CONSCIOUSNESS IN DREAMS

David Kahn* and Tzivia Gover†

*Department of Psychiatry, Harvard Medical School, Boston, MA, USA
†Holyoke Community College, Holyoke, MA, USA

This chapter argues that dreaming is an important state of consciousness and that it has many features that complement consciousness in the wake state. The chapter discusses consciousness in dreams and how it comes about. It discusses the changes that occur in the neuromodulatory environment and in the neuronal connectivity of the brain as we fall asleep and begin our night journeys. Dreams evolve from internal sources though the dream may look different than any one of these since something entirely new may emerge through self-organizing processes. The chapter also explores characteristics of dreaming consciousness such as acceptance of implausibility and how that might lead to creative insight. Examples of studies, which have shown creativity in dream sleep, are provided to illustrate important characteristics of dreaming consciousness. The chapter also discusses the dream body and how it relates to our consciousness while dreaming. Differences and similarities between wake, lucid, non-lucid and day dreaming are explored and the chapter concludes with a discussion on what we can learn from each of these expressions of consciousness.

I. Introduction

Dreams have alternately been hailed as messages from the gods and dismissed as random hallucinations. The pendulum of popular opinion has swung from one extreme to the other throughout recorded history and between cultures and

INTERNATIONAL REVIEW OF
NEUROBIOLOGY, VOL. 92
DOI: 10.1016/S0074-7742(10)92009-6

0074-7742/10 $35.00

camps, with scientists, psychologists, sages, and philosophers all weighing in. Aristotle (Gallop, 1996), for one, believed dreams were formed by the dreamer's impaired mind, and Plato (Talbot, 2009) argued that dreams represent a frightening breakdown of reason. In the Victorian era, some scientists posited that dreaming was pathological.

But rather than place dreaming on a mystical pedestal, or look at dreaming as a deficient form of consciousness, it is highly instructive to look at dreaming as an alternative form of consciousness and a different way of thinking.

Though Plato and Aristotle could not have proven it, today we know that the dreaming brain is, in a sense, differently abled. At least two important regions, the dorsal lateral prefrontal cortex (DLPFC) and the precuneus in the parietal lobe, are deactivated during rapid eye movement (REM) sleep, the period when most dreaming takes place.

Because of this, we lack the ability to fully exercise our short-term memory when we dream, both within the dream and upon awakening. This helps explain breaks in continuity during the dream and why it is difficult to recall dreams on waking. Also, we are unable to locate our physical body in space when asleep, which is why the dreamer does not realize her or his body is at home in bed during nocturnal adventures in familiar or fantastical landscapes. Making decisions or directing our will is likewise difficult while dreaming, because of these changes in brain activity during sleep.

Thoughts emanate from and generate attitudes, memories, and feelings from brain activity when awake. When dreaming, the same is true, but with altered brain activity. If these alterations are viewed as imperfections, or evidence that the brain is simply firing on too few cylinders, it is easy to dismiss dream content and write it off. If, on the other hand, dreaming is to be accepted as a different but valuable form of consciousness, there is much to learn, wonder at, and explore.

Thoughts while dreaming may start with neuronal impulses, as waking thoughts do, too. But awake, there are many distractions. Our external senses are alert and highly functioning during waking hours; sights, smells, bodily sensations, and needs externalize our focus. Impulses quickly attach themselves to the waking business at hand. A hunger pang in the stomach may trigger thoughts about what's in the refrigerator, for example.

Asleep and dreaming, the senses are muted if not shut down. Now the impulses are not directed into thoughts by external stimuli, but instead form and flow into an infinite stream of possible images, memories, emotions, and attitudes. Our minds might then react to the brain's output and look for connections between these thoughts, thus weaving the visually and emotionally intense scenarios we know as dreams.

The contents of much of our thinking when awake can fairly easily be attributed to physical and emotional well-being. Our most basic survival depends on our ability to plan, calculate, and even imagine. Waking brain function and thinking enables us to remember where we live, where we stored our food, and how to decide on a safe route of travel. But what about musing, fantasizing, brooding, or even doing Sudoku puzzles—could not we live well enough without these forms of thinking? Surely we could, but without the pleasures of art and play, not to mention doing really difficult puzzles.

