 51% were judged by subjects to contain at least one element that was directly identifiable with a recent waking event. Other studies have similarly documented the incorporation of waking episodes into home-recalled dreams (Blagrove et al., 2011; Nielsen & Powell, 1988), especially for dreams recalled from NREM sleep (Baylor & Cavallero, 2001; Cavallero, Foulkes, Hollifield, & Terry, 1990). Thus, a link between daily experience and dreaming is evident.

Of course, these are not novel proposals. It has long been suggested that dreams are related to waking experience. But importantly, the popular conception of dreams remains stubbornly rooted in the idea of dreams as a mysterious phenomenon emerging from mechanisms entirely different from those that give rise to waking thought. In contrast, we will continue to argue that mental imagery in dreams originates from the same fundamental mechanisms that produce waking thought and waking memory.

Dreaming Reflects Memory Consolidation in the Sleeping Brain

The reactivation of memory during sleep is thought to lead to consolidation and enhanced memory. If memories are indeed being “replayed” during human sleep, one might predict that the content of dreams is a reflection of this process. Indeed, several studies demonstrate that dreaming about a recent learning experience is associated with improved memory for that information later on (De Koninck et al., 1990; Fiss et al., 1977; Wamsley et al., 2012; Wamsley & Stickgold, 2010). In a study by Fiss et al. (1977) for example, participants whose dreams related to a short story read before sleep exhibited better memory for that story the following day. In an academic setting, De Koninck found that students who demonstrated better language acquisition during a 6-week French language immersion course had a higher frequency of dreams that incorporated French into dream content (De Koninck et al., 1990). More recently, Wamsley et al. demonstrated that dreaming about a virtual maze navigation task is associated with memory improvements after a nap (Wamsley & Stickgold, 2010) or a full night of sleep (Wamsley et al., 2012). Collectively, this evidence suggests that dream content may reflect offline memory consolidation. Importantly, we do not imply that dreaming is the
cause of memory consolidation. Rather, we suggest that dreams may reflect, at the phenomenological level, memory consolidation at the neurobiological level. However, despite this preliminary evidence, the connection between memory consolidation and dreaming has not yet been definitively demonstrated, and further research is needed.

**Memory and Imagination Across Wake and Dreaming**

We have suggested that dreams might reflect memory consolidation during sleep. But neither dreaming nor waking thought can be described as a simple “replay” of past experience. In waking moments of rest, memory fragments form the basis of novel imaginary constructs, as we daydream about possible future scenarios, and create entirely fictitious scenes in our minds during fantasy and creativity (Fox et al., 2013; Klinger, 1971; Singer, 1966). Similarly, during dreaming, disparate memory fragments combine in unique ways to form imaginary scenes, never before experienced by the dreamer (Nielsen & Stenstrom, 2005; Wamsley, 2014). This spontaneous evolution of memory at the phenomenological level during dreaming could be a reflection of the underlying process by which memories evolve into novel forms during sleep (Wamsley & Stickgold, 2011).

Although sleep has primarily been studied as a mechanism of enhancing memory and/or stabilizing it against the effects of interference, it has become increasingly evident that sleep plays a much more complex role than to simply cement experience in its original form. For example, as new word forms are learned, they come to interfere with existing lexical knowledge only after a period of sleep, demonstrating that the integration of new knowledge into existing networks is occurring during sleep (Dumay & Gaskell, 2007). Similarly, when new semantic information is learned (e.g., the meaning of a new word), the interference of this knowledge with existing semantic information is associated with particular features of the sleep EEG (Tamminen, Lambon Ralph, & Lewis, 2013). This gradual interleaving of new information with older memory is thought to require the formation of associations between related items, so that commonalities between those items can be represented in the cortex (Kumaran & McClelland, 2012; McClelland, 1995; Lewis & Durrant, 2011). Indeed, sleep has been demonstrated to play a role in associative memory (Tucker, Tang, Uzoh, Morgan, & Stickgold, 2011), in extracting relationships between items (Ellenbogen et al., 2006), and in facilitating generalization/gist extraction (Payne et al., 2009). Thus, sleep does not merely cement memory in its original form, but rather, facilitates the evolution of memory over time. Future research focused on the evolution of memory across offline periods of both sleep and resting wakefulness will be critical for understanding how memory evolves into novel forms across a continuum of conscious states (Wamsley, 2014).

**Neurobiological Overlap Between Dreaming and Wakefulness**

Dreaming and waking cognition also share a common neurobiological basis. Regional activation of networks involved in both memory and imagination may play a role in the process by which memories combine into fictitious scenarios during dreaming.

The default mode network (DMN) is hypothesized to support thought processes across conscious states of wake and sleep (Domhoff, 2011; Fox et al., 2013; Nir & Tononi, 2010; Pace-Schott, 2013; Wamsley, 2014; Wamsley & Stickgold, 2010, 2011). Most active during resting wakefulness, but relatively deactivated during task engagement (Buckner et al., 2008), this system consists of memory-related regions including the hippocampus, parahippocampus, ventromedial, and dorsomedial prefrontal cortices (collectively the mPFC), posterior cingulate cortices, retrosplenial cortices, temporal-parietal junction, lateral temporal cortex, and temporal poles (Buckner et al., 2008). Although directly linked to spontaneous cognition during wakefulness (Andrews-Hanna, Reidler, Huang, & Buckner, 2010; Mason et al., 2007), indirect evidence suggests that the DMN may be involved in dreaming as well (Domhoff, 2011; Fox et al., 2013; Wamsley, 2014). Functional imaging studies reveal that memory-related regions of the DMN, including the hippocampus, parahippocampus, and medial prefrontal cortex (mPFC), are relatively active in the human brain during sleep (Braun et al., 1997; Maquet, 2000), even during non-REM (NREM) sleep (Noz-
inger et al., 2002), and at greater levels in REM sleep relative to waking levels (Braun et al., 1997; Maquet, 2000). Interestingly, these regions are part of a subsection of the DMN—the “Scene Construction Network” (SCN) – which correlates with the ability to imagine both past and fictitious scenes (Hassabis, Kumaran, Maguire, 2007; Hassabis & Maguire, 2007, 2009; Mullally & Maguire, 2014). Although mere speculation at present, it is tempting to consider the possibility that the scene construction system might provide a neural basis for the generation of novel scenes during dreaming. At the moment, it is unclear whether functional imaging activity observed in both the DMN and SCN indicates actual activation as opposed to inhibition of these areas. Still, the involvement of both the DMN and SCN across wake and sleep hints at the potential involvement of these areas in the evolution of memory into novel forms across conscious states.

