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))

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[S6-05]

Social inheritance of Java sparrow rhythms

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[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.

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[S5-02]

Cross-dimensional interference between illusory size and duration

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[S5-03]

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[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

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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

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[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]

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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

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[S6-04]

Individual temporal plasticity in singing in the adult indris

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[S6-05]

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

*Andrea Ravignani[1]

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

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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

*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

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

*Anthony Kwong[1], Rebecca N Lewis[1], Masayo Soma[1], Andrea Ravignani[1], Taylor Hersh[1]

1. University of Manchester

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