Fri. Oct 17, 2025

Invited | Timing & Time Perception

Fri. Oct 17, 2025 11:00 AM - 12:00 PM JST | Fri. Oct 17, 2025 2:00 AM - 3:00 AM UTC Room 1(Mathematical Science Building)

[K1] Keynote : Kalanit Grill-Spector

Chair:Domenica Bueti(International School for Advanced Studies (SISSA))

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

[K1-01]

Understanding cognitive processing in the human visual system using spatiotemporal population receptive fields

*Kalanit Grill-Spector[1] (1. Stanford University (United States of America))

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))

Oral | Timing & Time Perception

Fri. Oct 17, 2025 1:00 PM - 2:30 PM JST | Fri. Oct 17, 2025 4:00 AM - 5:30 AM UTC Room 3(East B1)

[O1] Oral 1: Timing & Time Perception

Chair:Nedim Goktepe(INM- Leibniz Institute for New Materials)

1:00 PM - 1:15 PM JST | 4:00 AM - 4:15 AM UTC

[O1-01]

Affective modulation of temporal binding using linguistic stimuli

*Felipe Toro Hernández[1], Theresa Moraes Ramalho[2], André Mascioli Cravo[2], Peter M. E. Claessens[2] (1. Graduate Program in Neuroscience and Cognition, Federal University of ABC (UFABC), São Paulo, Brazil (Brazil), 2. Center for Mathematics, Computing and Cognition, Federal University of ABC (UFABC), São Paulo, Brazil (Brazil))

1:15 PM - 1:30 PM JST | 4:15 AM - 4:30 AM UTC

[O1-02]

Causality Judgments and temporal order in individuals with Schizophrenia: a new case of time re-ordering

*Anne Giersch[1,2], Brice Martin[4,3], Cristina Rusu[1,2], Hager Guendouze[1,2] (1. INSERM (France), 2. University of Strasbourg (France), 3. Hôpital du Vinatier, Lyon (France), 4. Centre Hospitalier Drôme Vivarais (France))

1:30 PM - 1:45 PM JST | 4:30 AM - 4:45 AM UTC

[O1-03]

The human propensity for regularity extraction requires us to reconsider how we construct randomly timed stimuli

*Jelle van der Werff[1], Tommaso Tufarelli[1], Laura Verga[1], Andrea Ravignani[1] (1. Sapienza University of Rome (Italy))

1:45 PM - 2:00 PM JST | 4:45 AM - 5:00 AM UTC

[O1-04]

Moments or Continuum? Testing the Temporal Resolution of Human Anticipation

*GEORGIOS MICHALAREAS[1,2,3], David Poeppel[4], Matthias Grabenhorst[3,2] (1. Cooperative Brain Imaging Center (CoBIC), Goethe University Frankfurt (Germany), 2. Max-Planck-Institute for Empirical Aesthetics, Frankfurt (Germany), 3. Ernst Strüngmann Institute for Neuroscience in Cooperation with Max Planck Society, Frankfurt (Germany), 4. New York University (United States of America))

2:00 PM - 2:15 PM JST | 5:00 AM - 5:15 AM UTC

[O1-05]

Spatial tool use modulates time perception in near and far space

*Amir Jahanian-Najafabadi[1], Argiro Vatakis[2], Christoph Kayser[1] (1. Department of Cognitive Neuroscience, Bielefeld University (Germany), 2. Department of Psychology, Panteion University of Social and Political Sciences (Greece))

2:15 PM - 2:30 PM JST | 5:15 AM - 5:30 AM UTC

[O1-06]

Generalizing temporal perception in humans: learning transfer across interval categorization and interval identification tasks

*German Mendoza[1], Hugo Rey Andrade-Hernandez[2], Hugo Merchant[1] (1. Instituto de Neurobiologýa, UNAM (Mexico), 2. Maestría en Ciencias (Neurobiologýa), UNAM. (Mexico))

Oral | Development, Clinical

Fri. Oct 17, 2025 3:30 PM - 5:00 PM JST | Fri. Oct 17, 2025 6:30 AM - 8:00 AM UTC Room 3(East B1)

[O2] Oral 2: Decelopment, Clinical

Chair:Rafael Román-Caballero(Universidad de Granada & McMaster University)

3:30 PM - 3:45 PM JST | 6:30 AM - 6:45 AM UTC

[O2-01]

“Past is Present, and Present is Past for Me": A case report of a 21-year-old female with autism spectrum disorder and enhanced episodic memory