And what then of dreams? Anyone who can recall their dreams knows that the detail, visual beauty, and complexity of some dreams are truly astounding. Also, the consistent and widespread experience of people gaining new insights and deeper self-knowledge by reflecting on their dreams is well known. Whether insight and knowledge are made during the dream or later upon awakening, the mind's persistence in searching for connection and making meaning from these images and fantasies seems to point in the direction of dreaming being an inherently valuable form of thinking, one that complements and adds dimension to the thinking achieved during waking hours.

II. How Does Dream Consciousness Come About?

Are you one self or many selves? What is it like to be you? How do you sense yourself in different external environments, in different internal environments? How does the self change when you are watching a sunset, are absorbed in a goal-oriented task such as balancing a checkbook, are listening to Mozart or chanting *kirtan*? How do you sense yourself in these different external environments? Consciousness is the You who you sense as yourself. Consciousness is the inner visual image, inner auditory image, feelings, assumptions, beliefs, opinions, attitudes, and combinations of thoughts and feelings (personal conversation [2010] with Linda Trichter Metcalf, author, with Tobin Simon, of *Writing the Mind Alive*, 2002). Moment to moment, this constellation tells you who you are and helps define your consciousness when awake.

Now consider what is the self when you are asleep and dreaming? In dreaming consciousness, the thoughts, actions, behaviors, beliefs, and associated feelings are often quite different than they are when awake. Hence, one of your selves is your dream self; the self who shows up as the protagonist. Or, more accurately, your dream self embodies one of your many selves.

One goal we set for ourselves is to review how changes in the brain during sleep and dreaming can account for changes in conscious experience. We explore this by noting specific changes that occur in the activation and chemistry of the brain as we fall asleep, and how these changes can account for the changes in the way that the mental and emotional contents of our dreams are expressed. We will see that many of these differences are accounted for by specific changes in the brain as we pass from the wake to the sleep state.

What happens in the brain when we dream? Brain data findings using electro-encephalogram, magnetoencephalogram, positron emission tomography, and functional magnetic resonance imaging suggest how the characteristics of dreaming consciousness come about as a result of changes in brain activation and chemistry.

As we fall asleep, a change in brain activity and brain chemistry begins to occur in parallel with the appearance of dream-like mental activity. Consciousness is already beginning to change at sleep onset. As sleep deepens, the cerebral energy metabolism and blood flow associated with neuronal activity begins to decrease. This is especially so during the slow-wave, also called non-REM (NREM), deep sleep stages 3 and 4. (Even in the deep sleep stages, brain activity remains at 80% of wake levels. The brain, asleep or not, is always active.) The connectivity between brain regions is also reduced in these deep sleep stages. The long-range connectivity between distant brain regions when awake gives way to only local connectivity between adjacent brain regions in deep sleep. This is similar to what occurs under anesthesia having the effect of reducing awareness of sensation and external stimuli on our physical body (Ferrarelli *et al.*, 2010). Long-range connectivity between cortical brain regions is necessary for the integration of information and for communication between distant brain regions in the wake and sleep states.

As we move out of deep sleep, the large, slow brain waves characteristic of deep sleep begin to change, resembling more and more the waves typical of the brain when awake. Appropriately, this wake-like state has been called "paradoxical sleep," because its brain wave structure so much resembles that of the wake brain. This paradoxical sleep stage usually appears about 90 min after falling asleep. This sleep stage has been aptly named the REM stage of sleep, as it is accompanied by REMs and is associated with dreaming. In this REM stage, many of the brain regions whose neural activity diminished as sleep ensued become reactivated (Braun *et al.*, 1997, 1998; Maquet *et al.* 1996; Nofzinger *et al.* 1997). Not all brain regions, however, become reactivated as we move from the deep sleep stages 3 and 4. Instead, there is a *selective* reactivation of neural activity as we move into the REM stage of sleep. This selective re- and deactivation affects dreaming and dream content by changing our short-term autobiographical memory recall, and by changing how we integrate previously learned information. For example, we may combine events from different times in our lives and we may combine different people we know into a blend of one or more people. Physiologically, there is reactivation of the limbic, paralimbic, and amygdala regions, the areas important for producing emotion. The medial prefrontal cortex (MPFC) is also reactivated in REM. It is believed that the MPFC allows for internally motivated behavior, as occurs in our wake lives and in our dreams. An example of internally motivated behavior is one that arises from thoughts, or feelings about ourselves or about some real or imagined behavior of others.

