

The Neuroscience of Sleep and Dreams

This book provides a complete introduction to the neuroscience of sleep and dreams in plain language. Patrick McNamara outlines new discoveries in the science of sleep and dreams, places them within an evolutionary context, and brings them together with existing scientific findings and implications for sleep medicine. Unlike other introductory texts, the important evolutionary background and social nature of sleep and dreams is emphasized. Major advances in sleep medicine, sleep and memory, dream content analyses, brain correlates of sleep stages, and lifespan development of sleep are covered in depth. While the text is geared toward students, the general reader and scientists studying other disciplines will find it accessible and informative.

Patrick McNamara is Associate Professor in the Department of Neurology at Boston University and Professor of Psychology, Northcentral University. He has received a VA Merit Review Award as well as two NIH research grant awards for his work on sleep and dreams. Magazines, newspapers, and TV shows have featured his work, including *New Scientist*, *The Boston Globe*, *NOVA*, and *PBS Closer to Truth*.

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The Neuroscience of Sleep and Dreams

Patrick McNamara

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*To Ina Livia McNamara,
on her tenth birthday*

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Preface

This introduction to the neuroscience of sleep and dreams is part of the *Cambridge Fundamentals of Neuroscience in Psychology* series published by Cambridge University Press. The goal of this series is to introduce readers to the use of neuroscience methods and research to inform psychological questions. A key theme of this book, therefore, will be to inform readers both about the basic science of sleep and dreams and to illuminate psychological questions that arise around sleep and dreams. This book can serve as a supplemental textbook in college/university courses such as Brain and Behavior, Psychopharmacology, Neuropsychology, Behavioral Neuroscience, Psychology of Dreams, Physiological Psychology and as a trade book for educated lay people, and/or as a main textbook in a college/university course or seminar at the advanced undergraduate level or the graduate level (along with supplemental scientific articles).

Some of the questions I will be addressing include: What is sleep and why are there two basic forms of sleep (REM and NREM; at least among terrestrial mammals)? Why is the amygdala activated and the dorsal-prefrontal cortex downregulated during REM? What is the evidence for immune system repair during slow wave sleep? What is sleep debt and how is it related to brain function? What are the psychological consequences of chronic sleep debt? What do the major parasomnias teach us about conscious states? The many intriguing and bizarre clinical symptoms of various sleep disorders (sleepwalking, REM Behavior Disorder, narcolepsy, parasomnias, etc.) will be discussed, as well as the latest findings on the role of sleep and dreams in memory and learning. With respect to dreams, some of the questions to be addressed are: Why do some people recall very few dreams while others are flooded with dream memories on a daily basis? Why are social interactions so ubiquitous in dreams? Can certain dream experiences signal illness or even death? Why are some dreams extraordinarily moving and others quite banal and forgetful? Why do some people find it easy to realize they are dreaming when they are in fact dreaming (“lucid dreams”) while others never achieve “lucidity”? Do we need to dream in order to remember things? Do we need dreams in order to be creative? How is the new rage for using smartphones and apps to track sleep patterns and dreams altering our understanding of sleep and dreams? What about

nightmares? Why do they occur and is there anything we can do about them? These are only a few of the fascinating puzzles concerning sleep and dreams that will be addressed in this book.

Unlike other introductory texts on sleep and dreams, I adopt a consistently evolutionary and social neuroscience approach to understanding the neuropsychology of sleep and dreams. I adopt this orientation as functional aspects of physiological systems are more easily understood within the framework of Darwinian evolutionary biology. To study sleep within an evolutionary context inevitably leads us to consider sleep as a social behavior, given that for most animals fitness trade-offs occur within social interactions. I will therefore argue that sleep can be profitably studied and understood, at least in part, as a social phenomenon. For example, fetal and infant sleep cannot be understood in the absence of its social context; that is, the infant's interactions with its mother. Similarly, sleep states from toddlerhood up to adulthood also occur within social contexts (e.g., attachment relationships with parents in childhood and then attachment relationships with sexual partners in adulthood, etc.) that shape all aspects of sleep expression. Sleep expression differs in the solitary sleeper as compared to co-sleepers. Co-sleeping is very likely the evolutionary default for human beings. Our ancestors were all co-sleepers and that fact can help to explain some of sleep's peculiar biologic features. While these elementary facts concerning sleep and social context have been assumed and occasionally acknowledged by sleep scientists, they have never received the sustained or explicit attention they deserve, it seems to me. Placing sleep within its social context will illuminate the everyday functional aspects of sleep and its disorders for readers of this introductory text on the neuropsychology of sleep and dreams.

