


P R E F A C E

Sleep was once a phenomenon of considerable interest to psychologists. One of Freud's most popular books (and arguably one of his best) dealt with dreams. In the classic 1924 study by Jenkins and Dallenbach, sleep provided convincing evidence in favor of the interference theory of forgetting. More than 50 years later, and almost a century after Freud, some of the most frequently asked questions in the introductory psychology course concern what dreams mean and why we seem to forget them. Despite impressive advances in understanding sleep as a biological phenomenon and in understanding the nature of mental processes in the normal waking state, our knowledge of mental life during sleep remains extremely impoverished.

Much of the current scientific interest in sleep can be traced to the discovery in 1953, by Aserinsky and Kleitman, of the association between rapid eye movements and dreaming. Ironically, however, the discovery of physiologically different sleep stages, and their differential association with dreaming and other mental activities, seems to have transformed sleep from a psychological topic to a biological one. A great deal of work addresses sleep as behavior at a purely biological level, as in studies of the ontogeny and phylogeny of sleep and other biological rhythms. And many major medical centers offer the services of a sleep disorders clinic oriented toward such problems as insomnia (a common symptom in depression and normal aging), narcolepsy, sleep apnea, and parasomnias such as enuresis and somnambulism. But surprisingly little current research focuses on perceptual, memory, and thought processes during this period of activity. There is, of course, a long tradition of work by psychologists on the effects of sleep deprivation on human performance. But research on cognitive processes during sleep itself has received comparatively little attention, both on the conference circuit and in print. Examination of *Sleep Research*, the annual archival publication of the Association of Professional Sleep Societies, reveals relatively little cognitive psychology. Similar trends are apparent in the published proceedings of the biennial European Conferences on Sleep Research and in the volumes of *Advances in Sleep Research*. There is, of course, a large literature (arising primarily from within the psychoanalytic tradition) concerning the interpretation of dreams. Unfortu-

nately, the methodology in these studies is generally clinical and hermeneutic, without the careful controls characteristic of experimental psychology.

Nevertheless, important questions about sleep persist that must be addressed at a purely psychological level: How much information from the environment can be processed by the sleeper? What sorts of mental activities are associated with sleepwalking and sleeptalking? Are dreams meaningful, and if so why aren't they better remembered? What are the possibilities for learning during sleep? Such questions have been asked by psychologists and others, but only rarely have they been addressed with the concepts, principles, and methods of contemporary cognitive psychology. One factor contributing to this situation is the isolation of psychoanalysis, with its interest in dreams, from mainstream scientific psychology. Another is the phenomenology of sleep itself: The sleeper typically appears oblivious to his or her environment, and the occurrence of sleep is generally inferred from this lack of responsiveness and the absence of conscious awareness of events during sleep. The common identification of cognition with consciousness leaves the impression that little or no mental activity occurs during sleep.

Of course, studies in which sleepers are awakened at various points in the night's sleep typically yield reports of thoughts, images, and dreams, but these are rarely remembered spontaneously in the morning. Some individuals engage in episodes of sleepwalking and sleeptalking, which can involve relatively complex speech acts and behavioral sequences—but, again, these are rarely if ever remembered. One explanation for this universally experienced memory deficit is that the cortical centers that mediate complex mental processing are disengaged or deactivated during sleep, with the result that the sleeper does not attend to environmental and mental events occurring during periods of sleep. Because these events are not noticed, they are not processed in a manner that encodes accessible traces of them in memory.

Thus, the most commonly accepted explanation of postsleep amnesia is in terms of consolidation failure. For example, it has been proposed that the low level of cortical arousal characteristic of sleep effectively prevents the sleeper from performing the cognitive operations necessary to encode memory traces of sleep events that are accessible in the subsequent waking state. According to this view, dreams and other sleep events are remembered only when the sleeper awakens during them, permitting retrieval from short-term memory. If the sleeper awakens shortly after a dream has occurred, residual information retrieved from short-term memory may serve as a cue to the retrieval of a highly degraded long-term memory trace. If retrieval is delayed until all traces of the dream have decayed or been displaced from short-term memory, the long-term traces will be virtually inaccessible.

As intuitively appealing as this explanation is, recent empirical work on sleep, as well as theoretical advances in the study of cognition, call it into account. For example, the idea of consolidation failure assumes a rigid distinction between short-term and long-term memory that is not supported by the

current literature. Moreover, cognitive theorists have recently begun to distinguish between effortful processes, which require intention and consume attentional resources, and automatic processes, which do not. More important, the domain of automatic processing has expanded to include rather complex mental activities—the kind that ordinarily would be expected to leave residual traces in permanent memory. Finally, studies of both brain-damaged patients and intact subjects support a concept of implicit perception and memory, in which current and past events may influence ongoing experience, thought, and action even though the individual lacks awareness (concurrent or retrospective) of the events themselves.

Recent research on sleep processes bears directly on these theoretical ideas. While sleepers are ordinarily considered unable to engage in complex, intentional cognitive activities during sleep, some evidence tends to contradict this assumption. For example, in the phenomenon of lucid dreaming, selected subjects report that they become aware of the fact that they are dreaming and are able to consciously direct the contents of the dream, while remaining asleep. This claim is difficult to verify objectively, for obvious reasons. But a series of highly provocative and apparently well-controlled studies has shown that subjects can make discriminative responses to verbal suggestions delivered while they are asleep. Although the possibility of sleep learning had been firmly rejected in a widely influential review published in 1955, studies of memory of events occurring during surgical anesthesia strongly suggest that sleep learning may be possible, provided that its success is measured in terms of implicit rather than explicit memory. These preliminary findings, which have emerged from a variety of laboratories employing rather different paradigms, suggest that cognitive activity of considerable complexity may be possible during sleep, provided that it is mediated by automated procedures and assessed by measures that do not require awareness of the events on the part of the subject.

