Fri. Oct 17, 2025

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)

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))

Symposium | Healthy and Pathological Aging

Fri. Oct 17, 2025 5:15 PM - 6:45 PM JST | Fri. Oct 17, 2025 8:15 AM - 9:45 AM UTC Room 3(East B1)

[S3] Symposium 3: Towards a comprehensive understanding of time processing changes in healthy and pathological aging

Chair:Thomas Hinault(INSERM)

5:15 PM - 5:30 PM JST | 8:15 AM - 8:30 AM UTC

[S3-01]

Towards a comprehensive understanding of time processing changes in healthy and pathological aging

*Thomas Thierry Hinault[1] (1. U1077 Inserm (France))

5:30 PM - 5:45 PM JST | 8:30 AM - 8:45 AM UTC

[S3-02]

Aging effects on the neural bases of temporal processing

*Thomas Thierry Hinault[1] (1. U1077 Inserm (France))

5:45 PM - 6:00 PM JST | 8:45 AM - 9:00 AM UTC

[S3-03]

Electrophysiological signature of explicit and implicit timing in young and older adults

*Giovanna Mioni[1], Fiorella del Popolo Cristaldi[1], Luigi Micillo[1], Nicola Cellini[1] (1. Department of General Psychology, University of Padova (Italy))

6:00 PM - 6:15 PM JST | 9:00 AM - 9:15 AM UTC

[S3-04]

Time processing in prodromal stages of Alzheimer’s Disease

*Alice Teghil[1] (1. Sapienza University of Rome (Italy))

6:15 PM - 6:30 PM JST | 9:15 AM - 9:30 AM UTC

[S3-05]

Temporal processing disturbances in the dementias – from mechanisms to management

*Muireann Irish[1] (1. The University of Sydney (Australia))

Symposium | Temporal Metacognition

Fri. Oct 17, 2025 9:00 AM - 10:30 AM JST | Fri. Oct 17, 2025 12:00 AM - 1:30 AM UTC Room 2(West B1)

[S2] Symposium 2: Watching the Clock Err: Different Levels of Explanation for Temporal Metacognition

Chair:Tutku Oztel(George Mason University)

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

[S2-01]

Watching the Clock Err: Different Levels of Explanation for Temporal Metacognition

*Tutku Oztel[1] (1. George Mason University (United States of America))

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

[S2-02]

Cognitive Architecture Through Methodological Lenses: Understanding Temporal Error Monitoring

*Tutku Oztel[1] (1. George Mason University (United States of America))

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

[S2-03]

“Catching yourself trip” on timing errors

*Fuat Balci[1] (1. University of Manitoba (Canada))

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

[S2-04]

Exploring the Domain-Generality of Temporal Metacognition: From introspective reaction time to confidence in explicit timing

*Nathalie Pavailler[1] (1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris-Saclay, Gif/Yvette, 91191 France (France))

Symposium | Temporal Experience

Fri. Oct 17, 2025 5:15 PM - 6:45 PM JST | Fri. Oct 17, 2025 8:15 AM - 9:45 AM UTC Room 2(West B1)

[S4] Symposium 4: The Varieties of Temporal Experience: The Past, Present, and Future of Time Perception Research

Chair:Martin Wiener(George Mason University)

5:15 PM - 5:30 PM JST | 8:15 AM - 8:30 AM UTC

[S4-01]

The Varieties of Temporal Experience: The Past, Present, and Future of Time Perception Research

*Martin Wiener[1] (1. George Mason University (United States of America))

5:30 PM - 5:45 PM JST | 8:30 AM - 8:45 AM UTC

[S4-02]

Is Time Special?

*Martin Wiener[1] (1. George Mason University (United States of America))

5:45 PM - 6:00 PM JST | 8:45 AM - 9:00 AM UTC

[S4-03]

Of time and memory in cognitive neurosciences: how the observer flaws our understanding of time

*Virginie van Wassenhove[1] (1. CEA NeuroSpin; INSERM Unicog; Univ. Paris-Saclay (France))

6:00 PM - 6:15 PM JST | 9:00 AM - 9:15 AM UTC

[S4-04]

Temporality and the brain: the long and winding emergence of time in cognitive neuroscience

*Ayelet N Landau[1,2] (1. Hebrew University of Jerusalem (Israel), 2. University College London (UK))

6:15 PM - 6:30 PM JST | 9:15 AM - 9:30 AM UTC

[S4-05]

Measuring the neural clocks: fifteen years of timing neurophysiology

*Hugo Merchant[1], Germán Mendoza[1], Oswaldo Pérez[1] (1. Instituto de Neurobiologia, UNAM, campus Juriquilla (Mexico))

Sat. Oct 18, 2025

Symposium | Space-Time Interference

Sat. Oct 18, 2025 10:45 AM - 12:15 PM JST | Sat. Oct 18, 2025 1:45 AM - 3:15 AM UTC Room 3(East B1)

[S5] Symposium 5: Space-time interference in behavior and neuronal processing

Chair:Martin Riemer(Technical University Berlin)

10:45 AM - 11:00 AM JST | 1:45 AM - 2:00 AM UTC

[S5-01]

Space-time interference in behavior and neuronal processing

*Martin Riemer[1] (1. Technical University Berlin (Germany))

11:00 AM - 11:15 AM JST | 2:00 AM - 2:15 AM UTC

[S5-02]

Cross-dimensional interference between illusory size and duration

*Daniel Bratzke[1], Rolf Ulrich[2] (1. University of Bremen (Germany), 2.University of Tübingen, Germany)

11:15 AM - 11:30 AM JST | 2:15 AM - 2:30 AM UTC

[S5-03]

Using speed to think about space and time

*Martin Riemer[1] (1. Technical University Berlin (Germany))

11:30 AM - 11:45 AM JST | 2:30 AM - 2:45 AM UTC

[S5-04]

The neural link between stimulus duration and spatial location in the human visual hierarchy

*Gianfranco Fortunato[1], Valeria Centanino[1], Domenica Bueti[1] (1. International School for Advanced Studies (SISSA) (Italy))

11:45 AM - 12:00 PM JST | 2:45 AM - 3:00 AM UTC

[S5-05]

A different angle on space-time interference: Disentangling cognitive maps and graphs in the human brain

*Yangwen Xu[1], Max A.B. Hinrichs[1], Roberto Bottini[2], Christian F Doeller[1,3] (1. Max Planck Institute for Human Cognitive and Brain Sciences (Germany), 2. Center for Mind/Brain Sciences, University of Trento (Italy), 3. Kavli Institute for Systems Neuroscience (Norway))

Symposium | Birds, Humans, and Primates

Sat. Oct 18, 2025 10:45 AM - 12:15 PM JST | Sat. Oct 18, 2025 1:45 AM - 3:15 AM UTC Room 2(West B1)

[S6] Symposium 6: Rhythmic sound development and plasticity in birds, humans, and primates

Chair:Andrea Ravignani(Sapienza University of Rome)

10:45 AM - 11:00 AM JST | 1:45 AM - 2:00 AM UTC

[S6-01]

Rhythmic sound development and plasticity in birds, humans, and primates

*Andrea Ravignani[1] (1. Dept. of Human Neurosciences, Sapienza University of Rome (Italy))

11:00 AM - 11:15 AM JST | 2:00 AM - 2:15 AM UTC

[S6-02]

Developmental Changes in the Temporal Properties of Preverbal Vocalizations in Early Human Infancy

*Miki Takahasi[1] (1. RIKEN (Japan))