On the other hand, the brain circuit consisting of regions that are important for executive functions, autobiographical memory recall, and goal selection (DLPFC) and for body location (precuneus) is selectively deactivated. Further, during REM sleep dreaming, there is a diminished coupling between frontal, prefrontal, and parietal regions of the brain in the gamma frequency range (Desmedt and Tonberg, 1994; Perez-Garci *et al*., 2001). This decoupling or dissociation between the prefrontal and parietal regions of the brain contributes to the lack of executive control over the unfolding dream scenario. Furthermore, areas that are important for visual processing and emotions are selectively activated while areas needed for full volitional control are not. Thus, we have little volitional control over the feelings and visual imagery that are internally generated while dreaming as the (non-lucid) dream unfolds. However, internally motivated and strongly emotional feelings and imagery are alive and well.

It is perhaps no coincidence that some of the areas that are selectively activated and deactivated during dreaming are involved in the spontaneous generation of music, for example, the generation of improvised jazz. Jazz improvisation has been found to be characterized by deactivation of the DLPFC together with activation of the MPFC (Limb and Braun, 2008). As Limb and Braun (2008) state in their article on the neural substrates of jazz improvisation, "... creative intuition may operate when an attenuated DLPFC no longer regulates the contents of consciousness, allowing unfiltered, unconscious, or random thoughts and sensations to emerge." This is what we believe accounts for some of the innovation and creativity in dreams where the DLPFC is also deactivated. Further, in both dreaming and jazz improvisation, there is a dissociation between the MPFC and the DLPFC, the former being activated, the latter not. With deactivation of the DLPFC, there is minimal focused attention allowing "free-floating spontaneous unplanned associations and sudden insights."

Additionally, while all neuromodulatory brainstem systems are available when awake and engaged in goal-directed behavior, when we fall asleep some of the neuromodulatory brainstem systems shut off. The main neuromodulators in the brain include serotonin, norepinephrine, dopamine, and acetylcholine. These neuromodulators affect cognitive function, mood, attention, the ability to retrieve memories, and the ability to pay attention. When we reach REM, two of these systems completely shut off, specifically the locus coeruleus (LC) neurons and the dorso raphe nucleus neurons, which house norepinephrine and serotonin, respectively. This causes a change in our brain chemistry that affects how our minds process information during the REM stage of dreaming. The LC neurons, for example, play a key role in maintaining vigilance, attention, and decision making. The extreme change in brain chemistry whereby the aminergic system completely shuts down while the cholinergic system remains high contributes to the occurrence of hallucinatory images during dreaming and the reduced ability to recognize implausibility within the dream, for example, encountering talking animals, as well as to a reduced ability to stay focused, such as the difficulty of dialing phone numbers or reading text in dreams. Because the inhibitory aminergic system is shut down and the cholinergic system is not, activity in the dreaming brain during REM sleep is more prone to "errors," that is, more likely to undergo unexpected twists and turns, for example, finding oneself suddenly in another city, and more likely to make uncommon associations within the unfolding dream narrative (Mamelak and Hobson, 1989), such as finding that fish are using snorkels to breathe air while walking on land.

III. What Characterizes Dream Consciousness?

Dreaming consciousness evolves without the intrusion of sensory input. Dreams are clearly emanations from our brain/mind as they do not require external stimulation. Dreams, then, are "all in our heads" (Metzinger, 2009). They take what is in our heads and create stories from it. The contents of our conscious minds are filtered through an altered sleeping brain. So dreams are both a distillation of what our lives consist of without the distractions of the external world and, at times, also entirely new creations put together by self-organizing processes in the dreaming mind without input or direction from external sources. Self-organizing processes are those in which the elements of a system themselves "decide" what comes next. The behavior that emerges comes about through the exchange of information between the interacting elements. In the dreaming brain, reciprocal and re-entrant interactions between neurons lead to new neural activity from which novel neural patterns can emerge. From this ongoing activity, dream images, thoughts, and feelings emerge. These are influenced not only by internal memories, conflicts, and desires but also, importantly, by ongoing wisps of information exchange, for example, the appearance of an unexpected person or animal that pushes the ongoing dream into unexpected directions (Kahn and Hobson, 1993). The dream, in a sense, has a mind of its own.

