

REVIEW

The Neurophysiology of Sleep in Parkinson's Disease

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ABSTRACT: Sleep disturbances are among the most common nonmotor complications of Parkinson's disease (PD), can present in prodromal stages, and progress with advancing disease. In addition to being a symptom of neurodegeneration, sleep disturbances may also contribute to disease progression. Currently, limited options exist to modulate sleep disturbances in PD. Studying the neurophysiological changes that affect sleep in PD at the cortical and subcortical level may yield new insights into mechanisms for reversal of sleep disruption. In this article, we review cortical and subcortical recording studies of sleep

in PD with a particular focus on dissecting reported electrophysiological changes. These studies show that slow-wave sleep and rapid eye movement sleep are both notably disrupted in PD. We further explore the impact of these electrophysiological changes and discuss the potential for targeting sleep via stimulation therapy to modify PD-related motor and nonmotor symptoms. © 2021 International Parkinson and Movement Disorder Society

Key Words: sleep; electrophysiology; Parkinson's disease; deep brain stimulation

Sleep is a fundamental biological process driven by distinct electrophysiological rhythms within the brain.¹ It has been found to be vital to health and severely disrupted in neurodegenerative disorders such as Alzheimer's disease and Parkinson's disease (PD).^{2,3} From the first essay by James Parkinson on "the shaking palsy," PD has foremost been considered a movement disorder.⁴ However, the last 2 decades have brought an explosion in our understanding of the myriad nonmotor manifestations of PD.^{5–8} More recently, a

particular appreciation of the strong association between PD and sleep disorders has emerged.^{9–11}

A wide spectrum of sleep disorders have been implicated in PD, encompassing disorders of sleep–wake transition as well as parasomnias involving abnormal movements during various phases of sleep.^{12–15} The most common PD-associated disturbances in sleep–wake transitioning include increased sleep latency, frequent awakenings, and sleep fragmentation, resulting in wakefulness after sleep onset (WASO) and reduced total sleep time.^{6,16–23} The parasomnias associated with PD have also gained much attention and include rapid eye movement sleep behavior disorder (RBD), periodic limb movements in sleep (PLMS), and restless legs syndrome.^{12–14} Sleep disorders such as RBD can even be the first prodromal symptom of PD prior to the emergence of formal motor symptoms.^{10,26,27} Altogether, sleep disorders were the second most prevalent nonmotor complaint among a large cohort of PD patients, affecting about 64% of patients (PRLAMO study).⁶ Sleep dysfunction in PD also represents a significant strain on caregivers and can predict earlier transfer to nursing homes.^{28–30} Sleep disorders therefore impact the majority of patients with PD and produce troublesome symptoms for which currently limited treatment options exist.^{31–33}