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- McNamara, P., Minsky, A., Pae, V., Harris, E., Pace-Schott, E., & Auerbach, S. (2015). Aggression in nightmares and unpleasant dreams and in people reporting recurrent nightmares. *Dreaming*, 25(3), 190–205. <http://dx.doi.org/10.1037/a0039273>.
- McNamara, P., Ayala, R., & Minsky, A. (2014). REM sleep, dreams, and attachment themes across a single night of sleep: A pilot study. *Dreaming*, 24(4), 290.
- McNamara, P., Pace-Schott, E. F., Johnson, P., Harris, E., & Auerbach, S. (2011). Sleep architecture and sleep-related mentation in securely and insecurely attached young people. *Attachment and Human Development*, 13(2), 141–154.
- McNamara, P., Johnson, P., McLaren, D., Harris, E., Beauharnais, C., & Auerbach, S. (2010). REM and NREM sleep mentation. *International Review of Neurobiology*, 92, 69–86.
- McNamara, P., Auerbach, S., Johnson, P., Harris, E., & Doros, G. (2010). Impact of REM sleep on distortions of self concept, mood and memory in depressed/anxious participants. *Journal of Affective Disorders*, 122(3), 198–207. PMID: 19631989.
- Capellini, I., McNamara, P., Preston, B. T., Nunn, C. L., & Barton, R. A. (2009). Does sleep play a role in memory consolidation? A comparative test. *PLoS ONE*, 4(2), e4609. PMID: 19240803.
- Preston, B. T., Capellini, I., McNamara, P., Barton, R. A., & Nunn, C. L. (2009). Parasite resistance and the adaptive significance of sleep. *BMC Evolutionary Biology*, 9, 7. PMID: 19134175.
- Capellini, I., Nunn, C. L., McNamara, P., Preston, B. T., & Barton, R. A. (2008). Energetic constraints, not predation, influence the evolution of sleep patterning in mammals. *Functional Ecology*, 22(5), 847–853.
- Stavitsky, K., McNamara, P., Durso, R., Harris, E., Auerbach, S., & Cronin-Golomb, A. (2008). Hallucinations, dreaming and frequent dozing in Parkinson's disease: Impact of right-hemisphere neural networks. *Cognitive and Behavioral Neurology*, 21(3), 143–149. PMID: 18797256.

- McNamara, P., Belsky, J., & Fearon, P. (2003). Infant sleep disorders and attachment: Sleep problems in infants with insecure-resistant versus insecure-avoidant attachments to mother. *Sleep and Hypnosis*, 5(1), 7–16.
- McNamara, P., Durso, R., & Auerbach, S. (2002). Dopaminergic syndromes of sleep, mood and mentation: Evidence from Parkinson's disease and related disorders. *Sleep and Hypnosis*, 4(3), 119–131.
- McNamara, P., Dowdall, J., & Auerbach, S. (2002). REM sleep, early experience and the development of reproductive strategies. *Human Nature*, 13(4), 404–435.
- McNamara, P., Andresen, J., Arrowood, J., & Messer, G. (2002). Counterfactual cognitive operations in dreams. *Dreaming*, 12(3), 121–133.
- McNamara, P., Andresen, J., Clark, J., Zborowski, M., & Duffy, C. (2001). Impact of attachment styles on sleep and dreams: A test of the attachment hypothesis of REM sleep. *Journal of Sleep Research*, 10, 117–127.
- McNamara, P. (2000). Counterfactual thought in dreams. *Dreaming*, 10(4), 232–245.
- Zborowski, M., & McNamara, P. (1998). The evolutionary psychology of REM sleep. *Psychoanalytic Psychology*, 15(1), 115–140.