IV. Characteristics of Dreams

An important characteristic of dreams is that they are hyperassociative, that is, there is a change in the kind of associations that become linked during dreaming. One study explored this through the use of a semantic priming task that measured the reaction time to find a word when it is preceded by a word that is associated with it. The authors of the study used weak and strong associations. For example, a weak association is dog–elephant or hot–temperature. A strong association is dog–cat or hot–cold. The study found that semantic priming was state dependent. Subjects awakened from REM sleep showed greater priming by weak primes than by strong ones during the moments following awakening from REM, the REM carryover period. In other words, primes that were weakly associated with the word that followed it were more rapidly associated than the strong primes during an REM carryover period (Stickgold *et al.*, 1999). Subjects tested during normal wake hours showed greater priming by strong primes, as expected. The authors of the study speculate that this change in the kind of associations that occurred in the REM carryover period is because of the absence of norepinephrine during REM. Norepinephrine is needed to be able to pick out the signal from the noise, in this case to disregard the minimally relevant words. Without the presence of norepinephrine, minimally relevant information became relevant. Hence, unexpected and enhanced associations are likely to occur in the dreaming brain.

Additionally, there is evidence that flexible and creative processing occurs without focused effort in REM sleep dreams. As the dream unfolds, it often contains unexpected associations between dream characters and between dream events. This creativity has been shown to carry over into the wake state where creative problem solving improved if sleep contained REM. Subjects who had achieved REM sleep during a nap did better on a remote associates task (RAT) than those who only had NREM or had no nap at all. In a RAT, subjects are asked to produce a word that is associated with test words. For example, the authors primed the test word “sweet” before sleep by showing the subjects the words “heart,” “sixteen”, and “cookie.” When subjects who were so primed were asked to find a word that is associated with a preceding word in a different RAT, they found the correct word (sweet) most often if they had a nap that contained REM. “REM enhances the integration of unassociated information for creative problem solving” (Cai *et al.*, 2009).

Several other studies, in fact, have demonstrated that after a night’s sleep there is an enhanced ability to solve anagram problems and an enhanced ability to find a hidden rule or obtain an insight that helps solve a difficult problem (Wagner *et al.*, 2004; Walker, 2009a; Walker *et al.*, 2002).

Another important characteristic of dreaming consciousness is that in dreams the dreamer often may engage in logical thought as good as that used when awake, while at the same time the dreamer is uncritical of illogical events and behaviors that are happening in the dream. In dreaming consciousness, therefore, implausible events often go unrecognized by the dreamer during the dream, and remain so until the dreamer awakens (Kahn and Hobson, 2004). Here is an excerpt from a recent dream from one of the authors, which illustrates this dual component to thinking in dreams:

> I am in a plane; my wife is also in the plane, seated farther back. The plane lands at Logan Airport. Then the plane continues to go on before I can get

> off. But now it is a train. I wonder how far the next stop is from Logan. The train, which now is more like a subway, stops, but I miss getting off. I try going from car to car but find that I am in a sort of large empty supply-like room on the train. I wonder if my wife is worried. I finally get off and I am about to call her on my cell phone when I see that there is a call coming in that requires me to hit the answer button.

In this dream, logic is retained in wondering how far it is to get back to the airport, in wondering if my wife is worried, and in wanting to use the cell phone.

But I accept that the plane becomes a train, then a subway car, and then I accept that it no longer resembles a subway car. And I accept that I have a wife (which I do not).

Another feature of dreaming consciousness may be its ability to help in emotion regulation (Walker, 2009b). When subjects were shown photos of faces that expressed different emotions, positive and negative, the subjects who had taken a nap and reached REM sleep were better able to identify positive emotions than subjects who did not reach REM sleep in their naps. In fact, those subjects who did not nap or reach REM sleep reported seeing more negative emotions. This indicates that REM might help in processing negative emotions.

Yet another characteristic of dreaming consciousness is the existence of a theory of mind (ToM), that is, an ability to make an informed guess as to what a person is thinking based on the person's actions (Kahn and Hobson, 2005), for example, the realization that if a colleague is opening a file drawer, that colleague is probably looking for a file. Studies have shown that dream characters interact with each other and have thoughts, feelings, and intentions among themselves and with the dreamer. In one excerpt, a subject reported:

> I was winning in a game of ping pong with my boyfriend, I knew he was thinking that my winning would make me feel good.

This excerpt is an example of the presence of ToM in the dream; the dreamer is able to think about what someone else is thinking about.