11:15 AM - 11:30 AM JST | 2:15 AM - 2:30 AM UTC

[S6-03]

The ontogeny of vocal rhythms in a non-human primate

*Teresa Raimondi[1,2], Lia Laffi[1,2], Chiara De Gregorio[2], Daria Valente[2], Walter Cristiano[2,3], Filippo Carugati[2], Valeria Ferrario[2], Valeria Torti[2], Jonah Ratsimbatsafy[4], Cristina Giacoma[2], Andrea Ravignani[1,5,6], Marco Gamba[2] (1. Sapienza University of Rome (Italy), 2. University of Turin (Italy), 3. Italian National Institute of Health (Italy), 4. Groupe d'Étude et de Recherche sur les Primates de Madagascar (Madagascar), 5. Aarhus University (Denmark), 6. The Royal Academy of Music (Denmark))

11:30 AM - 11:45 AM JST | 2:30 AM - 2:45 AM UTC

[S6-04]

Individual temporal plasticity in singing in the adult indris

*Marco Gamba[1], Lia Laffi[1], Silvia Leonetti[1], Filippo Carugati[1], Valeria Ferrario[1], Flavie Eveillard[1], Teresa Raimondi[1], Chiara De Gregorio[1], Longondraza Miaretsoa[1], Olivier Friard[1], Cristina Giacoma[1], Valeria Torti[1], Andrea Ravignani[1], Daria Valente[1] (1. Università di Torino (Italy))

11:45 AM - 12:00 PM JST | 2:45 AM - 3:00 AM UTC

[S6-05]

Social inheritance of Java sparrow rhythms

*Anthony Kwong[1], Rebecca N Lewis[1], Masayo Soma[1], Andrea Ravignani[1], Taylor Hersh[1] (1. University of Manchester (UK))

Sun. Oct 19, 2025

Symposium | Online and Mobile Environments

Sun. Oct 19, 2025 9:00 AM - 10:30 AM JST | Sun. Oct 19, 2025 12:00 AM - 1:30 AM UTC Room 3(East B1)

[S7] Symposium 7: Beyond the Lab: Timing Perception and Cognition in Online and Mobile Environments

Chair:David Melcher(New York University Abu Dhabi)

9:00 AM - 9:15 AM JST | 12:00 AM - 12:15 AM UTC

[S7-01]

Beyond the Lab: Timing Perception and Cognition in Online and Mobile Environments

*David Melcher[1] (1. New York University Abu Dhabi (United Arab Emirates))

9:15 AM - 9:30 AM JST | 12:15 AM - 12:30 AM UTC

[S7-02]

Synchronizing Perception Online: Temporal Binding, Attention, and Individual Differences

*Gianluca Marsican, David Melcher (New York University Abu Dhabi (United Arab Emirates))

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

[S7-03]

Temporal Perception and Anomalous Visual Experiences: Insights from Large-Scale Web-Based Psychophysics

*Michele Deodato, David Melcher (New York University Abu Dhabi (United Arab Emirates))

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

[S7-04]

Compressed experimentation: duration, passage of time, and the temporal structure of memory

*Marianna Lamprou Kokolaki[1], Virginie van Wassenhove[1] (1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris Saclay (France))

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

[S7-05]

Inferring alpha oscillations from visual illusion: A smartphone-based method

*Kaoru Amano[1] (1. The University of Tokyo (Japan))

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

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.
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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]

1. Instituto de Neurobiologia, UNAM, campus Juriquilla

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

Symposium | Healthy and Pathological Aging

Fri. Oct 17, 2025 5:15 PM - 6:45 PM JST | Fri. Oct 17, 2025 8:15 AM - 9:45 AM UTC Room 3(East B1)

[S3] Symposium 3: Towards a comprehensive understanding of time processing changes in healthy and pathological aging

Chair:Thomas Hinault(INSERM)

Time processing, the ability to process and memorize temporal information, is essential for cognitive functioning and supports the seamless execution of many of life's daily tasks. While cognitive aging is typically associated with changes in attention and memory, mounting evidence indicates distinct alterations in time processing in older age. These changes in time processing are exacerbated in pathological aging, including neurodegenerative conditions such as Alzheimer's disease and semantic dementia.
Research exploring interindividual differences in time processing with advancing age, and their underlying neural substrates, are crucial to inform our understanding of trajectories of healthy aging, as well as to improve the early detection of neurodegenerative disorders. Moreover, understanding the cognitive mechanisms driving age-related changes in time processing has the potential to improve our capacity to intervene and support older individuals to live well. In turn, investigating healthy and pathological aging trajectories can inform current neurocognitive models of time processing.
To address these questions, this symposium brings together a panel of diverse speakers from three different countries who will discuss recent developments in the cognitive neuroscience of time processing. Our objective is to provide a comprehensive overview of the neurocognitive mechanisms underpinning altered time processing in healthy and pathological aging, and to promote multidisciplinary collaboration to inspire new directions for future research.

5:15 PM - 5:30 PM JST | 8:15 AM - 8:30 AM UTC

[S3-01]

Towards a comprehensive understanding of time processing changes in healthy and pathological aging

*Thomas Thierry Hinault[1] (1. U1077 Inserm (France))

5:30 PM - 5:45 PM JST | 8:30 AM - 8:45 AM UTC

[S3-02]

Aging effects on the neural bases of temporal processing

*Thomas Thierry Hinault[1] (1. U1077 Inserm (France))

5:45 PM - 6:00 PM JST | 8:45 AM - 9:00 AM UTC

[S3-03]

Electrophysiological signature of explicit and implicit timing in young and older adults

*Giovanna Mioni[1], Fiorella del Popolo Cristaldi[1], Luigi Micillo[1], Nicola Cellini[1] (1. Department of General Psychology, University of Padova (Italy))

6:00 PM - 6:15 PM JST | 9:00 AM - 9:15 AM UTC

[S3-04]

Time processing in prodromal stages of Alzheimer's Disease

*Alice Teghil[1] (1. Sapienza University of Rome (Italy))

6:15 PM - 6:30 PM JST | 9:15 AM - 9:30 AM UTC

[S3-05]

Temporal processing disturbances in the dementias – from mechanisms to management

*Muireann Irish[1] (1. The University of Sydney (Australia))

Towards a comprehensive understanding of time processing changes in healthy and pathological aging

*Thomas Thierry Hinault[1]

1. U1077 Inserm

Time processing, the ability to process and memorize temporal information, is essential for cognitive functioning and supports the seamless execution of many of life’s daily tasks. While cognitive aging is typically associated with changes in attention and memory, mounting evidence indicates distinct alterations in time processing in older age. These changes in time processing are exacerbated in pathological aging, including neurodegenerative conditions such as Alzheimer’s disease and semantic dementia.
Research exploring interindividual differences in time processing with advancing age, and their underlying neural substrates, are crucial to inform our understanding of trajectories of healthy aging, as well as to improve the early detection of neurodegenerative disorders. Moreover, understanding the cognitive mechanisms driving age-related changes in time processing has the potential to improve our capacity to intervene and support older individuals to live well. In turn, investigating healthy and pathological aging trajectories can inform current neurocognitive models of time processing.
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Keywords: Cognitive Aging, Alzheimer’s disease, Mental time travel, Duration Processing, EEG

Aging effects on the neural bases of temporal processing

*Thomas Thierry Hinault[1]

1. U1077 Inserm

While behavioral studies have been conducted to specify age-related changes of time perception and the temporal structuration of memory content, the neural bases underlying these changes remain unknown. The TIMES project is currently investigating age-related changes in the neural mechanisms underlying temporal processing using simultaneous electroencephalography and functional magnetic resonance imaging (EEG-fMRI), in healthy young (20-35 years) and healthy older participants (60-75 years). In this talk, I will present preliminary results showing that individual levels of fronto-parietal theta-gamma synchrony are associated with the activity of the striatum and fronto-striatal functional connectivity couplings. These fronto-parietal theta-gamma couplings show a greater variability as a function of decreased striatal activity in older adults. By applying multiscale modelling to investigate network dynamics association with temporal processing, new insights can be obtained on both the evolution of the neural bases of temporal processing with advancing age and the heterogeneity of aging trajectories across individuals.