**Are Dreams More Symbolic Than Waking Cognition?**

To date, the idea that dreams contain a different kind of content than our waking thought still strongly colors perceptions and attitudes toward dreaming everywhere. Amazon.com sells more than 300 different “dictionaries” of dream symbols, each offering to decode the meanings of specific images, objects, and themes recalled from the reader’s nightly reveries. Thousands of other popular books, emerging from diverse psychoanalytic, spiritual, supernatural, psychological, and new-age perspectives, promise to reveal the secrets of effective dream “interpretation” techniques, by various methods purporting to allow the reader understanding of some deeper meaning which their dreams are attempting to communicate. That said, is it really true that dreams are any more symbolic than our waking thoughts?

Contrary to popular opinion, there is actually no evidence that dream content is any more symbolic than our waking cognition. As we argue here, there is more evidence to suggest that dream content is continuous with waking thought. Rather than containing any special symbolism, it is actually far more likely that, similar to waking cognition, dream imagery is a relatively transparent amalgam of our daily thoughts, feelings, and experiences.

**Applications for Clinical Practice: Do Dreams Have a “Meaning” That Can Be Interpreted?**

A major chasm exists between experimental dream research and clinical practice. More than 100 years after Freud popularized his psychoanalytic dream theory, many clinical practitioners continue to presume that dreams consist of symbolic imagery that can be “interpreted.” A striking number of clinicians employ discussion and interpretation of dreams as a part of their standard treatment approach. In a recent survey, across a broad sample of psychoanalytic and nonpsychoanalytic therapists, clinicians reported using the discussion of dreams in nearly 1/3 of sessions, on average (Schredl, Bohusch, Kahl, Mader, & Somesan, 2000). Yet there is no empirical evidence that dreaming is any more symbolic than other forms of mental experience.

In part, the persistence of dream analysis in clinical practice might stem from a valid intuition that dreaming provides a useful source of information about clients’ personal lives. Indeed, a strong link between dreaming and waking life has been demonstrated experimentally, as we have reviewed above. However, the nature of this link is not captured by the “interpretive” approach to dreaming, which presumes that dreams conceal a hidden meaning that must be discovered through the therapeutic process. Although we do know that memories from waking experience are reflected in dreaming, the genuinely empirical study of dreaming is still too far in its infancy to say much more than that at this time. Furthermore, beyond concerns about the validity of dream interpretation, there is little evidence that dream analysis is therapeutically valuable. For example, in one study comparing the effects of dream therapy, event interpretation, and unstructured therapy sessions, all three types of treatments were found to be equally as effective (Diemer, Lobell, Vivino, & Hill, 1996). This evidence suggests that dream-centered therapy is not uniquely therapeutic per se, but rather, that simply talk-
ing about one’s memories and future concerns in general can have a therapeutic effect.

So, do dreams have “meaning”? In summary, there is little evidence to suggest that dreaming, as opposed to waking thought or fantasy, is especially rich in symbolic meaning. Although discussing dreams with a therapist (or discussing the days events, for that matter) might make a patient feel better, there is no particular reason to think that dreams are harbingers of hidden messages that require expert decoding. However, although dreams may not disguise any “hidden” meaning, in the sense that advocates of interpretation propose, this does not preclude the possibility that dreams are nonetheless “meaningful” in a very different sense of the word. Dreams are certainly not random, uninteresting, or irrelevant to our lives. In fact, as we describe above, it is well established that people routinely dream of the persons, activities, and concerns which occupy them during waking life. Dreams incorporate fragments of recent and remote personal experiences and recombine these into novel creations reflecting (in a transparent fashion) the waking thoughts, experiences, and personality of the dreamer. In this broader sense, the search for meaning in dreams is certainly not futile.

Summary and Conclusions

In this review, we offer evidence for the perspective that dreaming is an extension of waking cognition. At the phenomenological level, both dreams and waking cognition contain a mixture of spontaneously arising thoughts, memories, and concerns. Subsequently, during both dreaming and wakefulness, memories combine spontaneously to provide the basis for novel imagined scenarios. At the neurobiological level, regional patterns of brain activity linked to memory and imagination are active in both waking rest and sleep. This suggests a possible neurobiological basis for the evolution of memory into novel imaginary forms throughout a continuum of conscious states. In light of this evidence, we argue against the perspective that dreams are “enigmatic” or “symbolic,” thereby requiring special treatment in relation to waking cognition. On the contrary, we suggest that dreams are best viewed as a transparent reflection of our waking thoughts, memories, and concerns. In conclusion, we offer an evidence-based view of dreaming, that although devoid of the assumption that dreams are especially symbolic, still maintains that dreams, like our waking thoughts, are nonetheless relevant to the dreamer’s life.

References


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