

Neurowaves and the Nature of Temporality

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Abstract

In this article, we provide a book review on Georg Northoff's "*Neurowaves: Exploring the Dynamic Nature of Time in the Brain*." It is a groundbreaking exploration of the intricate relationship between the brain and time. Drawing on spatiotemporal neuroscience, philosophy, psychology, and contemporary physics, Northoff metaphorizes time as waves, unraveling the complex interplay between duration and moments in time. The book extends these time waves to elucidate state transitions in brain and mind dynamics, emphasizing the holistic connection between the brain, environment, and mindfulness. Northoff argues that understanding how the brain operates in its environment is essential for comprehending the impact of brain-world-time relationships on the mind. Notably, Northoff underscores the significance of the brain's internal sense of time in shaping psychological traits, emphasizing the pivotal role of spontaneous brain activity in bridging brain functions and the mind.

Key Words: neurowaves, time perception, neural mechanisms, time coordination, world-brain relationship

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Accordingly, we will picture the mental apparatus as a compound instrument, to the components of which we will give the name of 'agencies', or (for the sake of greater clarity) 'systems'..... It would be sufficient if a fixed order were established by the fact that in a given psychical process the excitation passes through the systems in a particular temporal sequence. In other processes the sequence may perhaps be a different one; that is a possibility that we shall leave open. For the sake of brevity we will in future speak of the components of the apparatus as 'ψ-systems'."

Freud, 1900; p. 535

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Introduction

Georg Northoff is a leading neuroscientist and psychiatrist whose research spans neuroscience, psychology, and psychiatry. His work has been influential in understanding consciousness, the self, emotions, and mental illness. Among other things, his research involved the concept of “*spatiotemporal neuroscience*.” Spatiotemporal neuroscience focuses on the spatiotemporal nature of brain activity, i.e., how information in the brain propagates and works together across different temporal and spatial scales. This concept emphasizes the importance of the temporal and spatial distribution of brain activity in understanding complex mental processes such as cognition, emotion and consciousness.

Neurowaves: Exploring the Dynamic Nature of Time in the Brain by Georg Northoff is a groundbreaking book that explores the intricate relationship between the brain and time. The book expands on the theories of spatiotemporal neuroscience from a variety of perspectives, including philosophy, psychology, and neuroscience. In order to explain the concept of time, Northoff blends the constructive view of contemporary physics with ancient Eastern philosophical ideas, metaphorizing the dynamics of time in the form of waves, which in part explains the relationship between duration (a time line) and a point in time (a moment in time) (Bergson & Andison, 1946). On this basis, Northoff extends the concept of time waves to the state transitions between brain and mind dynamics, arguing that the brain should be placed in its environment to consider how it as a whole leads to mindfulness, i.e., how the relationship between brain-world-time affects the mind. How time is constructed and integrated in the brain is comprehensively explored in the book. This review aims to provide an in-depth analysis of the book, highlighting its key arguments, insights, and contributions to the field. To underscore the significance of the brain’s internal sense of time in shaping psychological traits, Northoff posits that the development of an individual’s internal temporal (as well as spatial) framework through spontaneous brain activity serves as the crucial bridge between brain functions and the mind. According to Fingelkurts et al. (2010) and Northoff et al. (2020 a; 2020 b), both neural and mental states align with the brain’s internal sense of time, often referred to as “running time” or “common currency.”

“How do the dynamics of time shape the connections between the world and the brain to produce psychological features such as self and consciousness?”-This is the central question that drives the book. Time is dynamic. The dynamics of the waves of time characterize the world as a whole, and we can imagine the form of such dynamic waves by observing the ebb and flow of overlapping ocean waves. Northoff argues that this same characterization of time applies to the internal time of the brain, which is part of the external time of the world, and which has a much larger scope. The waves of the world pass through

the brain. The waves of the world passing through the brain are central to the production of mental features such as self and consciousness - the dynamics of the world-brain relationship are the basis of our thoughts (Northoff, 2016, 2018). This is the main message of this book.

The “Introduction: The Brain’s Mental Surfing” in Northoff’s book delves into the profound connection between the concept of time and the brain. It starts by discussing the significance of time in shaping both our perception of the world and our mental processes. One key aspect is the ancient Greek differentiation between two gods of time, Chronos and Kairos, which the chapter explores to illuminate their interplay. It also emphasizes the brain’s role in constructing its internal sense of time and how it relates to the external world. A central theme is the “construction view” of time, highlighting its dynamic and relational nature, constantly shaping our experiences. The chapter integrates insights from ancient Chinese philosophy, linking the brain’s dynamic activity to the fundamental basis of the mind. The metaphor of the brain’s neural activity as oceanic waves underscores the temporal and dynamic nature of mental features. Overall, this chapter lays the groundwork for understanding how the brain’s dynamic processes and temporal intricacies contribute to the emergence of mental phenomena, such as self-awareness and consciousness, setting the stage for the subsequent chapters of the book.