*Ryuta Ochi[1,2], Shigeru Kitazawa[3], Mitsuru Kawamura[2] (1. Department of Psychology, Graduate School of Letters, CHUO University (Japan), 2. Division of Neurology, Department of Internal Medicine, School of Medicine, Showa Medical University (Japan), 3. Dynamic Brain Network Laboratory, Graduate School of Frontier Biosciences, The University of Osaka (Japan))

3:45 PM - 4:00 PM JST | 6:45 AM - 7:00 AM UTC

[O2-02]

Time attitudes and psychological distress: Exploring the interface between temporal representation and affect

*Thiago Bonifácio[1], André Mascioli Cravo[1] (1. Federal University of ABC (Brazil))

4:00 PM - 4:15 PM JST | 7:00 AM - 7:15 AM UTC

[O2-03]

Victims living in the now: A developmental glimpse on time perspectives through a criminological lense

*Sebastian L. Kübel[1,2,3] (1. University of Bern (Switzerland), 2. Max Planck Institute for the Study of Crime, Security and Law (Germany), 3. University of Leiden (Netherlands))

4:15 PM - 4:30 PM JST | 7:15 AM - 7:30 AM UTC

[O2-04]

Visual attention of infants in early interactions: Comparing early processing of music and language

*Rafael Román-Caballero[1,2], Maya Psaris[2], Betania Y. Georlette[3], Mohammadreza Edalati[3], Barbara Tillmann[4], Sahar Moghimi[3], Gabriel (Naiqi) Xiao[2], Laurel J. Trainor[2], Juan Lupiáñez[1] (1. Universidad de Granada (Spain), 2. McMaster University (Canada), 3. Université de Picardie (France), 4. Université de Bourgogne (France))

4:30 PM - 4:45 PM JST | 7:30 AM - 7:45 AM UTC

[O2-05]

Visual causality detection capabilities in individuals treated for prolonged early-onset blindness

*Marin Vogelsang[1], Lukas Vogelsang[1], Priti Gupta[2], Stutee Narang[2], Purva Sethi[2], Suma Ganesh[2], Pawan Sinha[1] (1. MIT (United States of America), 2. Dr Shroff’s Charity Eye Hospital (India))

4:45 PM - 5:00 PM JST | 7:45 AM - 8:00 AM UTC

[O2-06]

Performance of late-sighted children on the temporal order judgement task

*Lukas Vogelsang[1], Priti Gupta[2], Marin Vogelsang[1], Naviya Lall[2], Manvi Jain[2], Chetan Ralekar[1], Suma Ganesh[2], Pawan Sinha[1] (1. MIT (United States of America), 2. Dr Shroff’s Charity Eye Hospital (India))

Oral | Attention, Multisensory, Time Perception

Fri. Oct 17, 2025 3:30 PM - 5:00 PM JST | Fri. Oct 17, 2025 6:30 AM - 8:00 AM UTC Room 2(West B1)

[O3] Oral 3: Attention, Multisensory, Time Perception

Chair:Yuki Murai(National Institute of Information and Communications Technology)

3:30 PM - 3:45 PM JST | 6:30 AM - 6:45 AM UTC

[O3-01]

Discrete vs. continuous timer bars: How visual segmentation shapes the perception of time "running out"

*Jasmindeep Kaur[1], Jiaying Zhao[1], Joan Danielle Ongchoco[1] (1. The University of British Columbia (Canada))

3:45 PM - 4:00 PM JST | 6:45 AM - 7:00 AM UTC

[O3-02]

Neural Dynamics of Motor-Induced Attention during the Encoding and Retention of Temporal Intervals

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

4:00 PM - 4:15 PM JST | 7:00 AM - 7:15 AM UTC

[O3-03]

The priority accumulation framework – attention in time and space

*Mor Sasi[1], Daniel Toledano[1], Shlomit Yuval-Greenberg[1,2], Dominique Lamy[1,2] (1. Tel Aviv University (Israel), 2. Sagol school of neuroscience (Israel))

4:15 PM - 4:30 PM JST | 7:15 AM - 7:30 AM UTC

[O3-04]

Multisensory Integration and Delay Adaptation in Sensorimotor Timing

*Lingyue Chen[1], Loes C.J. van Dam[1], Zhuanghua Shi[2] (1. Technische Universität Darmstadt (Germany), 2. Ludwig-Maximilians-Universität München (Germany))

4:30 PM - 4:45 PM JST | 7:30 AM - 7:45 AM UTC

[O3-05]

