1 Definitions, Distinctions, and Limitations

Introduction

This chapter lays the groundwork for the seven detailed chapters that follow. Those seven chapters focus on the several dimensions of the theory and on the many empirical studies that support each of those dimensions. Then, the final three chapters demonstrate that many of these studies raise doubts about the assumptions underlying alternative theories. This order of presentation makes it possible to state the theory in a more direct and hopefully a more clear fashion, and it postpones any back-and-forth arguments about other theories. This approach also may provide readers new to the topic with a basis for drawing their own conclusions concerning the assumptions and research studies that provide the starting points for the other theories of dreaming.

This chapter begins with an overview of the several different types of thinking that occur during waking. It then discusses the many different types of mental activity that occur throughout the night and how they do or do not relate to dreaming. These definitions and distinctions serve as a starting point for more precise statements in later chapters, which factor in the neural substrates and cognitive processes that support different types of mental activity. The comparisons of the various forms of thought during waking and sleep lead to a definition of dreaming within a neurocognitive theoretical framework. The contrast between dreaming and all forms of waking thought provides a context for concluding it is necessary to guard against a "wake-state bias" before drawing any conclusions about dreaming (Windt, 2015).

These early sections of the chapter set the stage for explaining why many cognitive neuroscientists believe it is necessary to create a "foundational" theory, based on representative samples of nonclinical populations. In the

case of dream research, this approach bypasses the use of any psychiatric conditions as a way to understand dreaming. The chapter concludes with a discussion of the unusual combination of limitations researchers face in studying a unique mental state. To date, there is no known way to induce dreaming, as is possible with most waking cognitive processes. Nor can dreaming be observed by researchers, or reported upon by dreamers, while it is happening. As of now, and for the foreseeable future, the fact that dreaming has occurred can only be known to a research scientist with a very high degree of certainty if a research participant recalls a dream and is willing to report it as fully and accurately as possible.

Mental Activity during Waking and during the Night

There are two general types of thinking during waking, both of which have several slightly different subtypes. Directed thinking is task-oriented and goal-oriented. It usually concerns issues presented by the external world. Goal-directed thinking is also hierarchical "in the sense that it aims at the achievement of a number of goals and subgoals" (Christoff, 2014, p. 319). Internally generated thought, on the other hand, is often internally focused and spontaneous. However, it sometimes involves thinking through complex issues related to the waking world as well. Internally generated thought includes mind-wandering, which is characterized by frequent topic changes and underdeveloped thoughts. Daydreaming is a more specific and sustained form of mind-wandering, which is more likely to focus on personal concerns and to simulate those personal concerns in scenarios that have a narrative flow (Klinger, 2009; Singer, 1975). Creativity is a hybrid form of thought, which may begin spontaneously and remain internally focused for varying degrees of time. Eventually, creativity involves aspects of directed thought, which gives this hybrid state a back-and-forth quality in terms of the neural substrates that support it (Abraham, 2018; Beaty, Chen, Qiu, Silvia, & Schacter, 2018; Christoff, 2014; M. L. Meyer, Hershfield, Waytz, Mildner, & Tamir, 2019).

Just as there are several forms of waking thought, there are several different forms of mental activity during sleep. More exactly, there are several forms of mental activity during the night, which begin with the fact that some thinking occurs during one or more of the several brief arousals throughout the night. Brief arousals can last from a few seconds to 30

seconds or more, and they occur from childhood through adulthood (Bliwise & Scullin, 2017, pp. 26–27; Mathur & Douglas, 1995). The thoughts during brief arousals are often benign and are soon forgotten, but they can include frightening thoughts, expressions of concern over the next day's tasks, or general worries about the future. On rare occasions they include hallucinations, and the person is able to describe the contents (Iranzo, 2017, p. 1011). Brief arousals sometimes include talking that is not part of the dreaming process, as first verified through immediate questioning of the participants in studies in a sleep-dream laboratory (Arkin, 1981).

Nor do "sleep terrors," which are experienced by a significant minority of children in the first two or three years of life, and nearly 1% of adults, occur during sleep. They usually occur early in the night. They are "accompanied by a piercing scream," or crying, along with a "behavioral manifestation of fear." However, those who go through this experience usually have "little or no memory of the event" once they are calmed or when they wake up in the morning (Vaughn & D'Cruz, 2017, p. 583). Once thought to be nightmares, these frightening events are instead "disorders of arousal" (Avidan, 2017; Roger Broughton, 1968; C. Fisher, Kahn, Edwards, & Davis, 1973).