Keywords: aging

Electrophysiological signature of explicit and implicit timing in young and older adults

*Giovanna Mioni[1], Fiorella del Popolo Cristaldi[1], Luigi Micillo[1], Nicola Cellini[1]

1. Department of General Psychology, University of Padova

Age-related changes in temporal processing are widely reported, but it remains debated whether they result from a slowing of temporal processing or reduced cognitive functioning in older adults. This study examined electrophysiological signatures of explicit and implicit timing using EEG, focusing on CNV, N1/P2 amplitude, and beta band modulation. Young and older adults (N = 26) completed time bisection (explicit) and foreperiod (implicit) tasks. Results showed no significant CNV or N1/P2 differences between tasks in older adults. However, younger adults exhibited larger CNV amplitudes than older adults for supra-second intervals in the explicit task and for all intervals in the implicit task.
Additionally, younger participants showed greater beta desynchronization for all intervals in the implicit task. These findings suggest age-related differences in temporal processing, with younger adults displaying stronger neural engagement, particularly in implicit timing.

Keywords: aging, EEG

Time processing in prodromal stages of Alzheimer’ s Disease

*Alice Teghil[1]

1. Sapienza University of Rome

While impaired time processing is common in Alzheimer’ s Disease (AD), research on duration perception in early disease stages, such as Mild Cognitive Impairment (MCI), has yielded mixed results.
In this talk, I will present evidence that subtle alterations in duration processing may occur early in AD, as reduced performance in retrospective timing and temporal learning tasks already emerges in MCI. Differences in timing performance relative to healthy older adults are also found in Subjective Cognitive Decline (SCD), a preclinical phase of AD characterized by a self-perceived change in cognitive performance not revealed by neuropsychological tests. Recent results show that changes in duration processing in SCD are further modulated by the level of cognitive complaint, and are paralleled by time-dependent alterations in autobiographical memory. Findings shed light on factors underlying altered time perception in prodromal AD, and on the contribution of duration processing to episodic features of memory.

Keywords: Alzheimer’ s Disease

Temporal processing disturbances in the dementias –from mechanisms to management

*Muireann Irish[1]

1. The University of Sydney

Humans possess the remarkable capacity to navigate mentally through extended periods of subjective time. This capacity bestows immense flexibility in our thinking, enabling us to revisit events from the past via autobiographical memory, or to project oneself into the future via episodic foresight. There is now abundant evidence to indicate that these temporally extended voyages across past and future contexts are compromised in neurodegenerative disorders, reflecting the breakdown of large-scale brain networks implicated in memory, planning, and executive function. In this talk, I will provide an overview of mental time travel disturbances in frontotemporal dementia, semantic dementia, and Alzheimer’ s disease, paying particular attention to their respective underlying neurocognitive mechanisms. I will demonstrate how mental time travel disturbances likely represent a transdiagnostic feature of dementia, and how we can use this information to support many of the behavioural and functional impairments experienced by patients in their daily lives.

Keywords: Alzheimer’ s disease

Symposium | Temporal Metacognition

Fri. Oct 17, 2025 9:00 AM - 10:30 AM JST | Fri. Oct 17, 2025 12:00 AM - 1:30 AM UTC Room 2(West B1)

[S2] Symposium 2: Watching the Clock Err: Different Levels of Explanation for Temporal Metacognition

Chair:Tutku Oztel(George Mason University)

Recent studies have demonstrated that the scope of the metacognitive abilities can be expanded to time and other metric domains, reflected in a trial-by-trial match between timing errors and error monitoring components. This reveals a robust temporal error monitoring ability that can also be observed in numerosity and spatial forms. The symposium aims at providing an extensive discussion on different levels of explanation of temporal error monitoring by bringing together speakers that employ diverse methodologies in humans, rodents, and computational modeling. The first speaker will discuss how different methodological approaches can capture differential cognitive/phenomenological aspects of the metric error monitoring ability and shed light into our understanding of it at the cognitive level. The second speaker will discuss how this ability takes place at the computational level along with providing insights on its manifestation in mouse behavior. The last speaker will discuss how domain generality of temporal error monitoring can be investigated with motor action taking along with its physiological markers. While aiming at providing different methodological and theoretical approaches for the study of temporal error monitoring, this symposium series would be of particular interest for all researchers who aim to study time perception and magnitude representations at the consciousness level.

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

[S2-01]

Watching the Clock Err: Different Levels of Explanation for Temporal Metacognition

*Tutku Oztel[1] (1. George Mason University (United States of America))

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

[S2-02]

Cognitive Architecture Through Methodological Lenses: Understanding Temporal Error Monitoring

*Tutku Oztel[1] (1. George Mason University (United States of America))

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

[S2-03]

“Catching yourself trip” on timing errors

*Fuat Balci[1] (1. University of Manitoba (Canada))

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

[S2-04]

Exploring the Domain-Generality of Temporal Metacognition: From introspective reaction time to confidence in explicit timing

*Nathalie Pavailler[1] (1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris-Saclay, Gif/Yvette, 91191 France (France))

Watching the Clock Err: Different Levels of Explanation for Temporal Metacognition

*Tutku Oztel[1]

1. George Mason University

Recent studies have demonstrated that the scope of the metacognitive abilities can be expanded to time and other metric domains, reflected in a trial-by-trial match between timing errors and error monitoring components. This reveals a robust temporal error monitoring ability that can also be observed in numerosity and spatial forms. The symposium aims at providing an extensive discussion on different levels of explanation of temporal error monitoring by bringing together speakers that employ diverse methodologies in humans, rodents, and computational modeling.
The first speaker will discuss how different methodological approaches can capture differential cognitive/phenomenological aspects of the metric error monitoring ability and shed light into our understanding of it at the cognitive level. The second speaker will discuss how this ability takes place at the computational level along with providing insights on its manifestation in mouse behavior. The last speaker will discuss how domain generality of temporal error monitoring can be investigated with motor action taking along with its physiological markers. While aiming at providing different methodological and theoretical approaches for the study of temporal error monitoring, this symposium series would be of particular interest for all researchers who aim to study time perception and magnitude representations at the consciousness level.

Keywords: Temporal Error Monitoring, Metacognition, Time Perception, Levels of Processing

Cognitive Architecture Through Methodological Lenses: Understanding Temporal Error Monitoring

*Tutku Oztel[1]

1. George Mason University

Recent research indicates that error monitoring abilities extend to the metric domains of time, space, and number. In this talk, I will discuss our current understanding of metric/temporal error monitoring (TEM) by elucidating how diverse methodologies shape it.
First, I will focus on explicit measures of assessing TEM, delineating online and offline measurement. I will first discuss the discovery of phenomenological dissociation of timing error magnitude and direction within online measures. I will then identify key factors for monitoring cumulative timing errors within offline measures. Next, I will elaborate on TEM's application to non-motor timing, discussing how non-motor temporal biases are represented on a hypothetical mental timeline in temporal order judgment and why contextual temporal biases are exempt from metacognitive monitoring. Finally, I will address implicit indications of TEM through Bayesian integration of social cues in numerosity estimation. I will conclude by discussing implications for future investigations of TEM.

