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Cogwheel of Consciousness: RAS Control of Attention Executive Network and Sleep Transition

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Abstract

Consciousness is a unified subjective experience emerging from the interaction of awareness, sensory input, and autonomic brain processes. The reticular activating system (RAS), known as the cogwheel of consciousness, drives these processes and allows transitions from awake to sleep states. This article studies the RAS to understand human consciousness using Default Space Theory (DST), which postulates that an internal 3D model of reality created by the brain forms the basis of conscious experience. A detailed analysis of the RAS's components, functions, and neurotransmitters highlights its role in integrating sensory input and body oscillatory signals to form our conscious experience. Dysregulation of the RAS is further studied in coma, narcolepsy, ADHD, and anxiety to expand the applications of this research. Overall, this article provides valuable insights into how the RAS enables consciousness and attention while allowing sleep transitions, advancing our understanding of this complex cognitive phenomenon. Physiological endeavors; Brain Oscillations; Autonomic Control.

Keywords

Reticular Activating System, Consciousness, Attention Executive Network, Sleep-Wake Transitions, Default Space Theory, Thalamocortical Loops, Cardiorespiratory Coherence

Introduction

The concept of consciousness has long been a significant challenge in the realm of neuroscience [1]. Theories of consciousness date back to the 19th century when researchers first identified areas of the brainstem believed to be vital for alertness and awareness. Studies in the 20th century further revealed that certain transactions of the brain allowed individuals to maintain being awake, while others resulted in coma-like states [2,3]. These seminal studies resulted in the discovery of the Reticular Activating System (RAS) as the brain's mechanism for controlling arousal and awareness. Beyond these past studies, modern theories have emerged that attempt to explain the nature of consciousness and what allows individuals to possess consciousness. Many theories have been proposed to describe consciousness, such as the Global Workspace Theory (GWT) and the Integrated Information Theory (IIT). However, these and many other models fail to consider some important aspects of consciousness that relate to the brainstem and even the body overall. The Default Space Theory (DST) was developed to address some of these shortcomings, and states that consciousness consists of an internal three-dimensional simulation that the brainstem's thalamus helps to generate by "filling in" sensory information processed by other areas of the brain, while the default mode network (DMN), RAS, and other systems related to rhythms in areas like the heart and lungs work together to establish a baseline or framework in which this simulation exists [4,1]. Within this model, the RAS plays a critical role as a "cogwheel" within the system. The RAS and its functions within consciousness and awareness will be reviewed in this paper, including newer findings in relation to this brain network.

Overview of the Reticular Activating System

The Reticular Activating System (RAS) lies in the brainstem's reticular formation. The RAS contains various nuclei and neurons mostly within the pons and midbrain areas (upper brainstem) [5]. The RAS network includes the locus coeruleus, raphe nuclei, tuberomammillary nucleus, and pedunculopontine tegmentum [6,7]. The RAS uses neurotransmitters like norepinephrine, serotonin, histamine, acetylcholine, and dopamine to affect widespread areas of the brain to increase alertness and cognitive function [8,9]. Most of the ascending pathways of the RAS send signals to the intralaminar nuclei of the thalamus, which then relay information to various areas of the cerebral cortex in order to encourage cortical oscillations; a smaller number of pathways ascend directly to the neocortex [10]. The RAS nuclei are activated by lateral hypothalamus (LH) orexin neurons that receive photic input from the retina during wakefulness [6,7]. Slow oscillations from the RAS (<1 Hz) contribute—along with slower oscillations from the default mode network (DMN) and cardiorespiratory oscillations—to a "neural sensory memory space" within the thalamus that integrates sensory information and forms a 3D default framework in which sensory input is placed. This integration incorporates interoceptive and exteroceptive data through gap-junction coupling of membrane potentials in all areas of the body and brain, creating a holistic, physiologically based system that maintains homeostasis and ensures proper spatial functioning of the body within its environment [1,11]. Furthermore, in pathological states, lesions in the RAS can cause coma, as the RAS dysfunctionsally essential for arousal [12,13].

RAS Control of the Attention Executive Network

Attention and executive function rely on frontoparietal networks (FPN) for goal-directed selection amid competing stimuli [14]. The RAS modulates the FPN via LC-NE projections that enhance prefrontal signal-to-noise ratios, facilitating working memory, cognitive flexibility, and task-switching [15,9]. Phasic LC bursts respond to salient events, while tonic activity maintains vigilance; optimal NE levels follow an inverted-U curve, with excess impairing focus (as in stress) and deficiency causing inattention (e.g., ADHD) [16].