Despite the research possibilities offered by current advances in theory, most texts on sleep, whether intended for undergraduate use or scholarly reference, pay little attention to cognitive processes, aside from our ubiquitous failure to remember our dreams. A major exception to this generalization is *The Mind in Sleep* (Arkin, Antrobus, & Ellman, 1978), which provided a comprehensive account of research on cognitive processes during sleep since the discovery of the EEG correlates of dreaming. The volume focuses on such topics as the difference between stage REM and stage NREM mental activity, factors affecting dream recall, the effects of presleep and intrasleep stimulation, REM deprivation, sleeptalking, and night terrors. Unfortunately, the book is now out of date, especially with respect to current thinking in cognitive psychology; although a new edition has been promised, it is not yet available. Another primary source is a recent monograph, *Dreaming: A Cognitive-Psychological Analysis* (Foulkes, 1985). As comprehensive as the Arkin et al. anthology is, its contributors have almost nothing to say about the problem that concerned Freud most: the meaning of dreams. Foulkes' book approaches this problem

from the perspective of cognitive psychology, particularly psycholinguistics and cognitive development. His analysis clearly indicates that sleep researchers and cognitive psychologists have much of interest to say to each other.

In 1986, the Neurosciences Institute of Rockefeller University hosted a small workshop on the remembering and forgetting of dreams, which testifies to an increased interest in sleep among neurobiologists and psychiatrists; but cognitive psychologists were decidedly underrepresented at this meeting. A further impetus to dialog is the recently published report of an ad-hoc committee of the National Academy of Sciences to the Army Research Institute, concerning psychological techniques to enhance human performance (*Enhancing Human Performance: Issues, Theories, and Techniques*, 1988). While generally critical of most of the techniques that have been proposed for this purpose, the Committee strongly urged that further attention be devoted to the phenomenon of learning during sleep. We expect that this suggestion will lead to a greatly improved environment for research on all aspects of cognition in sleep.

The present volume represents the Proceedings of the Arizona Conference on Sleep and Cognition, held in Tucson January 19–22, 1989. A principal concern of the conference was the implications of recent work on implicit memory and other aspects of information-processing outside of awareness for studies of cognitive processes during sleep, and the role of the sleep laboratory as a vehicle for studying various aspects of information processing outside of awareness, in the absence of the active deployment of attention. To this end, selected investigators in the area of sleep who have an interest in cognitive processes were brought together with their counterparts in the area of cognition who have an interest in sleep. The goal of the conference was to create an environment in which representatives of these two quite different areas would meet and exchange ideas in a spirit of open inquiry and constructive criticism and advance the study of cognition during sleep beyond the stage of speculative thought. We hope that one outcome of this meeting, and publication of the Proceedings, will be a new agenda for research on sleep that will carry investigators of both camps well into the 21st century.

Part One of the volume contains two papers in which mental activity during sleep is used as a link between neuroscience and cognitive science. Antrobus provides a sweeping review of the literature on eye movements and imagery in dreaming, with particular reference to cortical activation during sleep. Similarly, Hobson provides an update of the Hobson–McCarley Activation–Synthesis model of dreaming.

Part Two includes a number of papers on various aspects of mental activity during sleep. Kutas offers an authoritative review of the literature on event-related (evoked) potentials during sleep. Harsh and Badia describe a series of experiments on the transfer to sleep of conditioned responses acquired during the normal waking state. Badia continues this discussion, focusing on the acquisition of new conditioned responses during sleep. Evans contributes an overview and update of his extremely provocative studies of

response to verbal suggestions during sleep, and the relation of this phenomenon to hypnosis and other dissociative states. Eich provides a new look, originally prepared for the 1988 National Academy of Sciences and Army Research Institute study of techniques for enhancing human performance, at the possibilities for sleep learning. LaBerge summarizes his programmatic research on lucid dreaming, in which the sleeper becomes aware of the fact that he or she is dreaming, and exercises some control over the content of the dream. Finally, Goldmann explores the parallels between information processing during sleep and during adequate surgical anesthesia.

Part Three focusses on cognition in the hypnagogic and hypnopompic states occurring in the transition from waking to sleeping and back again. Mendelson reviews the physiological and cognitive effects of drugs used in treating insomnia. Bonnet examines the factors affecting subjective reports of sleep onset—which, he notes, almost never agree with physiological measures. Dinges summarizes his research on performance impairments in the period after awakening and illustrates his argument with a dramatic example of hypnopompic reverie.

Part 4 returns to the question of dreams, this time in a clinical as opposed to an experimental context, with an emphasis on the effects of stress on dreams. Cartwright describes a new study of the dreams of women going through divorce and explores the implications of her findings in relation to the question of the meaning of dreams. Kramer summarizes his ongoing work on nightmares in Vietnam veterans suffering posttraumatic stress disorder.

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SLEEP AND COGNITION

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