Memory encoding for new information, not autobiographical memory load, predicts age-related acceleration in subjective time passage over the last decade

*Alice Teghil[1,2], Sebastian Wittmann[3], Adele Lifrieri[1], Sophia Saad[3], Maddalena Boccia[1,2], Marc Wittmann[3] (1. Department of Psychology, Sapienza University of Rome (Italy), 2. Cognitive and Motor Rehabilitation and Neuroimaging Unit, IRCCS Fondazione Santa Lucia, Rome (Italy), 3. Institute for Frontier Areas of Psychology and Mental Health, Freiburg (Germany))

4:45 PM - 5:00 PM JST | 7:45 AM - 8:00 AM UTC

[O3-06]

Interference between time and space in advanced age

*Cindy Jagorska[1], Isa Steinecker[1], Martin Riemer[1] (1. Technical University Berlin (Germany))

Poster | Other

Fri. Oct 17, 2025 12:45 PM - 2:45 PM JST | Fri. Oct 17, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P1] Poster: Day 1

[P1-01]

Development of the Japanese Version of the Adult Hyperfocus Questionnaire and Examination of Its Reliability and Validity (in progress)

*Kazutoshi Tamura[1], Akira Midorikawa[2] (1. Department of Psychology, Graduate School of Letters, Chuo University (Japan), 2. Department of psychology, Faculty of Letters, Chuo University (Japan))

[P1-02]

Timing alterations in ADHD: Combining a scoping review with a planned empirical study of Temporal Binding

*Veronica Casagrande[1], Grace Isaura Durkin[2], Vanessa de Andrade[3], Tiemi Thais Tomonaga[3], Patricia Cibelle Pinto de Oliveira[3], Lucas Correia Signorini[3], Claudia Berlim de Mello[4], Gustavo Melo de Andrade Lima[3], André Mascioli Cravo[5] (1. Graduate Program in Neuroscience and Cognition, Federal University of ABC (UFABC), São Paulo, Brazil (Brazil), 2. Graduate Program in Psychobiology, Federal University of São Paulo (UNIFESP), São Paulo, Brazil (Brazil), 3. Center for Education and Research on Brain Aging, Federal University of São Paulo (UNIFESP), São Paulo, Brazil (Brazil), 4. Psychobiology Department, Federal University of São Paulo (UNIFESP), São Paulo, Brazil (Brazil), 5. Center for Mathematics, Computing and Cognition, Federal University of ABC (UFABC), São Paulo, Brazil (Brazil))

[P1-03]

Interval timing in children with ADHD: Pilot study on timing differences

*Kateřina Dörflová[1,2], Veronika Rudolfová[3,2], Kristýna Malenínská[2], Tereza Nekovářová[2,3] (1. Third Faculty of Medicine, Charles University, Neurosciences (Czech Republic), 2. National Institute of Mental Health in Czechia (Czech Republic), 3. Faculty of Science, Charles University, Department of Zoology (Czech Republic))

[P1-04]

Neuronal signals in the primate cerebellum underlying the detection of rhythmic deviations

*Masashi Kameda[1], Masaki Tanaka[1] (1. Hokkaido university graduate school of medicine (Japan))

[P1-05]

Temporally distorted cortical neural dynamics of explicit timing following cerebellar dysfunction

*Chiara Zanonato[1,2], Richard Ivry[3,4], Assaf Breska[1,3] (1. Max Planck Institute for Biological Cybernetics, Tübingen (Germany), 2. University of Tübingen (Germany), 3. Department of Psychology, University of California, Berkeley, CA (United States of America), 4. Helen Willis Neuroscience Institute, University of California, Berkeley, CA (United States of America))

[P1-06]

Entrainment of periodic neural activity for rhythmic temporal prediction may involve cerebellar learning

*Ken-ichi Okada[1], Masaki Tanaka[1] (1. Hokkaido Univ. (Japan))

[P1-07]

Disentangling spatiotemporal correlates of time cognition: an ongoing investigation of the effects of cognitive aging and depressive symptoms

*Giulia Buzi[1], Florentine Fricker[1], Laura Masson[1], Francis Eustache[1], Thomas Hinault[1] (1. (1)Normandy Univ, UNICAEN, PSL Université Paris, EPHE, Inserm, U1077, CHU de Caen, Centre Cyceron, Neuropsychologie et Imagerie de la Mémoire Humaine, 14000 Caen, France. (France))

[P1-08]