The vivid and often upsetting mental imagery and thoughts that accompany sleep paralysis are not a form of dreaming either. Sleep paralysis occurs when the sleepers have "complete awareness of their surroundings," or while "feeling partially asleep with awareness." And yet, they are "unable to move even the fingers or to vocalize" (Vaughn & D'Cruz, 2017, p. 582). Episodes of sleep paralysis often happen during the morning awakening. Those who experience sleep paralysis cannot move because of an inhibition of muscle movements (atonia). Atonia occurs during one particular stage of sleep, which is called "REM (rapid eye movement) sleep" because of the fast and erratic eye movements that are one aspect of it, as discussed in the next chapter. However, REM-based atonia usually subsides during an awakening. In other words, on some occasions it is possible to be mentally awake and yet retain the atonia that accompanies REM sleep. Although sleep paralysis is often very frightening, it can include feelings of warmth, with a sensual tinge, along with the sense that there is some human, animal, or alien in the room.

In addition to these three types of wake-like mental activity during the course of a night's sleep, there are several different types of mental activity during sleep, as discovered through planned awakenings in sleep-dream

laboratories. Sometimes participants may report isolated, static mental imagery, which is usually visual in nature. At other times they may report a single thought or say they were thinking (Kamiya, 1961). There is also sleep talking during sleep. Sometimes it is related to ongoing dream content, as revealed by the dream reports that are collected after awakenings during the sleep-talking episode. At other times, sleep talking is not related to dreaming, as also documented by immediate awakenings in a sleep-dream lab (Arkin, 1981).

Along with the static imagery, brief thoughts, and sleep talking that occur during sleep, participants sometimes report mind-wandering after planned awakenings. They usually do not experience this mind-wandering as dreaming, even though they may report a degree of narrative flow in this form of thinking during sleep (Rechtschaffen, Verdone, & Wheaton, 1963). The fact that there can be mind-wandering during both waking and sleep is a useful discovery with regard to the construction of a neurocognitive theory of dreaming.

What Is Dreaming? A Neurocognitive Definition

There are over a dozen different definitions of dreaming. They range from very general definitions that encompass any form of mental activity that is reported after an awakening to more circumscribed definitions that emphasize a series of sensory mental images that have a narrative-like structure (Pagel et al., 2001). Based on the above discussion of the various kinds of mental activity that occur during both waking and sleep, dreaming is most generally defined within the context of the neurocognitive theory of dreaming as a unique form of spontaneous, internally generated thought. It shares features in common with mind-wandering and even more with daydreaming, although dreaming more frequently involves ongoing personal concerns (Fox, Nijeboer, Solomonova, Domhoff, & Christoff, 2013). More specifically, dreaming is defined in the neurocognitive theory of dreaming as an intensive and enhanced form of mind-wandering and daydreaming, in which dreamers experience themselves as being in hypothetical scenarios that almost always include other human beings and/or animals. In addition, the other human beings and animals are usually interacting with the dreamer in the context of vivid sensory environments.

The evidence for the usefulness and accuracy of this definition of dreaming is presented in chapters 2 and 3. Dreaming can occur during the

sleep-onset process, which shares aspects in common with waking, and is not yet sleep. Dreaming also can occur for at least several seconds during periods of drifting waking thought, when the participant is alone in a controlled laboratory setting. These findings suggest that sleeping and dreaming are not inherently connected, although the conditions leading to dreaming occur most frequently during sleep.

Guarding against a Wake-State Bias

Due to the unique nature of dreaming, it is essential to avoid sliding into a "wake-state bias" in theorizing about the content, meaning, and possible adaptive functions of dreaming. The wake-state bias involves "The practice of projecting beliefs about waking experience onto dreaming without critical reflection or solid empirical evidence" (Windt, 2015, p. 200). This bias seems to make sense to most people and is compelling because dreams appear to be based on perceptual information, just as thinking often is during waking. As a result, the experience often feels as if it is "real." In addition, dreams often contain settings, objects, and activities that occur during waking, such as home settings, familiar furniture, and social interactions with family members and friends. Interpersonal interactions give dreaming a sense of familiar narrative content, which also has parallels with waking thought. More generally, dreams create a "subjective impression of verisimilitude" (Windt, 2015, pp. 309–310). Finally, and just as important as any of the other factors, the "linguistic form of dream reports and their formulation in the first-person, past-tense," leads people to "inadvertently import wake-state bias into theoretical accounts of dreaming." People thereby lay "the groundwork for regarding dreams as meaningful and personally significant experiences alongside waking experiences" (Windt, 2015, p. 500).

Based on the sense of verisimilitude within the dreaming experience, the concept of wake-state bias can be extended to include issues such as the appearance of metaphor and emotions in dreams, which are discussed in chapters 5 and 8. It also may be relevant in the case of one or more of the adaptive theories of dreaming discussed in chapter 10.

Foundational Models and Transitional Models

This book makes use of a distinction between "foundational" and "translational" research, which is often employed in cognitive neuroscience. Foundational research is focused on building "a model of normal behaviors,

typically in normal adults"; translational research concerns "translating that model to a population of interest" (Ochsner & Kosslyn, 2014a, p. 481). This two-step strategy "allows initial research to focus on understanding core processes—considered in the context of different levels of analysis" (Ochsner & Kosslyn, 2014a, p. 482). Within this framework, the neuroimaging studies used in building the neurocognitive theory of dreaming are based on large samples from normally functioning adults, adolescents, and children. The studies of dream content are based on large samples obtained from similar types of participants. Virtually all of the studies have been replicated at least once. The few exceptions are clearly indicated when they are discussed.

