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REM sleep and the theory of relativity: a neurophysical-philosophical approach to subjective time

Sueño REM y teoría de la relatividad: una aproximación neurofísico-filosófica al tiempo subjetivo

Emilio Arch-Tirado[1], Miguel Á. Collado-Corona[1], Oscar Sánchez-Escandón[1,2], and Ana L. Lino-González[3]*

[1]Neurological Center, Centro Médico ABC, Sede Santa Fe; [2]Presidencia, Sociedad Mexicana para la Investigación y Medicina del Sueño; [3]Clinical Neurosciences Area, Instituto Nacional de Rehabilitación Luis Guillermo Ibarra Ibarra, Secretaría de Salud. Mexico City, Mexico

Abstract

This paper proposes an analogy between Einstein's time-space theory of relativity and the perception of time during REM sleep. Through the analysis of brief but intense dream experiences, it is proposed that the human brain generates a subjective time-space distortion similar to the time dilation described in relativistic physics. The paper reviews the neuroscientific foundations that explain the apparent expansion of dream time and proposes a reflection on subjective time as an emergent phenomenon of brain activity.

Keywords: *REM sleep. Theory of relativity. Dream time. Time-space distortion.*

Resumen

El presente trabajo propone una analogía entre la teoría de la relatividad temporoespacial de Einstein y la percepción del tiempo durante el sueño REM. A través del análisis de experiencias oníricas breves, pero intensas, se plantea que el cerebro humano genera una distorsión temporoespacial subjetiva semejante a la dilatación temporal descrita en la física relativista. Se revisan fundamentos neurocientíficos que explican la aparente expansión del tiempo onírico y se propone una reflexión sobre el tiempo subjetivo como fenómeno emergente de la actividad cerebral.

Palabras clave: *Sueño REM. Teoría de la relatividad. Tiempo onírico. Distorsión espacio-temporal.*

Correspondence:
Emilio Arch-Tirado
E-mail: arch.tirado@gmail.com

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Introduction

In 1848, Carroy described a paradigmatic oniric experience: he recounted the dream of Maury, who dreamed of being guillotined and awoke upon receiving a blow to the neck[1]. Carroy proposed that the entire dream occurred in the instant before awakening, suggesting that dream narratives may be condensed into seconds of real time. This idea was later supported by neuroscientific studies showing that most dreams occur during REM sleep, characterized by intense cortical activity and rapid eye movements[2].

Einstein's theory (1905) of spacetime relativity posits that time is relative to the observer's motion. In the famous twin paradox, a traveler moving at the speed of light would experience less time than their twin remaining on Earth[3]. The subjective experience of time may therefore radically differ from "objective" or externally measured time.

This article proposes an analogy between these two dimensions: relativistic time dilation and the subjective expansión of time experienced during dreams.

REM sleep and subjective time distortion

Research by Lecci et al. has shown that during REM sleep, the brain alternates between microstates of excitability approximately every 25 s, a pattern that may influence time perception[4]. In addition, findings suggest that during lucid dreaming, subjects are capable of performing complex cognitive and motor tasks over durations perceived as prolonged[5].

This perceived "slowing" of time within dreams mirrors Einstein's time dilation: two observers inhabiting the same physical universe may perceive different durations based on their respective states. The dreamer becomes an observer traversing a mental landscape disconnected from external chronology just as the relativistic traveler detaches from Earth-based time.

Physical análisis and symbolic modeling

Although the body is physically at rest during sleep, it continues to move with the Earth's orbital velocity, averaging 29.8 km/s. If a dream experience subjectively lasts 2 min but objectively occurs over only 2 s, a discrepancy of 120 s versus 2 s arises.

Using the classical formula for speed the Earth would travel 59.6 km in 2 s. However, from the perspective of the sleep, this same distance would appear to take 120 s, implying a much slower perceived velocity. This apparent distortion, although symbolic, exemplifies that the dreaming subject perceives time in a different framework than the physical one.

Neuroscience of subjective time

Georg Northoff's theory of "neuro-relativity" proposes that subjective time emerges from intrinsic brain activity rather than from external clocks[6]. During REM sleep, increased activity in the Default Mode Network and reduced prefrontal regulation generate an autonomous mental landscape where time is experienced as expanded[6,7].

The dreamer thus "lives more in less time." This phenomenon may have implications for studies of consciousness, creativity, and memory consolidation, as REM sleep not only reorganizes information but also reconstructs temporality.

Conclusion

REM sleep provides a unique opportunity to explore the relativity of time from a neurobiological perspective. Just as Einstein demonstrated that time is relative to the observer's motion, dreams demonstrate that time is also relative to one's state of consciousness and internal brain dynamics.

Even as the sleeping body remains physically still, the dreaming mind traverses a different topology, generating subjective spacetime realities. This coincidence between physical and neurobiological relativity justifies new interdisciplinary explorations between physics, philosophy of mind, and sleep neuroscience.

From a philosophical perspective, the experience of dreaming also challenges the linear and objective conception of time. Thinkers such as Henri Bergson and Edmund Husserl have defended the notion of "lived time" or "subjective duration" as opposed to the clock time of physics. Dreaming, by suspending external reference, becomes a privileged scenario to explore this internal, fluid, emotional, and non-linear duration. Dream consciousness behaves like a closed system in which time is reconfigured through subjective experience, opening the possibility that the human mind operates with temporal logics different from those traditionally established.

Thus, the convergence between physical relativity, the neurobiology of sleep, and the philosophy of time not only enriches our understanding of dreaming as a cerebral phenomenon but also invites us to rethink the very nature of time and its relationship to consciousness.

Finally, it can be concluded that dreaming involves the experience of two realities: real time and dream time, coexisting in the same moment and space, thereby generating a distortion of space and time. This suggests that the Theory of Relativity may be a valuable tool in the study of dreams.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. The study does not involve patient personal data nor require ethical approval. The SAGER guidelines do not apply.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

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