Comparing Neural Oscillations During Cued and Uncued Rhythmic Movement Using Simultaneous Intracranial Basal Ganglia and Cortical Recordings: An Ongoing Study

*Bar Yosef[1], Jingtong Lin[1], Ausaf Bari[1], Kathryn Cross[1] (1. University of California, Los Angeles (United States of America))

[P1-09]

Temporal Expectation and Dopamine: Insights from Omission Oddball Paradigm in Rats

*Riko Iizuka[1], Ryotaro Yamaki [1], Tomoyo Shiramatsu-Isoguchi[1], Shota Morikawa [2], Yuji Ikegaya [3], Hirokazu Takahashi [1] (1. Graduate School of Information Science and Technology, The University of Tokyo (Japan), 2. Graduate School of Science and Faculty of Science, University of Tokyo (Japan), 3. Graduate School of Pharmaceutical Sciences & Faculty of Pharmaceutical Sciences, The University of Tokyo (Japan))

[P1-10]

Effects of voluntary actions on temporal preparation in different temporal contexts: an ongoing study.

*Alexandre de Pontes Nobre[1], André Mascioli Cravo[1] (1. Center for Mathematics, Computing and Cognition, Federal University of ABC. (Brazil))

[P1-11]

Time, space and Temporal momentum: an online replication and beyond

*Mario Bonato[1], Manuel Vencato[1], Mariagrazia Ranzini[1], Marco Zorzi[1,2] (1. Department of General Psychology, University of Padua, Italy (Italy), 2. IRCCS San Camillo Hospital, Lido Venice (Italy))

[P1-12]

Temporal competition and temporal promotion effects of visual arousal on visual search task

*Mizuki Mori[1], Makoto Ichikawa[2] (1. Graduate School of Science and Engineering, Chiba University (Japan), 2. Graduate School of Humanities, Chiba University (Japan))

[P1-13]

Emotional Modulation of Time: The Role of Arousal, Valence, and Subjective Activation in an Immersive VR

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

[P1-14]

Aggression May Accelerate Passage of Time Regardless of Physiological Arousal

*Ryohei Mimura[1,2], Makoto Ichikawa[1] (1. Chiba University (Japan), 2. Hyogo prefectural police H.Q. (Japan))

[P1-15]

Learning to feel vibrations: Associatively learned boredom but not stress modulates time perception

*Müge Cavdan[1], Bora Celebi[1], Knut Drewing[1] (1. Justus Liebig University Giessen (Germany))

[P1-16]

Behavioral Evidence for Precision-Weighted Prediction Updating in the Sub-Second Range: A Pilot Study

*Maki Uraguchi[1], Hideki Ohira[1] (1. Nagoya University (Japan))

[P1-17]

Investigating the Modulation of Prior Formation in a Multisensory 2AFC Temporal Judgment Task

*Natsuki Ueda[1], Mitsunari Abe[1] (1. National Center of Neurology and Psychiatry (Japan))

[P1-18]

Modelling timing processes in motor imagery

*Ladislas Nalborczyk[1], Camille Grasso[2] (1. Aix Marseille Univ, CNRS, LPL (France), 2. Cognitive Neuroimaging Unit, CEA DRF/I2BM, INSERM, Université Paris-Sud, Université Paris-Saclay, NeuroSpin Center, Gif/Yvette (France))

[P1-19]

Characterising the spatial and temporal neural dynamics of temporal predictions in audition

*Clara Driaï-Allègre[1,2], Sophie Herbst[1] (1. Cognitive Neuroimaging Unit, INSERM, CEA, NeuroSpin (France), 2. Université Paris-Saclay (France))

[P1-20]

Beyond probability: Temporal prediction error shapes performance across development

*LOUIS-CLÉMENT DA COSTA[1], Sylvie Droit-Volet[2], Katherine Johnson[3], Jennifer T Coull[1] (1. CRPN, CNRS and AMU, UMR 7077, Marseille (France), 2. CNRS and Université Clermont Auvergne, UMR 6024, Clermont-Ferrand (France), 3. Melbourne School of Psychological Sciences, Melbourne (Australia))

[P1-21]

Interaction between timing, stimulus control of light and sound, and its effects on anticipatory responses in multiple and mixed fixed interval schedules in rats (Preliminary Results)

*Paulina Citlali Montoya Barragán[1], Heber Zapata[2], Jonathan Buriticá[1] (1. CEIC, UDG (Mexico), 2. UACH (Mexico))

[P1-22]

How ensemble temporal statistics influence duration perception of visual events

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

[P1-23]