PPN cholinergic and raphe serotonergic inputs further gate thalamic relay, prioritizing relevant sensory streams and suppressing noise [17]. In DST, the RAS filters raw data into the 3D default space, where thalamic

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integration with parietal/frontal loops enables spatial organization, internal imagery, and decision-making [18]. Neuroimaging confirms RAS activation during demanding tasks, and its dysregulation underlies ADHD attentional lapses and multitasking deficits [5]. The RAS thus functions as a mechanical cogwheel, synchronizing bottom-up salience detection with top-down executive commands for coherent, adaptive consciousness.

RAS in Sleep-Wake Transitions

The neural regulation of the sleep-wake cycle involves complex interactions between various neural circuits and neurotransmitter systems. The transition between wakefulness and different sleep stages is primarily regulated by the interaction between the ascending reticular activating system (RAS), the ventrolateral preoptic area (VLPO), and other hypothalamic regions. During wakefulness, neurons in the RAS, including neurotransmitters like acetylcholine, norepinephrine, serotonin, and orexin, promote cortical activation and alertness. The VLPO, containing GABAergic and galaninergic neurons, promotes sleep by inhibiting the RAS and other arousal systems. This reciprocal inhibition creates a "flip-flop" switch regulating sleep and wake states [6]. During NREM sleep, inhibitory GABAergic activity reduces thalamic relay neuron excitability, promoting synchronized EEG activity characteristic of deep sleep. REM sleep sees a reactivation of certain RAS components leading to cortical activation necessary for dreaming but also an inhibition of motor neurons to induce muscle atonia [19].

DST details altered brainwave patterns and cardiorespiratory function that follow neural regulation during different states. For instance, REM sleep interrupts memory consolidation processes, likely due to altered communication between the prefrontal cortex and the thalamus [20]. Increased parasympathetic activity reflected in specific cardiorespiratory patterns promotes restorative aspects of sleep associated with delta waves in NREM stages. Neural regulation disruptions in clinical settings can arise from damage or disease in areas like the RAS, hypothalamus, or neurotransmitter deficiencies such as orexin, resulting in disorders like narcolepsy or PTSD [1]. These disruptions manifest as excessive daytime sleepiness, fragmented sleep, or hyperarousal, demonstrating the crucial role of these neural circuits in maintaining healthy sleep-wake cycles.

Integration: RAS as the Cogwheel of Consciousness

The cogwheel model posits that thalamic fill-in takes place within the DST 3D default space, supported by the baseline RAS and DMN activity and other body rhythms [4,21]. Three layers of oscillations underlie the thalamic fill-in process: slow and idling RAS, DMN, and cardiorespiratory oscillations that form the default sensory memory framework, limbic system theta and beta oscillations that encode emotional valence, and corticothalamic oscillating alpha and gamma oscillations that encode perceptual fill-in. Regarding the implications of the cogwheel model for consciousness theories, it is essential to build on theories like the Global Workspace Theory and the Integrated Information Theory, as they provide critical insights into the role of unconscious processes and reflexive functions. However, the cogwheel model complements these theories by adding a physiological dimension that emphasizes the role of oscillatory activity in the thalamus and RAS structures. Furthermore, the cogwheel model complements the DST by explaining meditation expands the default space via increased cardiorespiratory coherence [1]. The model is also supported by neurological evidence from disorders of consciousness and attention, which demonstrate the catastrophic effects on awareness when the RAS's function is disrupted [13].

Discussion

Despite these limitations, and the need for further research to validate this entire perspective, dynamic systems theory in relation to the reticular activating system can provide a lot of beneficial information regarding consciousness and in what ways it can be impacted. Furthermore, through viewing the reticular activating system as a cogwheel in the consciousness process, insight is also provided into potential treatment options for disorders that impact consciousness, attention, or awareness, such as coma, narcolepsy, ADHD, and even disorders like anxiety and PTSD. Thus, this type of framework has significant potential to transform the approach to consciousness and related disorders.

Conclusion

Through understanding how the RAS functions, the impact that it has on consciousness and awareness, and some of the conditions or disruptions that affect the part of the brain, it becomes clear how vital this cogwheel is within the functions of consciousness' main functions. Furthermore, through understanding how the RAS can malfunction, it is also possible to become aware of how such an understanding can lead to the development of treatment plans and interventions that can help to improve the quality of life of those who are affected by such issues. Finally, with this information altogether, it is also possible to propose new directions for research to further test consciousness and the DST. Overall, then, the RAS is one of the most critical components of consciousness, and an essential component of the brain for which we must develop a comprehensive understanding.