Keywords: Temporal Error Monitoring

“Catching yourself trip” on timing errors

*Fuat Balci[1]

1. University of Manitoba

Recent evidence shows that humans and rats can monitor their timing errors, namely “temporal error monitoring”. In the first part of this talk, I will present new evidence corroborating these observations in two mice studies. First study shows monitoring of temporal control, forming a rudimentary temporal error monitoring. The second study demonstrates a refined magnitude-based error monitoring. Together, these results demonstrate the nested architecture of temporal awareness. Next, I will present two drift-diffusion models of temporal error monitoring. First model affords the etrospective detection of timing errors, whereas the second model reads out and anticipates timing errors. Notably, second model affords the translation of real-time error signals into improved timing without violating psychophysical features of timing behavior. Finally, the task representation dependency of the refinement element accounts for the widely reported reward-rate maximizing timing behavior. Ultimately, this talk signifies the maturing empirical and theoretical scenery in temporal error monitoring research.

Keywords: Temporal Error Monitoring

Exploring the Domain-Generality of Temporal Metacognition: From introspective reaction time to confidence in explicit timing

*Nathalie Pavailler[1]

1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris-Saclay, Gif/Yvette, 91191 France

Temporal metacognition refers to the ability to monitor and evaluate timing-related processes but whether this type of metacognition is domain-general or domain-specific is unknown. To address this question, I will present two different lines of work. In the first one, we investigated introspective reaction time (iRT) judgments and showed their reliance on multiple sources of information combining direct readouts of mental operations and inferential processes (Pavailler et al, 2025). iRT is postulated to be linked to a generic performance monitoring system, as reflected by the Error-Related Negativity recorded with EEG (Pavailler et al., in prep).
In a second line of work, we used metaperception and developed a confidence forced-choice paradigm (de Gardelle & Mamassian, 2014, 2016) contrasting temporal and visual bisection tasks. I will discuss how these two approaches contribute to a better understanding of whether temporal metacognition relies on specialized or shared cognitive and neural mechanisms.

Keywords: temporal metacognition

Symposium | Temporal Experience

Fri. Oct 17, 2025 5:15 PM - 6:45 PM JST | Fri. Oct 17, 2025 8:15 AM - 9:45 AM UTC Room 2(West B1)

[S4] Symposium 4: The Varieties of Temporal Experience: The Past, Present, and Future of Time Perception Research

Chair:Martin Wiener(George Mason University)

Time is experienced in myriad ways, between periods of high stability and instability, governing the ways in which we experience everyday moments, encode memories, make decisions, plan and organize our thoughts. The time perception researcher is thus faced with a challenge unlike other domains: whence to begin?
At the TRF2 meeting, we held a special event dedicated to the near-term goals of time perception research – the timing “moonshot”; in this symposium, we will bidirectionally extend this horizon to provide an overview of the past, the present, and the future of time perception research. That is, what does the history and emergence of timing research tell us about where it may be headed? What are the challenges, both common to other disciplines and unique to our own, in studying “time”? What answers have we achieved, with the advent of new technologies and recording techniques, and what remains unknown, or unknowable? Each of the four speakers will thus provide their own unique perspective on these questions. Unlike other symposia, the talks will be shorter in length and will be followed by a panel discussion among the speakers with a moderator and questions. The intended audience is early career scientists and students, with the goal being to help guide future inquiries and enable success, whether continuing in time perception research or exploring other domains.

5:15 PM - 5:30 PM JST | 8:15 AM - 8:30 AM UTC

[S4-01]

The Varieties of Temporal Experience: The Past, Present, and Future of Time Perception Research

*Martin Wiener[1] (1. George Mason University (United States of America))

5:30 PM - 5:45 PM JST | 8:30 AM - 8:45 AM UTC

[S4-02]

Is Time Special?

*Martin Wiener[1] (1. George Mason University (United States of America))

5:45 PM - 6:00 PM JST | 8:45 AM - 9:00 AM UTC

[S4-03]

Of time and memory in cognitive neurosciences: how the observer flaws our understanding of time

*Virginie van Wassenhove[1] (1. CEA NeuroSpin; INSERM Unicog; Univ. Paris-Saclay (France))

6:00 PM - 6:15 PM JST | 9:00 AM - 9:15 AM UTC

[S4-04]

Temporality and the brain: the long and winding emergence of time in cognitive neuroscience

*Ayelet N Landau[1,2] (1. Hebrew University of Jerusalem (Israel), 2. University College London (UK))

6:15 PM - 6:30 PM JST | 9:15 AM - 9:30 AM UTC

[S4-05]

Measuring the neural clocks: fifteen years of timing neurophysiology

*Hugo Merchant[1], Germán Mendoza[1], Oswaldo Pérez[1] (1. Instituto de Neurobiologia, UNAM, campus Juriquilla (Mexico))

The Varieties of Temporal Experience: The Past, Present, and Future of Time Perception Research

*Martin Wiener[1]

1. George Mason University

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Keywords: Time Perception, Cognitive Neuroscience, History of Timing, Philosophy of Timing

Is Time Special?

*Martin Wiener[1]

1. George Mason University

Is “time” special? The answer to this question may seem obvious to a group of timing researchers at a timing conference, but the importance of a thing can be obscured by its closeness. In this talk, I will provide a reasoned argument for why the study of time is, in fact, special and why researchers can and should focus their attention to how the brain processes and perceives intervals of time. The title of the talk also reflects the internal conflict that many researchers studying time must face: since time is such an omnipresent feature of consciousness, of what use is there in studying it at all? Are we really studying “time”, or are we using temporal behavior to study other phenomena? This talk will lay out that argument and then proceed to counter it with the alternative view that time is, in fact, special.

Keywords: time

Of time and memory in cognitive neurosciences: how the observer flaws our understanding of time

*Virginie van Wassenhove[1]

1. CEA NeuroSpin; INSERM Unicog; Univ. Paris-Saclay

We segment time into past, present, and future, and scale temporal phenomenologies to “now”, a lifetime or universal times. This operationalization provides a practical approach to the study of temporal cognition, but it also suggests that neural systems process information differently when it is available in the present than when it is not. In cognitive neuroscience, this operationalization also divides the study of time into timing research, which focuses on online time perception (the integration of past experiences and prior knowledge to inform expectations and future predictions) and memory research, centered on the reconstruction of past events and foresight or imagination. Interestingly, both approaches require a temporal coordinate system or reference frame for time to enable the flexible mapping of information. Yet neither domain directly tackles the issue. The physical realization of a mental time axis in the brain currently eludes existing frameworks.

Keywords: time perception

Temporality and the brain: the long and winding emergence of time in cognitive neuroscience

*Ayelet N Landau[1,2]

1. Hebrew University of Jerusalem, 2. University College London

Understanding how our sensory systems generate coherent experiences of the world has been an outstanding quest for centuries. Throughout history, philosophers, biologists, psychologists, and –in the past few decades - cognitive neuroscientists have sought answers to how our brain generates thinking and feeling, behavior, and consciousness. Among the most fundamental aspects of conscious experience is the perception of time. In this talk I will discuss a bias that has characterized this quest: a spatial approach to understanding the neural mechanisms of cognition. I will critically assess this emphasis, offer a historical account, and point to its tacit assumptions and limitations. I will highlight key moments when opportunities to incorporate temporal principles were overlooked. Drawing on recent examples, I will discuss the potential of integrating the temporal domain into our understanding of the brain. Finally, I will show how a temporal prism can illuminate the study of mechanisms of time perception.