Temporal Reward Prediction in the Visual Corticostriatal Circuit

*Rebekah Yidan Zhang[1,2], Lianne Saussy[1], Marshall Hussain Shuler[1,2] (1. Johns Hopkins University (United States of America), 2. Kavli Neuroscience Discovery Institute (United States of America))

[P1-24]

Exploring the effects of rhythmic vibratory stimuli on time perception

*Yoshihiko Watanabe[1], Sae Kaneko[2] (1. Graduate School of Humanities and Human sciences, Hokkaido University (Japan), 2. Faculty of Humanities and Human Sciences, Hokkaido University (Japan))

[P1-25]

How facial features affect time perception: from the perspective of race and eye contact.

*Yuki Ogawa[1], Yusuke Moriguchi[2], Mitsuhiko Ishikawa[1] (1. Hitotsubashi University (Japan), 2. Kyoto University (Japan))

[P1-26]

Seeking the internal clock: Does the modality effect exist in retrospective timing and if so, is it multiplicative as in prospective timing?

*Ruoyu Zhang[1], Luke Jones[1], Ellen Poliakoff[1] (1. the University of Manchester (UK))

[P1-27]

The Interaction Between Timing, Impulsive Choice, and Risk Taking in Children with ADHD: Exploring the Role of Pharmacological Treatment

*Gloria Ochoa-Zendejas[1], Ivette Vargas-de la Cruz[2], Cristiano Valerio dos Santos[3], Jonathan Buriticá[1] (1. Lab. of Cognition and Comparative Learning, Univ. of Guadalajara-CEIC, Guadalajara. (Mexico), 2. Universidad de Guadalajara, Departamento de Neurociencias, Centro Universitario de Ciencias de la Salud (Mexico), 3. Universidad de Guadalajara, Centro de Estudios e Investigaciones en Comportamiento (Mexico))

[P1-28]

Assessing domain-generality of temporal metacognition: behavioral and electrophysiological insights

*Nathalie Pavailler[1], Antoine Vaglio[1], Nathan Faivre[3], Tadeusz Kononowicz[2], Virginie van Wassenhove[1] (1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris-Saclay, Gif/Yvette, 91191 (France), 2. Université Paris-Saclay, CNRS, Institut des Neurosciences Paris-Saclay (NeuroPSI), 91400 Saclay (France), 3. Université Grenoble Alpes, Université Savoie Mont Blanc, CNRS, LPNC, Grenoble (France))

[P1-29]

Retrieving sequence of duration(s) from working memory

*Yunyun SHEN[1], Sophie K Herbst[1], Virginie van Wassenhove[1] (1. CEA, DRF/Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; CNRS; Université Paris-Saclay, F-91191 Gif/Yvette, France (France))

[P1-30]

Investigating heart–eye coupling during active visual search in early infancy: a planned study

*Akane Hisada[1], Tomoko Isomura[1] (1. Nagoya University (Japan))

[P1-31]

Temporal Binding and Sense of Agency in Oculomotor Control

*Lynn Huestegge[1], Julian Gutzeit[1] (1. University of Wuerzburg (Germany))

[P1-32]

What’s the difference between a premature and a timed anticipatory movement ?

*Marcus Missal[1], Dominika Drazyk[1] (1. Université catholique de Louvain, Institute of Neuroscience (Belgium))

[P1-33]

Revealing rhythm categorization in human brain activity

*Tomas Lenc[1,2], Francesca M. Barbero[2], Nori Jacoby[3,4], Rainer Polak[5,6], Manuel Varlet[7], Nicola Molinaro[1,8], Sylvie Nozaradan[2,9] (1. Basque Center on Cognition, Brain and Language (BCBL), Donostia-San Sebastian (Spain), 2. Institute of Neuroscience (IoNS), University of Louvain (UCLouvain), 1348 Louvain-la-Neuve (Belgium), 3. Computational Auditory Perception Group, Max Planck Institute for Empirical Aesthetics, Grüneburgweg 14, 60322 Frankfurt am Main (Germany), 4. Department of Psychology, Cornell University, Ithaca, NY 14853 (United States of America), 5. RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo (Norway), 6. Department of Musicology, University of Oslo (Norway), 7. The MARCS Institute for Brain, Behaviour & Development, Western Sydney University, Sydney (Australia), 8. Ikerbasque, Basque Foundation for Science, 48009 Bilbao (Spain), 9. International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal (Canada))

[P1-34]