Time Alignment: Brain to the world/body

In his book, Northoff describes brain waves, and the mechanisms by which they occur, consisting of neural activity in the brain in Chapter 1. Subsequently, he demonstrates how brain waves are synchronized with the body (Chapter 3) and the world (Chapter 2) - the brain waves are aligned and integrated with the body and the world in time.

Northoff delves into the complex world of neural activity waves in the brain and their construction. It explores the brain’s internal perception of time and how it intertwines with the external time of our world. The chapter thoroughly examines the frequencies and temporal windows of brain activity, emphasizing their pivotal role in shaping our consciousness and processing external stimuli (Wolff et al., 2022; Golesorkhi et al., 2021a; Golesorkhi et al., 2021b). It underscores the ever-changing and dynamic nature of mental attributes, intricately linked to the brain’s neural activity. Additionally, the chapter touches upon the concept of the brain’s scale-free activity, nested within the framework of the world’s inner time.

In Chapter 2, Northoff delves into the synchronization between waves of brain activity and the rhythms of world time. It explores how the brain aligns and seamlessly integrates its waves with the timing of both the body and the external environment. The chapter draws an

intriguing parallel between the ever-evolving nature of consciousness and the constant flow of a river or stream. It underscores the brain's pivotal role, likening it to a neuronal surfboard gracefully riding and surfing the waves generated by the body and the world. Furthermore, it delves into the intriguing concept of the self, portraying it as a wave that gracefully rides atop the larger wave of the surrounding environment. However, Self-awareness is not stable and is sometimes affected by external stimuli (or environmental changes) (Chen et al., 2023). And the self may not be mental but physical – it is certainly not a mental substance or property as distinguished from the body as physical substance or property (Churchland 2002; Metzinger 2003).

The brain, the body and the world are intricately linked, and time is a key mediator of this relationship. Chapter 3 focuses on the fact that the coordination of time and space allows the brain to synchronize with the environment through the channel of the body. This synchronization involves the brain aligning itself with the body's heartbeat and the sub-low rhythms of the stomach (Park et al., 2014; Richter et al., 2017). Importantly, these temporal harmonizations do not occur passively, but are actively regulated processes. Temporal coordination between the brain and the body has profound implications for the state of consciousness, with significant implications for both the external and internal dimensions of our consciousness. Indeed, understanding the complex temporal dynamics of brain-body interactions is critical to revealing the nature of consciousness. Several studies have shown that meanings of internal and external content are ultimately based on the dynamics of brain-body coupling (Tallon-Baudry et al., 2018).

Self Time and Time Speed

Our consciousness is perpetually in a state of flux, much like a flowing stream or river, a concept eloquently referred to as the “stream of consciousness” by the renowned American psychologist, William James. This analogy can also be applied to the dynamic nature of brain waves, viewing them through a similar lens. Consciousness, then, is based on the brain's role as a neuronal surfboard that glides and surfs on the waves of the body and the world. It is clear that consciousness as a surfboard requires a surfer who guides and directs the surfboard: the ego, as Northoff discusses in Chapter 4. The position of the surfboard is constantly changing, while the surfer maintains continuity of state and time, that is, continuity of moments elapsed in time. Northoff shows how brainwaves construct their own durations as the basis for our sense of self. Yet another key feature of waves is their speed, which stems from the fact that they can be faster or slower. In Chapter 5, Northoff shows how the brain's construction of speed and velocity produces states such as depression and mania,

and that the characteristics of these states include the perception of extremes of intrinsic time and speed, such as too slow or too fast.

Chapter 4 of the book delves into the intricate integration of the brain's internal time with the external temporal framework, focusing on the pivotal role of temporal receptive windows in shaping conscious perception. It explores how different sensory and motor regions within the brain interact and converge to process and encode external stimuli. The author underscores the significance of temporal receptive windows in elucidating how the brain constructs our conscious perception of the external world. These windows facilitate the selective processing and integration of sensory information, enabling us to comprehend our surroundings. The chapter also delves into the brain's spontaneous activity, characterized by temporal and spatial dimensions, in shaping our conscious perception. It discusses how sensory regions, such as visual and auditory areas, collaborate with motor regions to create a cohesive and unified external world experience. Additionally, the concept of nested temporal scales is explored, demonstrating how they contribute to the dynamic nature of our mental processes and our perception of time. In summary, Chapter 4 illuminates the intricate relationship between the brain's temporal dynamics and conscious perception, emphasizing the role of temporal receptive windows and nested temporal scales in shaping our awareness of the world.