Another characteristic of consciousness in the dream state is that people think more about social interactions while dreaming than they do when awake, and that those interactions are often charged with aggression. On the average a dreamer reports almost four characters per dream, five if the dreamer includes him or herself. This points to a wide range of interactions with others in dreams. In a study in which wake reports were elicited by randomly beeping subjects to find out what they were thinking, researchers found that social interactions were reported less in these wake reports than in dream reports (McNamara *et al.*, 2005). Looking at these social interactions occurring in dreams in more detail, the study found that dreamer-initiated aggressions were found to occur only in the

REM and not in the NREM stage of sleep. On the other hand, dreamer-initiated friendliness was reported twice as often in NREM dream reports. Apparently, not only are dreams more vivid in the REM stage but they are also more aggressive. While it is not entirely clear why dreamer-initiated aggressive social interactions are more likely to occur in the REM stage of dreaming, a possible explanation might lie in the selective activation that occurs in REM versus NREM. In REM several affect-laden limbic areas reactivate while they remain deactivated in NREM stages 3 and 4. These affect-laden limbic areas that reactivate in REM but remain deactivated are the medial prefrontal, anterior cingulate, insula, and temporal pole.

V. Dream Consciousness and the Dream Body

Despite the fact that our physical eyes are closed, our senses "asleep," and our body in bed is paralyzed, our dream body can see, hear, taste, smell, move, and feel.

Why do we have a body at all when we are dreaming? After all, the dream is a form of thinking; it is constructed of images, memories, thoughts, and attitudes. Yet not only do we have a body in our dreams, but we have a highly attuned body that can feel texture, taste, run, and make love. It functions very much like our awake body and in some ways even surpasses it. For instance, we can fly in our dreams, fall from tall buildings without getting hurt, disarm powerful opponents, and squeeze through narrow passageways or pedal bicycles up near-vertical inclines. It seems that in dreaming we project our consciousness into the dream body and fully inhabit it.

But how does the dreamer within the dream know where his or her dream body is within the dreamscape? When awake, a person knows where he or she is with the activation of brain regions such as the precuneus in the parietal lobe. In REM sleep dreaming, the precuneus is deactivated. Are there other areas that take over, because almost every area that is active when awake is also active in REM sleep? Does the dreaming brain show us that the brain is more flexible than we think, that there are other ways of getting things done? Or is the explanation that we are so involved in the experience of the dream that our dream body becomes as real as our physical body?

In a number of experiments that induced illusory ownership of fake body parts, we see that consciousness can be tricked into believing that a fake limb is real. In the so-called rubber hand illusion (Slater *et al.*, 2009), the tapping on a person's hidden hand and synchronously on a fake rubber hand led to a feeling of ownership of the fake hand. Similar experiments have shown that this effect is not limited to the hand. When a person's back was stroked while viewing their own body through a mirror display, the person located him or herself to the position of the virtual body being viewed. Further, actual physical stroking is not necessary for this mistaken belief. One need only take the image as one's own, that is, take the image into one's consciousness, to believe it to be happening to oneself and not to someone outside of oneself.

In dreams, something similar appears to be taking place. Images and our place within these images are taken into our consciousness—or we project our consciousness into the images, particularly into the image of the dream body. We do not see images of ourselves—we experience ourselves. We know where we are in space without using the precuneus because we experience the image of ourselves as ourselves. The precuneus is necessary only when we need to know where our physical body is in space. In dreams, the image takes the place of the physical body; it becomes the physical body, at least as far as our dreaming consciousness is concerned. Hence, just as in the rubber hand illusion, we totally believe that the image of the self is the self.

VI. How Do Dream Consciousness and Lucidity Differ from Wake Consciousness?

Lucid dreaming, when the dreamer is conscious that he or she is dreaming, offers a hybrid of wake and dream consciousness. The lucid state is not as stable as the wake or REM states and hence often moves back into either non-lucid dreaming or into waking.

In studying the physiological correlates of lucid dreaming (Voss *et al.*, 2009), it was found that there is a shift of brain activity in the direction of waking as one becomes lucid within REM. A degree of self-reflective awareness occurs such that the dreamer becomes aware that he or she is lying in bed dreaming. In order for this to happen, several brain regions that had become inactive during the REM stage of sleep, such as the DLPFC and the precuneus, reactivate when lucidity emerges in REM. Additionally, during lucid dreaming, compared with non-lucid dreaming, there is an increase in overall cortical connectivity and greater activity in the gamma band of frequencies. The gamma band, around 40 Hz, is a frequency band known to be associated with conscious processing. Its predominance during lucidity indicates that conscious processing is taking place. This processing leads the dreamer to the awareness that he or she is, in fact, dreaming. In short, self-reflective awareness and volitional control re-emerge in the dreamer when there is a reactivation of the DLPFC, an increase in gamma frequency power, and an increase in global cortical connectivity.