Memory traces of duration and location in the right intraparietal sulcus

*Martin Riemer[1], Thomas Wolbers[2], Hedderik van Rijn[3] (1. Technical University Berlin (Germany), 2. DZNE Magdeburg (Germany), 3. University of Groningen (Netherlands))

[P1-35]

Neural Correlates of Perceptual Biases in Visual Duration Estimation

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

[P1-36]

Uncovering the neuroanatomical substrates of impulsive behaviour induced by the temporal predictability of events: an fMRI-EMG investigation

*Inga Korolczuk[1,2], Boris Burle[2], Bruno Nazarian[3], Marion Royer D'Halluin[2,4,5], Franck Vidal[4], Jennifer T Coull[2] (1. Department of Psychology, Medical University of Lublin (Poland), 2. Centre for Research in Psychology and Neuroscience (UMR7077), Aix-Marseille University & CNRS (France), 3. Aix-Marseille Université, UMR 7289 CNRS, Institut de Neurosciences de la Timone, Marseille, Provence-Alpes-Côte d'Azur, 13005, France (France), 4. CHU Sainte-Justine Research Center, Montréal, Québec, Canada (Canada), 5. Department of Neurosciences, Université de Montréal, Montréal, Québec, Canada (Canada))

[P1-37]

Basic mechanism underlying the audio-visual temporal recalibration for the long stimuli

*Yaru Wang[1], Makoto Ichikawa[1] (1. Chiba University (Japan))

[P1-38]

Understanding Discomfort Caused by Audiovisual Temporal Asynchrony: Insights from Egg Cracking and Grissini Breaking Videos

*Mayuka Hayashi[1], Waka Fujisaki[1] (1. Japan Women's Univ. (Japan))

[P1-39]

Unconscious motor–visual temporal recalibration occurs in both active and passive movements

*Masaki Tsujita (Faculty of Child Studies, Kamakura Women's University)

[P1-40]

The sound octave equivalence in a songbird as shown by the event-related brain potentials and the operant behavior.

*Rin Ito[1], Yukino Shibata[1,2], Kazuo Okanoya[1] (1. Teikyo University, 2. Hokkaido University)

TRF

Fri. Oct 17, 2025 1:20 PM - 5:00 PM JST | Fri. Oct 17, 2025 4:20 AM - 8:00 AM UTC TCVB tour

[T03] Tokyo River Cruise & Hamarikyu Gardens

TRF | Other

Fri. Oct 17, 2025 10:45 AM - 11:00 AM JST | Fri. Oct 17, 2025 1:45 AM - 2:00 AM UTC Room 1(Mathematical Science Building)

[T00] Opening Remarks

Yuko Yotsumoto

Sat. Oct 18, 2025

Invited | Other

Sat. Oct 18, 2025 3:15 PM - 4:15 PM JST | Sat. Oct 18, 2025 6:15 AM - 7:15 AM UTC Room 2(West B1)

[K2] ECR Keynote: Devika Narain

Chair:Martin Wiener(George Mason University)

3:15 PM - 4:15 PM JST | 6:15 AM - 7:15 AM UTC

[K2-01]

Prior beliefs for timing movements: from neurons to manifolds

*Devika Narain[1] (1. Erasmus Medical Center (Netherlands))

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))

Oral | Memory, Emotion, Decision

Sat. Oct 18, 2025 9:00 AM - 10:30 AM JST | Sat. Oct 18, 2025 12:00 AM - 1:30 AM UTC Room 3(East B1)

[20301-06] Oral 4: Memory, Emotion, Decision

Chair:Müge Cavdan(Justus Liebig University Giessen)

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

[20301-06-01]

Investigating the effect of emotion on the temporal resolution of visual processing in viewing flickering LED.

*Makoto Ichikawa[1], Misa Kobayashi[2] (1. Graduate School of Humanities, Chiba University (Japan), 2. Graduate School of Science and Engineering, Chiba University (Japan))

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

[20301-06-02]

Alpha power indexes working memory load for durations

*Sophie Herbst[1], Izem Mangione[1], Charbel-Raphael Segerie[2], Richard Höchenberger[2], Tadeusz Kononowicz[4,1,3], Alexandre Gramfort[2], Virginie van Wassenhove[1] (1. Cognitive Neuroimaging Unit, INSERM, CEA, Université Paris-Saclay, NeuroSpin, 91191 Gif/Yvette, France (France), 2. Inria, CEA, Université Paris-Saclay, Palaiseau, France (France), 3. Institute of Psychology, The Polish Academy of Sciences, ul. Jaracza 1, 00-378 Warsaw, Poland (Poland), 4. Institut NeuroPSI - UMR9197 CNRS Université Paris-Saclay (France))