In Chapter 5, Northoff delves into its proposal of an intricate relationship between the temporal dynamics of the brain and our sense of self and explores the concept of the self as a dynamic entity, akin to a wave riding on the larger wave of the environment, continuously adapting to ever-changing surroundings. Northoff supports his argument with vivid analogies and theoretical frameworks, discussing the brain's self-organization concerning time. He emphasizes how the brain continually constructs and updates its internal temporal framework. The author delves into the implications of this temporal construction for our sense of self, emphasizing its malleability. He suggests that the brain's inner time grants flexibility and adaptability to the self, enabling alignment with the shifting temporal patterns of the external world. Furthermore, the chapter examines various factors influencing our sense of self, including social interactions and cultural context. Northoff discusses the role of temporal experiences, memories, and the integration of past, present, and future in shaping our sense of self and identity continuity. By weaving together neuroscience, philosophy, and psychology, Chapter 5 offers a thought-provoking exploration of the dynamic interplay between the brain's temporal dynamics and our sense of self. It illuminates the continuous adaptation of the self to changing temporal patterns, shedding light on time's profound impact on our subjective experience of self and consciousness.

In Chapter 6, Northoff provides a critical discussion of philosophy of mind, neuroscience, and artificial intelligence. Northoff explores various theories of consciousness, challenges passive models of the brain, and emphasizes its active role in shaping consciousness. He delves into the interaction between neural processes and consciousness, focusing on the role of time in shaping conscious experience. Additionally, the author highlights the implications of viewing the brain as an active agent for artificial intelligence research. Overall, Chapter 6 offers a critical evaluation of consciousness theories, emphasizing the dynamic nature of the brain's engagement with the world and its significance for understanding consciousness and AI. Overall, the chapter contributes to the ongoing discourse on consciousness by challenging traditional perspectives and advocating for an active and constructive role of the brain in shaping conscious experience. It prompts readers to reevaluate reductionist approaches and emphasizes the importance of considering the brain's temporal dynamics in understanding the mechanisms underlying consciousness.

The “Coda” chapter underscores the importance of understanding the brain's temporal dynamics in shaping consciousness, emphasizing its alignment with the body and environment. He revisits concepts like temporal receptive windows and nested temporal scales, highlighting their role in constructing our sense of self and the dynamic nature of consciousness. Furthermore, the chapter explores the broader implications of these ideas for psychology, philosophy, and AI research, advocating for interdisciplinary collaboration and the incorporation of temporal perspectives into these fields. Northoff reflects on the philosophical implications of his research and suggests future directions for studying consciousness and temporal dynamics. He encourages readers to continue exploring the intricate relationship between the brain, body, world, and time, emphasizing its profound implications for our understanding of consciousness. Overall, this chapter serves as a concluding reflection on the book's main themes, reinforcing the significance of the brain's temporal dynamics in shaping consciousness and advocating for further exploration and collaboration in this field.

Discussion

Strengths

This book's strengths lie in its interdisciplinary approach, cross-cultural perspective, and the introduction of innovative concepts that revolutionize our understanding of consciousness. It encourages readers to think critically and paves the way for exciting developments in the study of the mind and consciousness.

Interdisciplinary Perspective: One of its standout features is its integration of concepts and insights from various disciplines,

including neuroscience, philosophy, psychology, and artificial intelligence. This interdisciplinary approach provides readers with a comprehensive understanding of the intricate relationships between the brain, body, world, and time. It facilitates a more holistic exploration of consciousness.

Cross-Cultural Perspective: The book goes beyond Western perspectives by incorporating concepts from traditional Chinese philosophy and merging them with modern physics. This approach yields a constructive interpretation of "time" and clarifies the characteristics of internal brain time and external world time. It lays a philosophical foundation for the study of consciousness and broadens the horizons of consciousness research.

Unique and Thought-Provoking Concepts: The book presents novel and profound ideas that challenge conventional thinking. Concepts such as "temporal receptive windows," "nested temporal scales," and the active role of the brain in shaping consciousness provide fresh frameworks for understanding our subjective experiences. These thought-provoking insights stimulate critical thinking and open up new avenues for research and contemplation.

Drawbacks

It's important to note that these potential drawbacks can vary depending on the reader's background, preferences, and expectations. Some may value the book's depth and theoretical exploration, while others might seek a more simplified or practical approach.

Complexity and Technicality: The book delves deeply into intricate subjects tied to neuroscience, philosophy, and consciousness. This complexity might pose difficulties for readers unfamiliar with these fields. The technical language and intricate arguments may demand considerable effort to fully grasp, potentially limiting accessibility for those without a robust background in these areas.

Limited Practical Application: While the book presents captivating theoretical viewpoints and concepts, it may offer restricted practical applications or actionable insights for readers seeking more applied or pragmatic knowledge. The focus on theoretical discussions and abstract concepts may not readily translate into everyday life or furnish specific practical guidance for particular research or professional domains.

Conclusion

"Neurowaves: Exploring the Dynamic Nature of Time in the Brain" presents a groundbreaking examination of the complex interplay between the brain and time. Integrating insights from spatiotemporal neuroscience, philosophy, psychology, and

contemporary physics, the book provides a profound understanding of the relationships among the brain, the world, and time. We wholeheartedly recommend this book to individuals intrigued by interdisciplinary—whether you're an academic, researcher, or an avid reader, the profound insights it offers are certain to be of significant benefit to you.

Data availability

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Conflict of interest statement

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