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Indexes to the Epilepsy Accessions of the Epilepsy Information System J. Kiffin Penry, 1978 **Sleep & Dreaming** D. Cohen, 2013-10-22 Sleep and dreaming are manifestations in higher organisms of a fundamental circadian rhythm of inactivity activity During the past thirty years research has provided a great deal of new information about the phenomenon and phenomenology of sleep and the relationship between sleep and wakefulness This book aims to describe organise and interpret some of this new knowledge in order to stimulate a greater appreciation of the role of sleep and dreaming in human adaptation The study of sleep and dreaming provides a very special perspective on human functioning It stands in direct contrast to more traditional paradigms utilised in psychology that place the locus of explanation of human behaviour in the external environment **Sleep 1974** ,1975 Sleep Disorders Part II Pasquale Montagna, Sudhansu Chokroverty, 2012-11-27 Sleep Disorders II covers various aspects of sleep disorders These include the different classification of sleep disorders the genetic influences of sleep disorders abnormality in the sleeping pattern and the circadian rhythm sleep disorder A sleep disorder is a medical disorder that affects the sleeping patterns of humans and sometimes animals The disruptions in sleep can be caused by different factors such as teeth grinding night terrors and the like The book also discusses different perspectives on insomnia and hypersomnia According to the International Classification of Sleep Disorders insomnia is a sleep that is low in quality or a difficulty in sleeping On the other hand hypersomnia is a sleeping disorder characterized by excessive daytime sleepiness EDS or prolonged nighttime sleep The book discusses narcolepsy a syndrome that is characterized by excessive daytime sleepiness that is associated with cataplexy and other REM sleep phenomena The different medicines for this disease are also discussed People who are practicing neurology and internal medicine especially those in pulmonary cardiovascular gastrointestinal renal and endocrine specialties will find this book valuable A comprehensive resource for the study of sleep science sleep medicine and sleep disorders Fascinating noninvasive neuroimaging studies that demonstrate marked changes during different sleep states A state of the art reference that summarizes the clinical features and management of many of the neurological manifestations of sleep disorders Indexes to the Epilepsy Accessions of the Epilepsy Information System ,1981 **SLEEP 1974: INSTINCT, NEUROPHYSIOLOGY, ENDOCRINOLOGY, EPISODES, DREAMS, EPILEPSY AND INTRACRANIAL PATHOLOGY- PAPERS PRESENTED AT THE 2ND EUROPEAN CONGRESS ON SLEEP RESEARCH- EUROPEAN SLEEP RESEARCH SOCIETY. ,**

Biological Barriers in Behavioral Medicine Wolfgang von der Linden, 2013-11-11 A New Looking Glass for Behavioral Medicine In 1984 John Briggs a science writer and specialist in interdisciplinary studies teaching at the New School for Social Research and F David Peat a physicist who was for many years a fellow with the National Research Council of Canada published a book about the revolutions that were taking place in physics mathematics chemistry biology and neurophysiology and about the scientists whose new theories were changing our understanding about the nature of the universe

The title of their book was Looking Glass Universe after Lewis Carroll s classic story of Alice and her friends Through the Looking Glass Briggs and Peat s book is a well written challenging volume about human beings and how they think about old problems in new and sometimes startling ways I mention Briggs and Peat s book only partially because I happen to have a personal interest in the potential applications of new ways of looking at and thinking about nature and data derived from modern physics and systems theory for health psychology and behavioral medicine e g Schwartz 1984 In a letter Wolfgang Linden wrote to me on January 23 1987 he shared with me at my request his rough thoughts about his personal goals for this book

Psychotropic Agents ,2012-12-06 The description of the pharmacology of psychotomimetics cannabis and alcohol in this third volume concludes the discussion on psychotropic agents As psychomotor stimulants these groups of psychotropic agents are of little or no therapeutic relevance but since they are used in a nonmedical manner or are even considered by some groups of the population as social commodities their behavioral effects and psychopharmacological properties are not the concern of the pharmacologist alone The same is true of psychotomimetics as well as cannabis and its components Psychotomimetics have a social history going back many hundreds of years and are among the most potent psychotropic agents known to man The closing description of psychopharmacology also deals with the psychotropic effects of a number of drugs not primarily considered to be psychotropic Their psychotropic effects are either an inherent constituent of their therapeutic profile as is the case with opiates hypnotics and caffeine or they may occur indirectly as side effects or accompanying effects during therapy This applies to β adrenoreceptor antagonists and anticholinergics The editors are also aware that a description of psychotropic agents would not have been complete without discussing the medical ethical and legal aspects of the development clinical testing and use of such drugs

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Neuroendocrinology ,1977 **Sleep '84** Werner Paul Koella, Eckart Rütger, Hartmut Schulz, 1985 *Sleep Disorders* Pasquale Montagna, Sudhansu Chokroverty, 2011 The second part of a two part work in the Handbook of Clinical Neurology series on sleep disorders **Epilepsy, Sleep, and Sleep Deprivation** R. Degen, Ernst Niedermeyer, 1984 Index of Conference Proceedings Received 1974-1978 British Library. Lending Division, 1979 **Sleep 1976** ,1977
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