Keywords: cognitive neuroscience

Measuring the neural clocks: fifteen years of timing neurophysiology

*Hugo Merchant[1], Germán Mendoza[1], Oswaldo Pérez[1]

1. Instituto de Neurobiologia, UNAM, campus Juriquilla

During the last fifteen-years many laboratories across the globe have recorded the neural activity of different brain areas during timing tasks, including perceptual or motor paradigms that require processing single intervals or rhythmic sequences. A handful of time-varying signals in the discharge rate of neurons have been identified as potential neural clocks. Here, we show how the neural populations of cells in the medial premotor areas and the putamen encode different timing features during a set of timing tasks, strongly suggesting that neural sequences and state space neural trajectories are the substrate of timing and that these signals are interacting dynamically with other sensory and motor execution neural responses of the timing tasks. We are also discussing how this interval timing information needs to be integrated with the incoming neural signals of primary sensory areas to generate efficient loops, especially in rhythmic tasks.

Keywords: neural correlates

Symposium | Space-Time Interference

Sat. Oct 18, 2025 10:45 AM - 12:15 PM JST | Sat. Oct 18, 2025 1:45 AM - 3:15 AM UTC Room 3(East B1)

[S5] Symposium 5: Space-time interference in behavior and neuronal processing

Chair:Martin Riemer(Technical University Berlin)

Time perception is related to the perception of space. This idea has received support from behavioral and neuroscience studies. At the behavioral level, mutual interference between the perception of time and space have been demonstrated. Larger objects are perceived as lasting longer, and the physical duration of stimuli affect their perceived size. Casasanto and Boroditsky (2008) reported evidence for an asymmetric relationship between space and time, with time being more affected by space than vice versa. This finding has stimulated the idea of a hierarchical representation of space and time, which is in line with conceptual metaphor theory but has also invoked skepticism (Riemer & Cai, 2024). The theory of an asymmetric representation of time and space is one focus of this symposium. At the neuronal level, evidence for a common processing of time, space and other magnitudes in the parietal cortex (especially the right intraparietal sulcus; Bueti & Walsh, 2009) has led to the idea of a dimension-unspecific magnitude system. The idea of a common mechanism for the processing of temporal and spatial information has been reinforced by the discovery of time cells in the medial temporal lobe, a brain structure primarily known for its role in spatial processing (Eichenbaum, 2017). Together, these findings represent potential neuronal origins for the emergence of space-time interference in behavior.
The first two talks of the symposium are predominantly focused on behavioral studies about the (a)symmetric representation of time and space, while in the last two talks we will take a look at the neuronal processes underlying time and space perception.

10:45 AM - 11:00 AM JST | 1:45 AM - 2:00 AM UTC

[S5-01]

Space-time interference in behavior and neuronal processing

*Martin Riemer[1] (1. Technical University Berlin (Germany))

11:00 AM - 11:15 AM JST | 2:00 AM - 2:15 AM UTC

[S5-02]

Cross-dimensional interference between illusory size and duration

*Daniel Bratzke[1], Rolf Ulrich[2] (1. University of Bremen (Germany), 2.University of Tübingen, Germany)

11:15 AM - 11:30 AM JST | 2:15 AM - 2:30 AM UTC

[S5-03]

Using speed to think about space and time

*Martin Riemer[1] (1. Technical University Berlin (Germany))

11:30 AM - 11:45 AM JST | 2:30 AM - 2:45 AM UTC

[S5-04]

The neural link between stimulus duration and spatial location in the human visual hierarchy

*Gianfranco Fortunato[1], Valeria Centanino[1], Domenica Bueti[1] (1. International School for Advanced Studies (SISSA) (Italy))

11:45 AM - 12:00 PM JST | 2:45 AM - 3:00 AM UTC

[S5-05]

A different angle on space-time interference: Disentangling cognitive maps and graphs in the human brain

*Yangwen Xu[1], Max A.B. Hinrichs[1], Roberto Bottini[2], Christian F Doeller[1,3] (1. Max Planck Institute for Human Cognitive and Brain Sciences (Germany), 2. Center for Mind/Brain Sciences, University of Trento (Italy), 3. Kavli Institute for Systems Neuroscience (Norway))

Space-time interference in behavior and neuronal processing

*Martin Riemer[1]

1. Technical University Berlin

Time perception is related to the perception of space. This idea has received support from behavioral and neuroscience studies. At the behavioral level, mutual interference between the perception of time and space have been demonstrated. Larger objects are perceived as lasting longer, and the physical duration of stimuli affect their perceived size. Casasanto and Boroditsky (2008) reported evidence for an asymmetric relationship between space and time, with time being more affected by space than vice versa. This finding has stimulated the idea of a hierarchical representation of space and time, which is in line with conceptual metaphor theory but has also invoked skepticism (Riemer & Cai, 2024). The theory of an asymmetric representation of time and space is one focus of this symposium.

At the neuronal level, evidence for a common processing of time, space and other magnitudes in the parietal cortex (especially the right intraparietal sulcus; Bueti & Walsh, 2009) has led to the idea of a dimension-unspecific magnitude system. The idea of a common mechanism for the processing of temporal and spatial information has been reinforced by the discovery of time cells in the medial temporal lobe, a brain structure primarily known for its role in spatial processing (Eichenbaum, 2017). Together, these findings represent potential neuronal origins for the emergence of space-time interference in behavior.
The first two talks of the symposium are predominantly focused on behavioral studies about the (a)symmetric representation of time and space, while in the last two talks we will take a look at the neuronal processes underlying time and space perception.

Keywords: Space-time interference, spatial, speed, fMRI, time cells

Cross-dimensional interference between illusory size and duration

*Daniel Bratzke[1]

1. University of Bremen

Ono and Kawahara (2007) were the first to demonstrate that illusory size differences, as induced by the Ebbinghaus illusion, can interfere with the perception of duration and vice versa. This talk will present two studies, illustrating that this type of space-time interference (a) generalizes across various visual spatial illusions, including the Müller-Lyer, Ponzo, and horizontal-vertical illusions, (b) can be observed with different timing methods (categorization and temporal reproduction), (c) resembles space-time interference between physical size and duration, and (d) likely occurs fairly late in the processing stream.

References

Ono, F., & Kawahara, J.-I. (2007). The subjective size of visual stimuli affects the perceived duration of their presentation. Perception & Psychophysics, 69(6), 952–957. https://doi.org/10.3758/bf03193932

Keywords: size and duration

Using speed to think about space and time

*Martin Riemer[1]

1. Technical University Berlin

The observation of asymmetric interference between time and space, with time being more influenced by space than vice versa, has often been interpreted as reflecting a hierarchical representational structure. In this talk I will describe how the factor of speed, which is inherent in many experiments on space-time interference (e.g., growing lines, moving dots), can contribute to the observed asymmetry. I will present theroretical and empirical evidence that the introduction of speed leads to a more pronounced effect of space-on-time, and hence larger asymmetry. I conclude that the speed account provides a straightforward explanation for the phenomenon of asymmetric space-time interference in experiments using dynamic stimuli.