Based on this distinction, psychiatric patients and their various symptoms, such as hallucinations, delusions, and confabulations, are not useful for comparisons with dreams. These abnormalities may be due to many different factors, not all of which are likely known as yet. Psychiatric conditions are also problematic because they involve a comparison of an unusual waking state with a normal cognitive process, which occurs spontaneously when several conditions are met. Although such comparisons sound plausible at first glance and often have been made in Western philosophy and medicine for at least the past several centuries, they have turned out to be superficial and wrong, as shown throughout this book.

The two exceptions to the exclusion of those diagnosed with one or another psychiatric illness are noted at the places where the studies of them are cited. The first and most important exception occurs in a lengthy discussion in chapter 2, which focuses on the impact of brain lesions on dreaming. Most of the patients discussed are people who experienced lesions due to accidents or strictly neurological pathologies. However, one subset of these patients was subjected to a form of neurosurgery. This surgical procedure was used with psychiatric patients from the late 1930s to the early 1960s in the United States, Canada, and parts of Western Europe. Secondly, there are also references to neuroimaging and electroencephalogram (EEG) studies of patients suffering from posttraumatic stress disorder (PTSD).

The Limitations on Scientific Studies of Dreaming and Dream Content

Every scientific field faces one or more unique barriers, which often can be dealt with through new and constantly improving instrumentation. However, there is a unique combination of obstacles inherent in dream

research. This is the case even though new technologies first made the scientific study of dreaming and dream content possible in a systematic way. Even with a focus on foundational studies, the confluence of issues facing dream researchers place limits on how much technological advances can do to overcome the difficult challenges dream research faces. These obstacles keep dream research on the margins in the neurocognitive and psychological sciences.

Foremost among the limits on dream research, there are very few instances in which dream researchers have been able to do experiments. They cannot manipulate independent variables because it is not possible to make dreams happen. Nor are there any physiological or behavioral measures that can serve as reliable and valid dependent variables. In the face of these problems, experimental studies are sometimes attempted but they often cannot provide adequate controls for potential confounding factors. (The occasional claim that topics or images suggested to participants can be detected in brain-wave patterns are based on small pilot studies (e.g., Horikawa & Kamitani, 2017; Horikawa, Tamaki, Miyawaki, & Kamitani, 2013). Any possibility that dream content might be traced through brain patterns in any useful detail remains a distant future possibility.)

Therefore, the only way to know the effects of any manipulations of variables is through verbal reports by participants. However, participants do not invariably recall a dream or may in some instances choose to alter or omit parts of their dream report. There are also problems in collecting large numbers of dream reports using either questionnaires or two-week dream diaries. These problems are discussed in the relevant contexts in later chapters. Moreover, there may be limits on the human ability to make accurate judgments about personal memories in general (Alexandra & Chua, 2018), which makes it problematic to rely on dreamers' judgments about their dream reports. Such judgments are based on metamemory and involve some of the most recently evolved prefrontal areas, including the frontal pole (Mansouri, Koechlin, Rosa, & Buckley, 2017).

Some scientific fields depend very heavily on direct observations by researchers, aided in more recent decades by sound-activated audio technologies and/or movement-activated visual equipment. Obviously, however, dreams cannot be observed while they are happening. Nor can participants make reports of ongoing subjective experience as it is unfolding, as is possible in many waking studies in other fields within psychological science.

Still, as noted at the outset of this section, the study of dreaming is similar to other scientific fields of research in that it has been aided by advances in technology. By the late 1950s, the widespread use of the polysomnograph (which records electrical wave patterns from the brain, the heart, muscles, and eyes) made it possible to map the stages of sleep throughout the night and to do detailed studies of the sleep-onset process. The polysomnograph also made it possible to collect dream reports in a more controlled way in sleep-dream laboratories and to detect the specific types of brain waves (discussed in chapter 2) that are present during drifting waking thought, the sleep-onset process, and dreaming. Neuroimaging studies in the 1990s made it possible to move beyond, and even supersede, the general electrical patterns provided by the EEG. Neuroimaging studies therefore are given a primary role in this book, although past EEG findings are incorporated into the context provided by neuroimaging findings whenever it is possible. At about the same time as neuroimaging technologies became more generally available in the 1990s, the growing availability of desktop computers made it possible to do faster and more accurate quantitative analyses of very large samples of dream content almost instantaneously, as well as to use more sophisticated ways to determine *p* values and effect sizes (Noreen, 1989).

With the necessary definitions and distinctions clearly in mind, along with the limitations facing dream research, the next seven chapters provide a gradually unfolding account of the neurocognitive theory of dreaming.

The Neurocognitive Theory of Dreaming

The Where, How, When, What, and Why of Dreams

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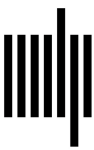

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