Lucid dreaming is unique in that it is perhaps the only time we are fully engaged in dreaming while, at the same time, having access to our awake consciousness. When awake the brain is creating reality, but we do not know it. That is, we are not aware that our brains are actually creating a representation of the physical world. Likewise, in non-lucid REM, we do not know we are dreaming. In non-lucid dreaming, the dreamer believes that he or she is seeing and moving through a real physical space and the dreamer is unaware that this space does not exist, or that the scene emanates from the dreamer's own mind. This belief does not diminish even if some very strange behaviors and events occur. The dreamer is not aware that he or she is lying in bed asleep (unless the dreamer becomes lucid).

This unawareness rarely happens during focused wake behavior, though it may emerge during the wake state when the mind is wandering or when fantasizing or when engaging in a guided visualization.

Consciousness when awake proceeds within a known world. We predict what is going to happen next and develop over time a model of the world from sensory input and learned experience. We know what to expect. In fact, we become so certain of our predictions that if the unexpected happens we may not even notice it. This is especially so if we are fully engaged in a task, as shown in the study in which viewers were attentive to the number of times members of two teams passed a basketball in a basketball game. The viewers were unaware of a person dressed in a gorilla costume walking on the basketball court between the players (Simons, 2010).

In those cases when, in fact, we do notice something unexpected, we are surprised or even startled by this unexpected event. Often we will try to find a reason for its occurrence, for example, this is an opera and unusual things happen in an opera. In dream consciousness, on the contrary, we do not take much notice of unusual events.

As the philosopher and scientist Thomas Metzinger says, consciousness situates us in the world: in the wake world when we are awake and in the dream world when we dream. When we dream we no longer have a model that is entirely based on learned knowledge of what is and what is not expected to occur. Further, sensory perceptions are not brought in from the wake world to help orient us. Importantly, even though the brain makes the dream, it is not recognized as a model but as a reality (Windt and Metzinger, 2008). Sometimes the reality is questioned because of its bizarreness, but the dreamer may concoct an equally bizarre explanation for rationalizing it away, thus remaining in the dream.

At other times, however, when the dreamer becomes lucid, he or she recognizes the dream as a dream, that is, as a model of reality. There are different degrees of lucidity, ranging from the recognition that one is dreaming to directing the course of the dream, that is, to having volitional control over the narrative of the dream.

In the following dream report it is the bizarre elements in a dream that cue the dreamer into the fact that she is dreaming:

> My sister and I are standing outside my house, in a quiet suburban neighborhood. As we stand talking to one another, a subway train zooms on a perpendicular trajectory through the street and up into the sky. I look at the train, then turn to my sister and say, "Wow, that's weird!" I add, "Have you ever seen a subway car shoot up vertically like that?" She doesn't answer, but clearly she has never seen such a thing. I can tell that she's trying to come up with some kind of logical explanation for what we've just seen. Then I say, "There's only one explanation! It's a dream." But my sister is no longer listening to me. I get more excited. "Joanne, this is your opportunity to wake up! Wake up within the dream!" But she just shakes her head, rejecting my suggestion. I tell her to look into my eyes. "We're in this dream together!"
>
> For the rest of the night I have dreams in which I find my sister and try to get her to remember the dream we were in together.

Another lucid dream experience is catalyzed by a false awakening, in which the dreamer believes she has woken up, but then realizes that she is in fact still sleeping:

> I wake and look through my open bedroom door into my study. There I see a stranger standing in the room. I am frightened, but then realize I am not awake after all, but am still dreaming. I see that the stranger has his back to me, and since I now know I'm dreaming, I decide who this person will be. I decide it will be my brother. When the man turns around it is indeed my brother. I say, "Come on, let's fly. It's easy." So my brother and I fly down the stairs to the front door. I suggest we fly through the wall, instead. I instruct my brother: "Just imagine that it's a door and go through it." Together we fly around the front lawn, over the shrubs and so on. Now I wonder whether this is in fact a lucid dream or an Out of Body Experience (OBE). If it is an OBE, I wonder if the neighbors would see us flying, if they should look outside in our direction.

In this dream, the false awakening prompts lucidity within the dream. Once the dream becomes lucid, the dreamer contemplates yet another possibility, that of an OBE.

Importantly, the forms of consciousness we have explored here —wake, lucid, and non-lucid—complement each other in the sense that each offers a unique perspective on life's experiences. Goal-oriented, purposeful behaviors are best done during wake consciousness. Experiencing the impossible—flying, time travel, morphing into animal form, and engaging with the deceased—is generally possible only in dreaming consciousness. Lucidity allows us to peek behind the veil that separates waking and dreaming consciousness—and to experience two forms of consciousness simultaneously.