Keywords: space-time interference

The neural link between stimulus duration and spatial location in the human visual hierarchy

*Gianfranco Fortunato[1], Valeria Centanino[1], Domenica Bueti[1]

1. International School for Advanced Studies (SISSA)

A critical aspect of perception is the brain’ s ability to integrate multiple sensory dimensions. While spatial influences on duration perception have been documented, the neural link between spatial and temporal coding remains underexplored. Using ultra-high-field fMRI and neuronal-based modelling, we investigated where and how the processing and representation of visual duration and spatial location are related. We found that duration coding transforms along the cortical hierarchy—from monotonic and spatially dependent in early visual cortex to unimodal and spatially invariant in frontal areas.
Notably, in the dorsal visual stream, especially the intraparietal sulcus (IPS), neuronal populations show common selective responses for both spatial and temporal stimulus dimensions. Furthermore, spatial and temporal topographies are systematically linked in IPS. These findings provide insights into the neural mechanisms underlying visual duration perception and emphasize the importance of interactions between multiple sensory dimensions—space, time, numerosity, speed, etc.—in shaping brain responses.

Keywords: cortical hierarchy

A different angle on space-time interference: Disentangling cognitive maps and graphs in the human brain

*Yangwen Xu[1], Max A.B. Hinrichs[1], Roberto Bottini[2], Christian F Doeller[1,3]

1. Max Planck Institute for Human Cognitive and Brain Sciences, 2. Center for Mind/Brain Sciences, University of Trento, 3. Kavli Institute for Systems Neuroscience

Our mental representations can be structured into two basic formats. One is cognitive maps, where representational contents are arranged in a space and encoded as coordinates. The other is cognitive graphs, where representational contents are associated through co-occurrence in time and encoded among relations. However, these two forms of representations are usually correlated and confounded, making their neural underpinnings challenging to verify. For example, the "place cells" found in the hippocampus, which fire at particular locations in an environment, can also be interpreted as "time cells", which fire following a particular temporal sequence. In this symposium, I will present our recent fMRI study aiming to illuminate this puzzle. We let participants learn a virtual environment of an Euclidean graph where map and graph information is orthogonalized, and the neural underpinnings of these two forms of mental representations were unraveled using both univariate and multivariate fMRI methods.

Keywords: space-time interference

Symposium | Birds, Humans, and Primates

Sat. Oct 18, 2025 10:45 AM - 12:15 PM JST | Sat. Oct 18, 2025 1:45 AM - 3:15 AM UTC Room 2(West B1)

[S6] Symposium 6: Rhythmic sound development and plasticity in birds, humans, and primates

Chair:Andrea Ravignani(Sapienza University of Rome)

Rhythm and timing capacities are fundamental aspects of cognition, movement, and communication, essential for human expression, social interaction, and cognitive development. Studying these capacities from a combined developmental and cross-species perspective offers a comprehensive understanding of their complexities, nuances, and evolutionary roots. In this proposed symposium we focus on rhythm in the acoustic domain and discuss its many developmental and cross-species facets.
Why sound? Surely timing and rhythm capacities can manifest in multiple dimensions and modalities. Here we focus on sound as a common thread connecting the different talks because: 1) it is easy to record and measure in empirical contexts; 2) it is also easy to control and administer in experimental contexts; 3) it can be sampled at high temporal resolutions; 4) it connects with abilities that appear early in human life, are plastic, and are present in other species.
Why rhythm? Timing and rhythm have had an interesting historical relationship. By some they are seen as strongly related. Others consider them mechanistically unrelated systems. In both cases, rhythm provides a “twin system” for timing, i.e. the other side of the coin of human timing.
Why development and plasticity? Infants as young as a few months old exhibit rhythmic entrainment, synchronizing their movements with external beats. This capacity develops and refines throughout early childhood, laying the foundation for music and language acquisition. Rhythm and timing abilities are closely tied to cognitive development, in e.g. attention, memory, and executive functions.
Studying these relationships provides insights into cognitive development and potential interventions for developmental disorders. Studying infant responses to rhythmic sounds can reveal the earliest manifestations of timing and time perception, shedding light on their developmental origins.
Why cross-species? This approach can show similarities and differences with animal groups closer or farther from us. Studying rhythmic behaviors in animals, such as songs of songbirds or drumming in great apes, can reveal shared neural mechanisms and cognitive processes underlying timing and time perception. How do these arise? On the one hand, common ancestry can give rise to “homologies”: comparative neuroanatomy can uncover homologous brain structures involved in timing and rhythm, providing clues about the evolutionary conservation of these mechanisms. On the other hand, convergent evolution can create “analogies”: finding rhythmic abilities in diverse species can suggest convergent evolutionary pressures that have shaped timing and rhythm across the animal kingdom. Finally, animal work can discover new animal models for human disorders. Research on animal models can help us better understand those human disorders – e.g. Parkinson's disease, schizophrenia, and autism spectrum disorder - which often involve disruptions in rhythmic and timing abilities.
Together, the cross-species and plasticity angles allow comparing developmental trajectories of rhythm and timing capacities across species. One of our goals is to showcase how colleagues working on timing and time perception can connect to the study of rhythmic sounds in other species and human development. A comparative and developmental approach can pinpoint evolutionary trends, test the boundaries of cognitive and neural plasticity, and provide testable hypotheses for timing and time perception.

10:45 AM - 11:00 AM JST | 1:45 AM - 2:00 AM UTC

[S6-01]

Rhythmic sound development and plasticity in birds, humans, and primates

*Andrea Ravignani[1] (1. Dept. of Human Neurosciences, Sapienza University of Rome (Italy))

11:00 AM - 11:15 AM JST | 2:00 AM - 2:15 AM UTC

[S6-02]

Developmental Changes in the Temporal Properties of Preverbal Vocalizations in Early Human Infancy

*Miki Takahasi[1] (1. RIKEN (Japan))

11:15 AM - 11:30 AM JST | 2:15 AM - 2:30 AM UTC

[S6-03]

The ontogeny of vocal rhythms in a non-human primate

*Teresa Raimondi[1,2], Lia Laffi[1,2], Chiara De Gregorio[2], Daria Valente[2], Walter Cristiano[2,3], Filippo Carugati[2], Valeria Ferrario[2], Valeria Torti[2], Jonah Ratsimbatsafy[4], Cristina Giacoma[2], Andrea

Ravignani[1,5,6], Marco Gamba[2] (1. Sapienza University of Rome (Italy), 2. University of Turin (Italy), 3. Italian National Institute of Health (Italy), 4. Groupe d'Étude et de Recherche sur les Primates de Madagascar (Madagascar), 5. Aarhus University (Denmark), 6. The Royal Academy of Music (Denmark))

11:30 AM - 11:45 AM JST | 2:30 AM - 2:45 AM UTC

[S6-04]

Individual temporal plasticity in singing in the adult indris

*Marco Gamba[1], Lia Laffi[1], Silvia Leonetti[1], Filippo Carugati[1], Valeria Ferrario[1], Flavie Eveillard[1], Teresa Raimondi[1], Chiara De Gregorio[1], Longondraza Miaretsoa[1], Olivier Friard[1], Cristina Giacoma[1], Valeria Torti[1], Andrea Ravignani[1], Daria Valente[1] (1. Università di Torino (Italy))

11:45 AM - 12:00 PM JST | 2:45 AM - 3:00 AM UTC

[S6-05]

Social inheritance of Java sparrow rhythms

*Anthony Kwong[1], Rebecca N Lewis[1], Masayo Soma[1], Andrea Ravignani[1], Taylor Hersh[1] (1. University of Manchester (UK))

Rhythmic sound development and plasticity in birds, humans, and primates

*Andrea Ravignani[1]

1. Dept. of Human Neurosciences, Sapienza University of Rome

Rhythm and timing capacities are fundamental aspects of cognition, movement, and communication, essential for human expression, social interaction, and cognitive development. Studying these capacities from a combined developmental and cross-species perspective offers a comprehensive understanding of their complexities, nuances, and evolutionary roots. In this proposed symposium we focus on rhythm in the acoustic domain and discuss its many developmental and cross-species facets.
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Why rhythm? Timing and rhythm have had an interesting historical relationship. By some they are seen as strongly related. Others consider them mechanistically unrelated systems. In both cases, rhythm provides a “twin system” for timing, i.e. the other side of the coin of human timing. Why development and plasticity? Infants as young as a few months old exhibit rhythmic entrainment, synchronizing their movements with external beats. This capacity develops and refines throughout early childhood, laying the foundation for music and language acquisition. Rhythm and timing abilities are closely tied to cognitive development, in e.g. attention, memory, and executive functions.
Studying these relationships provides insights into cognitive development and potential interventions for developmental disorders. Studying infant responses to rhythmic sounds can reveal the earliest manifestations of timing and time perception, shedding light on their developmental origins.