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

[20301-06-03]

Mentally shifting in time induces a shift in the amplitude of evoked responses

*Anna Maria Augustine Wagelmans[1], Virginie van Wassenhove[1] (1. Cognitive Neuroimaging Unit, INSERM, CEA, Université Paris-Saclay, NeuroSpin (France))

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

[20301-06-04]

Mental Time Travel Impairments in Neurodegenerative Diseases

*Valentina La Corte[1,2], Pascale Piolino[1,2] (1. Memory, Brain and Cognition lab,UR 7536, University Paris Cité (France), 2. Institut Universitaire de France (France))

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

[20301-06-05]

Level of Detail in Near and Far Future Imagined Events

*Ori Levit[1], Guy Grinfeld[1], Cheryl Wakslak[2], Yaacov Trope[3], Nira Liberman[1] (1. School of Psychological Science, Tel Aviv University (Israel), 2. Department of Management and Organization, University of Southern California, Los Angeles, California (United States of America), 3. Department of Psychology, New York University, New York (United States of America))

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

[20301-06-06]

Perceptual decision making of nonequilibrium fluctuations

*Aybüke Durmaz[1], Yonathan Sarmiento[1,2], Gianfranco Fortunato[1], Debraj Das[2], Mathew Ernst Diamond[1], Domenica Bueti[1], Édgar Roldán[2] (1. Sissa (International School for Advanced Studies) (Italy), 2. ICTP (The Abdus Salam International Centre for Theoretical Physics) (Italy))

Oral | Prediction, Temporal perception, Computational Modeling

Sat. Oct 18, 2025 1:00 PM - 2:30 PM JST | Sat. Oct 18, 2025 4:00 AM - 5:30 AM UTC Room 3(East B1)

[O6] Oral 6: Prediction, Temporal perception, Computational Modeling

Chair:Pascal Mamassian(CNRS & Ecole Normale Supérieure Paris)

1:00 PM - 1:15 PM JST | 4:00 AM - 4:15 AM UTC

[O6-01]

Temporal Prediction through Integration of Multiple Probability Distributions of Event Timings

*Yiyuan Teresa Huang[1], Zenas C Chao[1] (1. International Research Center for Neurointelligence, The University of Tokyo (Japan))

1:15 PM - 1:30 PM JST | 4:15 AM - 4:30 AM UTC

[O6-02]

The anticipation of imminent events is time-scale invariant

*Matthias Grabenhorst[1,2], David Poeppel[3], Georgios Michalareas[4,1,2] (1. Ernst Struengmann Institute for Neuroscience (Germany), 2. Max Planck Institute for Empirical Aesthetics (Germany), 3. New York University (United States of America), 4. Goethe University (Germany))

1:30 PM - 1:45 PM JST | 4:30 AM - 4:45 AM UTC

[O6-03]

The timing of neural-cardio-respiratory network states predicts perception across the senses

*Andreas Wutz[1] (1. University of Salzburg (Austria))

1:45 PM - 2:00 PM JST | 4:45 AM - 5:00 AM UTC

[O6-04]

What does the Fröhlich effect tell us about sensation time?

*Pascal Mamassian[1] (1. CNRS & Ecole Normale Supérieure Paris (France))

2:00 PM - 2:15 PM JST | 5:00 AM - 5:15 AM UTC

[O6-05]

Oscillatory Entrainment in Non-Deterministic Continuous Environments, Independent of Bayesian Interval Learning: Computational and Behavioral Evidence

*Elmira Hosseini[1,2], Assaf Breska[1] (1. Max-Planck Institute for Biological Cybernetics (Germany), 2. Tübingen University (Germany))

2:15 PM - 2:30 PM JST | 5:15 AM - 5:30 AM UTC

[O6-06]

An investigation of auditory rhythms with a spiking neural network autoencoder

*Rodrigo Manríquez[1,2], Sonja A. Kotz[2,3], Andrea Ravignani[4,5], Bart de Boer[1] (1. Vrije Universiteit Brussel (Belgium), 2. Maastricht University (Netherlands), 3. Max Planck Institute for Human Cognitive and Brain Sciences (Germany), 4. Sapienza University of Rome (Italy), 5. Aarhus University & The Royal Academy of Music (Denmark))

