Symposium | Mammalian Brain

Fri. Oct 17, 2025 9:00 AM - 10:30 AM JST | Fri. Oct 17, 2025 12:00 AM - 1:30 AM UTC Room 1(Mathematical Science Building)

[S1] Symposium 1 :Time and Rhythm in the Mammalian Brain

Chair:Sonja Kotz(Maastricht University), Teresa Raimondi (Sapienza University of Rome)

Time and rhythm, the structured recurrence of events in time, orchestrate multiple functions in animal and human life, from oscillations in physiology, to gait patterning and social interaction. Despite their central role, the biological roots and evolution of time and rhythmicity remain only partially understood. This symposium will illuminate time and rhythm's multifaceted nature through an integrative, comparative framework, bridging proximate mechanisms and evolutionary explanations.
A central premise is that time and rhythm are not unitary phenomena but units of dissociable behavioral and neural modules. A comparative approach can dissect time and rhythm into components and trace their presence across taxa. Identifying homologies and analogies in temporal and rhythmic behavior allows reconstruction of their phylogenetic history and evolutionary significance.
However, isolated top-down (neurobiological) and bottom-up approaches have limitations. Top-down approaches identify brain modules enabling time and rhythm but are often ecologically limited and invasive. Bottom-up approaches detail observable output and ecological relevance but are a "black box" regarding proximate evolutionary causes, challenging phylogenetic tracing.
This symposium advocates for an integrative approach synthesizing both perspectives. Non-human animal models can reveal proximate neural and physiological mechanisms and ultimate causes (e.g., ecological pressures, communication, social dynamics) shaping the evolution of time and rhythm. Rodents and primates offer insights into convergent and divergent temporal and rhythmic behavior via phylogenetic and ethological proximity, respectively.
With this symposium, we pursue the following key objectives:
1. Fostering Interdisciplinary Dialogue: To bring together leading researchers from diverse fields including cognitive neuroscience, neurophysiology, comparative psychology, and ethology in a dialogue between mechanistic and evolutionary viewpoints.
2. Reviewing Current Advances: To provide a comprehensive overview of the most recent and innovative advances in experimental paradigms that link observed behavior to underlying brain activity across a wide range of species.
3. Catalyzing Future Research: To identify and catalyze promising new research directions and methodologies by highlighting both the conserved and unique aspects of timing and rhythmicity across different species.
4. Constructing a Comprehensive Framework: To collaboratively construct a more comprehensive and biologically grounded framework for understanding time and rhythm by recognizing their inherent architecture, remarkable evolutionary plasticity in response to diverse selective pressures, and fundamental role in coordinating the lives of animals, including humans.

9:00 AM - 9:30 AM JST | 12:00 AM - 12:30 AM UTC

[S1-01]

Time and Rhythm in the Mammalian Brain

*Sonja A Kotz[1], Teresa Raimondi[2] (1. Maastricht University (Netherlands), 2. Sapienza University of Rome (Italy))

9:30 AM - 9:45 AM JST | 12:30 AM - 12:45 AM UTC

[S1-02]

Tick-Tock Across Species: Comparative timing in audition

*Sonja A Kotz[1] (1. Maastricht University (Netherlands))

9:45 AM - 10:00 AM JST | 12:45 AM - 1:00 AM UTC

[S1-03]

When reward is right, macaques can have rhythm

*Hugo Merchant[1], Ameyaltzin Castillo-Almazán[1], Pablo Márquez[1], Vani Rajendran[1] (1. Instituto de Neurobiologia, UNAM, campus Juriquilla (Mexico))

10:00 AM - 10:15 AM JST | 1:00 AM - 1:15 AM UTC

[S1-04]

Rhythmic synchronization ability of rats

*Reo Wada[1], Hiroki Koda[1] (1. The University of Tokyo (Japan))

10:15 AM - 10:30 AM JST | 1:15 AM - 1:30 AM UTC

[S1-05]

Emergence of rhythm during sequential tapping in chimpanzees and humans

*Yuko Hattori[1] (1. Kyoto University (Japan))