Keywords: development, plasticity, infancy, comparative, vocal rhythm

Developmental Changes in the Temporal Properties of Preverbal Vocalizations in Early Human Infancy

*Miki Takahasi[1]

1. RIKEN

The production of vocal sounds shares peripheral organs with vital functions such as breathing, sucking, mastication, and swallowing. Human infants begin performing these functions immediately after birth, and they consist of rhythmic movements driven by central pattern generators (CPGs) in the medulla oblongata. In this study, we explore how voluntary vocal control develops from these foundational rhythmic behaviors, focusing on developmental changes in the temporal characteristics of early vocalizations in human infants. Drawing on previous findings regarding the developmental shift in the timing of continuous vocalizations and the intervals of vocalization observed during mother-infant interactions, we consider the adaptive significance of the evolution of vocal control in humans.

Keywords: Preverbal Vocalizations

The ontogeny of vocal rhythms in a non-human primate

*Teresa Raimondi[1,2], Lia Laffi[1,2], Chiara De Gregorio[2], Daria Valente[2], Walter Cristiano[2,3], Filippo Carugati[2], Valeria Ferrario[2], Valeria Torti[2], Jonah Ratsimbatsafy[4], Cristina Giacoma[2], Andrea Ravignani[1,5,6], Marco Gamba[2]

1. Sapienza University of Rome, 2. University of Turin, 3. Italian National Institute of Health, 4. Groupe d'Étude et de Recherche sur les Primates de Madagascar, 5. Aarhus University, 6. The Royal Academy of Music

A building block of human music is the production of small-integer ratios: almost universally, units start predictably in time, at an integer multiple of a base temporal unit. Humans produce integer ratios as adults cross-culturally, but the production of ratios crystallises over development. Is the development of small-integer ratios human-specific? Here we look for the development of small-integer ratios in the song of the only singing lemur, *Indri indri,* by integrating comparative and developmental angles. We compute rhythmic ratios between adjacent intervals and test whether these ratios match small-integer values. Our data show high levels of rhythmic stability around isochrony, the 1:1 ratio, like a ticking metronome, in both sexes and at every developmental stage. As in humans, two additional small-integer ratios (1:2 and 2:1) emerge over development. Similarly to us, another mammal displays developmental changes in rhythm production, a crucial feature of human musicality.

Keywords: vocal rhythms, non-human primate

Individual temporal plasticity in singing in the adult indris

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Only long-term studies can answer how individual characteristics vary over time. Regarding the timing of vocal emissions in non-human primates, many studies argue that genetics plays a key role in limiting intra and inter-individual variations and allowing the species to which a vocalizerbelongs to be easily recognized. These considerations appear limiting when applied to singing primates, which have shown significant flexibility in adulthood. We investigated the variation over time in the temporal structure of songs the indris gave. We mapped categorical rhythmic production of individuals of both sexes, showing that the number of rhythmic categories can change within and between individuals. Indris exhibit three small integer-ratio rhythms, but the three rhythms are not present in all individuals. Although we do not know whether perception is similarly biased towards the same categories, the occurrence of particular rhythmic categories may serve to build particular rhythmicity of the collective singing.

Keywords: indris

Social inheritance of Java sparrow rhythms

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Rhythm is observed in the vocalizations of a range of species. Animal rhythms frequently favour small integer ratios (SIRs), with isochrony being especially common. We analysed song rhythms in a population of Java sparrows (*Padda oryzivora*); a species in which juvenile males learn songs from adult male tutors. We introduce a new method of rhythm analysis to test the significance of nonstandard SIRs, commonly found in this species. We showed that birds mirror the rhythmic preferences of their song tutors; the effect persisting over several generations. Different song lineages develop their own rhythms, resembling distinct rhythm preferences seen across human musical cultures. Moreover, bird culture overpowers a tendency towards stable equilibria in dynamical systems, moving away from integer ratio attractors. Our findings underscore social learning as the main mode of rhythm transmission in Java sparrows, with implications for conservation for this endangered species.

Keywords: Java sparrows

Symposium | Online and Mobile Environments

Sun. Oct 19, 2025 9:00 AM - 10:30 AM JST | Sun. Oct 19, 2025 12:00 AM - 1:30 AM UTC Room 3(East B1)

[S7] Symposium 7: Beyond the Lab: Timing Perception and Cognition in Online and Mobile Environments

Chair:David Melcher(New York University Abu Dhabi)

The ability of the brain to represent, integrate, and segregate events over time lies at the core of human cognition and behaviour. From low-level sensory processing to high-level cognitive functions, temporal processing shapes how we perceive the world, allocate attention, and make decisions.
Traditionally, research on temporal processing has relied on highly controlled laboratory settings. These environments enable millisecond-level precision for stimulus presentation and response recording, providing powerful tools to uncover the temporal structure of perception. However, lab-based experiments have notable limitations: they often rely on narrow participant pools, limiting generalizability and statistical power, and they require significant resources, physical space, and specialized equipment.
While laboratories remain the gold standard in timing research, these constraints highlight the growing appeal of web-based experimentation (Bridges et al. 2020). Recent advances in online platforms have improved the precision and reliability of behavioural and psychophysical tasks conducted remotely, creating new opportunities for high-quality timing research outside the lab. Similarly, the widespread use of smartphones and tablets has enabled novel methods to study temporal dynamics in ecologically valid, real-world contexts (Marsicano et al. 2022; 2024). Both web-based and mobile approaches, though offering reduced experimental control, allow for scalable data collection across diverse populations and can track within-subject variability across time and settings.
This symposium presents recent empirical evidence on the potential and limitations of web- and smartphone-based experimentation for investigating temporal perception and cognition. We highlight studies showing that, with appropriate tools and procedures, online platforms can achieve high levels of temporal precision comparable to traditional lab settings. These include web-based experiments on temporal integration and segregation across uni- and multisensory modalities and responses to rhythmic sensory stimulation (Marsicano et al., 2022; 2024; Deodato et al., 2024; Lamprou-Kokolaki et al., 2024). We also emphasize the benefits of accessing large, heterogeneous samples online, which supports the identification of individual differences and distinct temporal processing profiles. In addition, we introduce a smartphone-based approach for estimating individual alpha oscillation frequency via a visual illusion (Xu et al., 2025). This method uses perceived jitter to infer temporal characteristics of neural activity, capturing individual variability, mood-related changes, and diurnal patterns under naturalistic conditions. Across the symposium, we compare behavioural patterns and performance metrics across web, mobile, and lab contexts, showing broadly comparable data quality and variability. We also address key methodological challenges, such as device heterogeneity, participant attention, and timing uncertainty, and propose strategies to improve reproducibility, including calibration routines, browser-based latency checks, and frame-locked stimulus presentation. We review commonly used platforms (e.g., PsychoPy/PsychoJS, jsPsych) and evaluate the strengths of mobile tools for timing research. By integrating this diverse body of evidence, the symposium highlights how web and mobile technologies are expanding the reach of timing research, offering scalable, inclusive, and ecologically valid approaches to investigating the temporal dynamics of cognition.