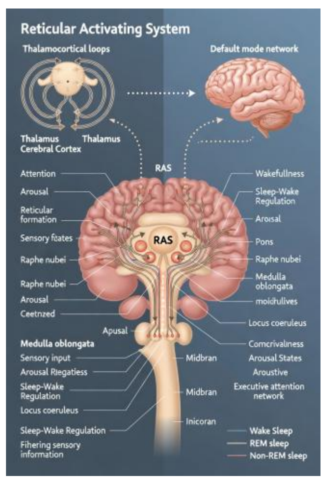

Figure 1: Reticular Activating System.

References

1. Jerath R. (2015) A unified 3D default space consciousness model. Fronti Psychol. 6:1274.
2. Bremer F. (1937) L'activité électrique de l'écorce cérébrale. Actualités Scientifiques et Industrielles. 658.
3. Moruzzi G, Magoun HW. (1949) Brain stem reticular formation and activation of the EEG. Electroencephalog Clin Neurophysiol. 1(4):455-73.
4. Jerath R, Crawford MW. (2014) Neural correlates of visuospatial consciousness in 3D default space. Consci Cognition. 28:81-93.
5. Garcia-Rill E. (2013) The reticular activating system. In Handbook Clin Neurol. 116:157-66.
6. Saper CB. (2005) Hypothalamic regulation of sleep and circadian rhythms. Nature. 437(7063):1257-63.

DOI: *http://doi.org/10.52793/JNSR.2026.6(2)-57*

7. Nishino S. (2000) Hypocretin (orexin) deficiency in human narcolepsy. The Lancet. 355(9197):39-40.
8. Jones BE. (2003) Arousal systems. Fronti Biosci. 8:438-51.
9. Aston-Jones G, Cohen JD. (2005). An integrative theory of locus coeruleus-norepinephrine function: adaptive gain and optimal performance. Ann Rev Neurosci. 28:403-50.
10. Llinás R. (1998) The neuronal basis for consciousness. Philosophical Transactions of the Royal Society B. 353(1377):1841-49.
11. Jerath R, Crawford MW. (2015) How does the body affect the mind? Role of cardiorespiratory coherence. Adv Mind-Body Med. 29(4):4-16.
12. Parvizi J, Damasio AR. (2003) Neuroanatomical correlates of brainstem coma. Brain. 126(7):1524-36.
13. Laureys S. (2005) The neural correlate of (un)awareness. Trends in Cognitive Sci. 9(12):556-59.
14. Corbetta M, Shulman GL. (2002) Control of goal-directed and stimulus-driven attention in the brain. Nature Rev Neurosci. 3(3):201-15.
15. Sara SJ. (2015) Locus coeruleus in time with the making of memories. Curr Opin Neurobiol. 35:87-94.
16. Sergeant J. (2000) The cognitive-energetic model of ADHD. Neurosci Biobehav Rev. 24(1):7-12.
17. Kinomura S. (1996) Activation by attention of the human reticular formation and thalamic intralaminar nuclei. Science. 271(5248):512-15.
18. Jerath R. (2019) The default space theory of consciousness. Medical Hypoth. 123:51-56.
19. Hobson JA. (1998) The neuropsychology of REM sleep dreaming. Neuro Rep. 9(3):1-14.
20. Jerath R. (2017) The dynamic role of breathing and cellular membrane potentials in consciousness. World J Neurosci. 7(1):66-81.
21. Jerath R. (2024) Beyond awareness: the binding of reflexive mechanisms with the conscious mind. Fronti Human Neurosci. 18:1520138.
22. Baars BJ. (1989) A cognitive theory of consciousness. Cambridge University Press.
23. Edlow BL. (2012) Neuroanatomic connectivity of the human ascending arousal system critical to consciousness and its disorders. J Neuropathol Experi Neurol. 71(6):531-46.
24. Haines DE. (2018) Neuroanatomy atlas in clinical context. Lippincott Williams & Wilkins.
25. Sherman SM, Guillery RW. (2006) Exploring the thalamus and its role in cortical function. MIT Press.
26. Steriade M. (2006) Grouping of brain rhythms in corticothalamic systems. Neurosci. 137(4):1087-106.
27. Tononi G. (2016) Integrated information theory: from consciousness to its physical substrate. Nature Rev Neurosci. 17(7):450-61