Time and Rhythm in the Mammalian Brain

*Sonja A Kotz[1], Teresa Raimondi[2]

1. Maastricht University, 2. Sapienza University of Rome

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A central premise is that time and rhythm are not unitary phenomena but units of dissociable behavioral and neural modules. A comparative approach can dissect time and rhythm into components and trace their presence across taxa. Identifying homologies and analogies in temporal and rhythmic behavior allows reconstruction of their phylogenetic history and evolutionary significance.
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Keywords: Time, Rhythm, Synchronization, Oscillation, Evolution

Tick-Tock Across Species: Comparative timing in audition

*Sonja A Kotz[1]

1. Maastricht University

Exploring basic timing and subjective rhythms comparatively is crucial for understanding the neural mechanisms underlying auditory processing and cognition. Our studies reveal that even at a fundamental level (auditory thalamus, MGB), the processing of temporal regularity aligns in rats and humans, highlighting the MGB' s importance in adaptive auditory filtering of spectrotemporal signal quality. Furthermore, comparative research between macaques and humans demonstrates shared neural oscillations for tracking, anticipating, and attending to temporal regularities, suggesting a conserved evolutionary basis for this ability. Investigating these basic timing mechanisms and their potential link to subjective rhythmic experiences therefore can illuminate the evolution of complex cognitive functions related to temporal processing across species.

Keywords: evolution

When reward is right, macaques can have rhythm

*Hugo Merchant[1], Ameyaltzin Castillo-Almazán[1], Pablo Márquez[1], Vani Rajendran[1]

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A large set of new behavioral and electrophysiological studies support the notion that monkeys are not only able to perceive and synchronize to an isochronous metronome but also to more complex inputs. EEG studies in the Rhesus monkey have shown that macaques produce evoked potentials linked to subjectively accented 1:2 and 1:3 rhythms from auditory metronomes. In addition, monkeys trained on tapping tasks can flexibly and predictively produce periodic intervals in synchrony with auditory and visual metronomes, can continue tapping without sensory cues, and can even consistently tap to the subjective beat of music excerpts.
Hence, macaques extract a rhythm from a continuous stream of sensory events, generate an internal rhythmic signal that predicts future beat events, and produce anticipatory motor commands such that movements slightly anticipate the next rhythm. Crucially, reward is a fundamental element so that monkeys can properly drive their predictive abilities within these tasks.

Keywords: rhythm, macaques

Rhythmic synchronization ability of rats

*Reo Wada[1], Hiroki Koda[1]

1. The University of Tokyo

Studying how animals perceive and respond to rhythm is important for understanding the evolutionary origins of musical abilities. Rhythmic synchronization, where animals coordinate their movements with a rhythmic stimulus, is one way to examine rhythmic cognition and is thought to be accompanied by vocal learning ability. Recent studies suggest possible rhythmic synchronization in rats, a non-vocal learning animal, but different tasks and limited findings make species comparisons difficult. Here, we employed an approach similar to that for other species and investigated whether rats also spontaneously synchronize their tapping with a rhythmic auditory stimulus. The results showed that rats responded synchronously to stimulus presentation in the fast-tempo condition. This finding suggests that non-vocal learning species, such as rats, can synchronize external rhythm only when the tempo of the rhythm is close to the tempo of their movement.

Keywords: Rhythmic synchronization, rats

Emergence of rhythm during sequential tapping in chimpanzees and humans

*Yuko Hattori[1]

1. Kyoto University

Both humans and non-human animals are known to spontaneously generate motor rhythms when controlling temporally sequential movements, such as walking or speaking. However, most previous studies on motor-related rhythms have primarily focused on externally guided synchronization, leaving the properties of rhythms that emerge spontaneously during motor learning, especially in non-human animals, largely unexplored.
In this study, I examined the spontaneous generation of motor rhythms in chimpanzees and humans as they learned to perform sequential key-tapping tasks. By comparing the rhythmic characteristics between the two species, I aim to shed light on the evolutionary pathway of rhythm generation abilities during motor learning and explore uniquely human mechanisms underlying this capacity.

Keywords: chimpanzees, tapping