VII. What We Can Learn from Dream Consciousness

Science gives us a great deal of information about the brain's neural activity and chemistry when dreaming. It can explain why dreams are heavy on emotion and light on logic, for example. But science is still groping for an understanding of why we dream and what, if anything, can be made of dream content. Comparing the brain's activity and function, and the resulting states of consciousness when awake, in normal REM sleep, and when lucid dreaming, we find similarities and differences in brain activity and function in each of these states that help provide us with a richer understanding of consciousness.

While dreaming we are not constrained by what we know is possible. Even if there were no carryover into wake behavior, while dreaming we benefit by thinking the unthinkable and, importantly, believing it and experiencing it.

And sometimes this exposure to an "unreal" world may lead to an infusion of fresh ideas, as has been shown in many cases where scientific and artistic inspiration came through dreams. Even if the highly rational perspective were true, and dreams have no inherent meaning, people often gain insight into themselves by looking at the dream after waking, just as after we read a book, recite a poem, or look at a painting we gain insight into ourselves and the world.

Dreaming consciousness, especially lucid dreaming consciousness, provides another way for the brain-mind to understand itself. Unlike the wake brain-mind that relies on external sensory input and on the activation of specific brain regions to locate itself in space, these are not all available to the brain-mind while asleep and dreaming. Yet, we certainly are aware of where our dream body is in dream space (you are in your childhood home, outdoors planting a garden, or in your ninth-grade history classroom). What in dream consciousness is letting you know where your dream body is? What do these alternative ways of proprioceptively locating the dream body tell us about consciousness? What does it tell us about how the brain-mind works? And when we lift the veil that guards the transparency of our representation of the physical and dream worlds by becoming lucid, how does this lucidity inform us about the underlying brain basis for consciousness? Surely, addressing these questions will help provide a way for the brain-mind to better understand itself.

In each of these expressions of consciousness, its brain basis is clear, even if not yet fully elucidated. The brain is a dynamic pulsating living organ whose cells mutually interact within a neurochemical milieu that affects the expression of consciousness, as do the neuronal networks that are and are not engaged. For example, when awake, a network consisting of the fronto-parietal-hippocampal regions becomes engaged for performance on a task that requires recall and learning; when awake and the mind is wandering, the medial parietal and medial prefrontal cortices become engaged for stimulus-independent mind wandering; when in REM sleep, the DLPFC and precuneus regions do not reactivate even though most other brain regions do. Further, during REM, the brain switches from cholinergic–aminergic to purely cholinergic. If lucidity occurs during this REM dream, there is partial reactivation of the prefrontal and parietal regions to give yet another expression of consciousness.

So, as Aristotle and Plato believed, the brain of the sleeping dreamer is, in fact, different, though as we have seen, it is not disabled. It is differently abled by virtue of its changing dynamics and neurochemistry. Dreaming, it can be argued, is, in fact, a no-holds-barred form of thinking that is often visually rich, emotionally charged, creative, associative, and seemingly boundless in its content and creative configurations. In particular, dreaming consciousness affords us the ability to be a part of and experience a world unconstrained by the realities of the wake physical world—and, when awake, to use the images and stories we have created while dreaming. Although easy to dismiss as meaningless hallucination, and although easily forgotten, dreams allow us to experience things beyond our abilities in waking reality, and beyond the laws of physical science and nature. Dreams give us the opportunity to bring into the physical world the insights and the creative and original perspectives contained within them.

References

Braun, A. R., Balkin, T. J., Wesensten, N. J., Carson, R. E., Varga, M., Baldwin, P., Selbie, S., Belenky, G., and Herscovitch, P. (1997). Regional cerebral blood flow throughout the sleep–wake cycle. *Brain* **120**, 1173–1197.

Braun, A. R., Balkin, T. J., Wesensten, N. J., Gwadry, F., Carson, R. E., Varga, M., Baldwin, P., Belenky, G., and Herscovitch, P. (1998). Dissociated pattern of activity in visual cortices and their projections during human rapid eye-movement sleep. *Science* **279**, 91–95.

Cai, D. J., Mednick, S. A., Harrison, E. M., Kanady, J. C., and Mednick, S. C. (2009). REM, not incubation improves creativity by priming associative networks. *Proc. Natl. Acad. Sci. U.S.A.* **106**(25), 10130–10134.