9:00 AM - 9:15 AM JST | 12:00 AM - 12:15 AM UTC

[S7-01]

Beyond the Lab: Timing Perception and Cognition in Online and Mobile Environments

*David Melcher[1] (1. New York University Abu Dhabi (United Arab Emirates))

9:15 AM - 9:30 AM JST | 12:15 AM - 12:30 AM UTC

[S7-02]

Synchronizing Perception Online: Temporal Binding, Attention, and Individual Differences

*Gianluca Marsican, David Melcher (New York University Abu Dhabi (United Arab Emirates))

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

[S7-03]

Temporal Perception and Anomalous Visual Experiences: Insights from Large-Scale Web-Based Psychophysics

*Michele Deodato, David Melcher (New York University Abu Dhabi (United Arab Emirates))

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

[S7-04]

Compressed experimentation: duration, passage of time, and the temporal structure of memory

*Marianna Lamprou Kokolaki[1], Virginie van Wassenhove[1] (1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris Saclay (France))

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

[S7-05]

Inferring alpha oscillations from visual illusion: A smartphone-based method

*Kaoru Amano[1] (1. The University of Tokyo (Japan))

Beyond the Lab: Timing Perception and Cognition in Online and Mobile Environments

*David Melcher[1]

1. New York University Abu Dhabi

The ability of the brain to represent, integrate, and segregate events over time lies at the core of human cognition and behaviour. From low-level sensory processing to high-level cognitive functions, temporal processing shapes how we perceive the world, allocate attention, and make decisions. Traditionally, research on temporal processing has relied on highly controlled laboratory settings.
These environments enable millisecond-level precision for stimulus presentation and response recording, providing powerful tools to uncover the temporal structure of perception. However, lab-based experiments have notable limitations: they often rely on narrow participant pools, limiting generalizability and statistical power, and they require significant resources, physical space, and specialized equipment. While laboratories remain the gold standard in timing research, these constraints highlight the growing appeal of web-based experimentation (Bridges et al. 2020). Recent advances in online platforms have improved the precision and reliability of behavioural and psychophysical tasks conducted remotely, creating new opportunities for high-quality timing research outside the lab.
Similarly, the widespread use of smartphones and tablets has enabled novel methods to study temporal dynamics in ecologically valid, real-world contexts (Marsicano et al. 2022; 2024). Both web-based and mobile approaches, though offering reduced experimental control, allow for scalable data collection across diverse populations and can track within-subject variability across time and settings.

Keywords: Temporal Processing, Web-Based Research, Sensory Integration, Entrainment, Individual Differences

Synchronizing Perception Online: Temporal Binding, Attention, and Individual Differences

*David Melcher[1]

1. New York University Abu Dhabi

Temporal processing is fundamental to perception, attention, and decision-making, yet investigating its mechanisms at scale remains a challenge (Bridges et al., 2020). This talk presents a series of web-based sensory integration tasks, from low-level audiovisual simultaneity judgments to perceptual decisions such as visual causality. Results demonstrate that, under carefully controlled conditions, online methods can yield data quality and temporal precision comparable to laboratory settings. Critically, the large and diverse samples enabled by online research allowed for the identification of distinct profiles of audiovisual temporal integration and segregation, linked to individual differences in autistic and schizotypal traits (Marsicano et al., 2022). Moreover, rhythmic sensory stimulation delivered online effectivelymodulated temporal processing and visuo-spatial attention across varied personological profiles. These findings underscore the promise of online experimentation not only as a method for investigating temporal cognition, but also as a scalable tool for modulating it through targeted manipulations (Marsicano et al., 2024).

Keywords: Web-Based Research, Temporal Processing

Temporal Perception and Anomalous Visual Experiences: Insights from Large-Scale Web-Based Psychophysics

*Michele Deodato[1]

1. New York University Abu Dhabi

Perceiving the timing and sequence of events is a fundamental component of human cognition. Disruptions in this temporal processing can cascade into broader cognitive deficits and have been implicated in several neuropsychiatric conditions, including schizophrenia.
With the increasing need for scalable and accessible cognitive assessment tools, online experiments are emerging as a powerful approach for investigating perceptual and cognitive functions in diverse populations. We demonstrate the feasibility of conducting web-based psychophysical experiments using precisely timed visual stimuli. Using the two-flash fusion task, we collected large-scale data alongside self-report questionnaires. Our findings replicate the well-established decline in visual temporal acuity with ageing. Strikingly, we also observe that individuals who report more frequent anomalous perceptual experiences and higher levels of schizotypal traits tend to exhibit better visual temporal acuity. These results challenge conventional assumptions and open new avenues for understanding the relationship between temporal perception and atypical cognitive experiences. Overall, the findings highlight the promise of web-based psychophysics as a valid and scalable method for studying individual differences in perception and cognition across broad populations.

Keywords: Large-Scale Web- Based Psychophysics

Compressed experimentation: duration, passage of time, and the temporal structure of memory

*Marianna Lamprou Kokolaki[1], Virginie van Wassenhove[1]

1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris Saclay

We live in a rich, dynamic, and multisensory world that our brain segments into narratives yet time studies in lab settings provide impoverished (though well-controlled) environments.

Online experiments can be one step towards real-world settings by enabling comparative studies of temporal experiences (e.g. duration, passage-of-time, segmentation) using rich stimuli (e.g. virtual-environment) while testing a large and diverse pool of participants quickly. For instance, using novel duration and speed-of-time bisection tasks at realistic time scales, we showed that event density shapes temporal judgments (Lamprou-Kokolaki et al., 2023). Using a series of online experiments, we found that sequence chunking influences temporal distances in memory with a surprising observation: memorability changes create implicit boundaries that affect temporal distances (Lamprou-Kokolaki et al., in prep.). Thus, online experimentation can foster new approaches to more classical paradigms, providing robust results and serving as a powerful tool for conducting short, efficient, yet rich experimental studies.

Keywords: duration, passage of time

Inferring alpha oscillations from visual illusion: A smartphone-based method

*Kaoru Amano[1]

1. The University of Tokyo

We previously demonstrated that the perceived frequency of the illusory jitter reflects (1) individual differences, (2) spontaneous intra-individual fluctuations, and (3) modulation via transcranial alternating current stimulation (tACS), all in the frequency of alpha oscillations (Minami & Amano, 2017). Building on these findings, we have developed a smartphone-based technology that estimates individual alpha frequency by measuring perceived jitter frequency, and are now working toward real-world implementation. In this presentation, we first revisit the relationship between illusory jitter and alpha oscillations. We then report new findings from smartphone-based psychological experiments examining alpha frequency under naturalistic conditions. Specifically, we present data showing shifts in alpha frequency associated with mood changes before and after yoga practice. Additionally, we describe diurnal variations in alpha frequency captured by the app, partially validated against chronicelectrocorticography (ECoG) recordings. These results highlight the potential of perception-based methods for scalable, non-invasive monitoring of neural oscillations in daily life.

Keywords: alpha frequency