Simons, D. J. (2010). DVD Gorilla movie. http://viscog.beckman.illinois.edu/flashmovie/15.php

Desmedt, J. E., and Tonberg, C. (1994). Transient phase locking of 40 Hz electrical oscillations in prefrontal and parietal human cortex reflects the process of conscious somatic perception. *Neurosci. Lett.* **168**, 126–129.

Ferrarelli, F., Massimini, M., Sarasso, S., Casali, A., Riedner, B. A., Angelini, G., Tononi, G., and Pearce, R. A. (2010). Breakdown in cortical effective connectivity during midazolam-induced loss of consciousness. *Proc. Natl. Acad. Sci. U.S.A.* **107**, 2681–2686.

Gallop, D. (1996). Aristotle: On Sleep and Dreams. Aris & Phillips LTD, Warminster, UK.

Kahn, D., and Hobson, J. A. (1993). Self-organization theory of dreaming. *Dreaming* **3**, 151–178.

Kahn, D., and Hobson, J. A. (2004). State-dependent thinking: a comparison of waking and dreaming thought. *Conscious Cogn.* **14**, 429–439.

Kahn, D., and Hobson, A. (2005). Theory of mind in dreaming: awareness of feelings and thoughts of others in dreams. *Dreaming* **15**(1), 48–57.

Limb, C. H., and Braun, A. R. (2008). Neural substrates of spontaneous musical performance: an fMRI study of jazz improvisation. *PLoS ONE* **3**(2), 1–9.

Mamelak, A. N., and Hobson, J. A. (1989). Dream bizarreness as the cognitive correlate of altered neuronal behavior in REM sleep. *J. Cognit. Neurosci.* **1**, 201–222.

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

McNamara, P., McLaren, D., Smith, D., Bowen, A., and Stickgold, R. (2005). A "Jekyll and Hyde" within: aggressive versus friendly interactions in REM and non-REM dreams. *Psychol. Sci.* **16**(2), 130–136.

Metzinger, T. (2009). The Ego Tunnel. Basic Books, New York.

Nofzinger, E. A., Mintun, M. A., Wiseman, M. B., Kupfer, D. J., and Moore, R. Y. (1997). Forebrain activation in REM sleep: an FDG PET study. *Brain Res.* **770**, 192–201.

Perez-Garci, E., del-Rio-Portilla, Y., Guevara, A.M.A., Arch, C., and Corsi-Cabera, M. (2001). Paradoxical sleep is characterized by uncoupled gamma activity between frontal and perceptual cortical regions. *Sleep* **24**(1), 118–126.

Metcalf, L. T., and Simon, T. (2002). Writing the Mind Alive: The Proprioceptive Method for Finding Your Authentic Voice. Ballantine Books, New York.

Slater, M., Perez-Marcos, D., Ehresson, J. H., and Sanchez-Vives, M. (2009). Inducing illusory ownership of a virtual body. *Front. Neurosci.* **3**(2), 214–220.

Stickgold, R., Scott, L., and Rittenhouse, C. (1999). Sleep-induced changes in associative memory. *J. Cognit. Neurosci.* **11**(2), 182–193.

Talbot, M. (2009). Nightmare scenario: learning to rewrite our bad dreams.The New Yorker November 16, 43.

Voss, U., Holzmann, R., Tuin, I., and Hobson, J. A. (2009). Lucid dreaming: a state of consciousness with features of both waking and non-lucid dreaming. *Sleep* **32**(9), 1191–1200.

Wagner, U., Gais, S., Halder, H., Verleger, R., and Born, J. (2004). Sleep inspires insight. *Nature* **427**, 352–355.

Walker, M. (2009a). Sleep dependent memory integration. *Front. Neurosci.* **3**(3), 418–419.

Walker, M. (2009b). REM, dreams and emotional brain homeostasis. *Front. Neurosci.* **3**(3), 442–443.

Walker, M. P., Liston, C., Hobson, J. A., and Stickgold, R. (2002). Cognitive flexibility across the sleep–wake cycle: REM-sleep enhancement of anagram problem solving. *Brain Res. Cogn. Brain Res.* **14**, 317–324.

Windt, J. M., and Metzinger, T. (2008). The philosophy of dreaming and self-consciousness: what happens to the experiential subject during the dream state? In: New Science of Dreaming, vol. 3 (B. Deirdre and N. McPatrick, eds.), Greenwood Press, London.