Oral | Computational Modeling, Neural Mechanisms

Sat. Oct 18, 2025 9:00 AM - 10:30 AM JST | Sat. Oct 18, 2025 12:00 AM - 1:30 AM UTC Room 2(West B1)

[O5] Oral 5: Computational Modeling, Neural Mechanisms

Chair:Assaf Breska(Max-Planck Institute for Biological Cybernetics)

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

[O5-01]

Centralized mechanisms of explicit and implicit timing in the human cerebellum: a neuropsychological approach

*Chiara Zanonato[1,2], Richard Ivry[3,4], Assaf Breska[1,3] (1. Max-Planck-Institute for Biological Cybernetics, Tübingen (Germany), 2. University of Tübingen (Germany), 3. Department of Psychology, University of California, Berkeley, CA (United States of America), 4. Helen Willis Neuroscience Institute, University of California, Berkeley, CA (United States of America))

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

[O5-02]

Unique Effect of Entrainment on Perception? Context-Specific Temporal Prediction Mechanisms in Multiple Aspects of Perception

*Christina Bruckmann[1,2], Assaf Breska[1] (1. Max Planck Institute for Biological Cybernetics (Germany), 2. University of Tübingen (Germany))

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

[O5-03]

Rationalizing temporal decision making and the neural representation of time

*Marshall G Hussain Shuler[1,2] (1. Johns Hopkins (United States of America), 2. Kavli Neuroscience Discovery Institute (United States of America))

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

[O5-04]

A Methodology to Accelerate Our Information Processing Toward Revealing the Relation between Process Speed and Time Perception

*Oki Hasegawa[1], Shohei Hidaka[1] (1. Japan Advanced Institute of Science and Technology (Japan))

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

[O5-05]

Sensory Reliability Shapes Sequential Effects in Human Duration Perception

*Taku Otsuka[1,2], Joost de Jong[1,3], Wouter Kruijne[1], Hedderik van Rijn[1] (1. University of Groningen (Netherlands), 2. The University of Tokyo (Japan), 3. Université de Paris (France))

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

[O5-06]

Bach and Bayes: Prediction in Noisy Musical Sequences

*Akanksha Gupta[1], Alejandro Tabas[2,3] (1. INS, INSERM, Aix-Marseille University, Marseille (France), 2. Perceptual Inference Group, Basque Center on Cognition, Brain and Language, San Sebastian (Spain), 3. Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig (Germany))

Poster | Other

Sat. Oct 18, 2025 12:45 PM - 2:45 PM JST | Sat. Oct 18, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P2] Poster: Day 2

[P2-01]

Disentangling the effects of movement speed and travel distance on perceived traveled time

*Cindy Jagorska[1], Christopher Hilton[1], Martin Riemer[1] (1. Technical University Berlin (Germany))

[P2-02]

withdrawn

. (.)

[P2-03]

Impaired Temporal Perception Following Sight Restoration After Congenital Cataracts

*Abel Mewleddeg Legu[2], Gianluca Mariscano[1], David Melcher[1,4], Ehud Zohary[2,3] (1. Department of Psychology, New York University Abu Dhabi (United Arab Emirates), 2. Project Eyeopener (Ethiopia), 3. The Hebrew University of Jerusalem (Israel), 4. Center for Brain and Health, New York University Abu Dhabi (United Arab Emirates))

[P2-04]

Decoding the reproduction of durations in size-varying virtual environment

*Camille L. Grasso[1], Matthew Logie[1], Virginie van Wassenhove[1] (1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris-Saclay, Gif/Yvette, 91191 France (France))

[P2-05]

Ticking Forward or Counting Down: The Impact of Clock Format on Time Perception and Task Performance

Maria Nogales[1], *Judit Castellà[1] (1. Autonomous University of Barcelona UAB (Spain))

[P2-06]

Electrophysiological signatures of post-interval activity in explicit and implicit timing

*Mariagrazia Capizzi[1], Cristina Narganes Pineda[1], Pom Charras[3], Giovanna Mioni[2], Antonino Visalli[4] (1. Mind, Brain and Behavior Research Center (CIMCYC), University of Granada; Department of Experimental Psychology, University of Granada, Granada, Spain (Spain), 2. Department of General Psychology, University of Padua, Padua (Italy), 3. Univ Paul Valéry Montpellier 3, EPSYLON EA 4556, F34000, Montpellier, France (France), 4. Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia (Italy))

[P2-07]

Time in the primate hippocampus during a metronome task

*Mildred Salgado-Menez[1], Ana Maria Malagon[1], Victor de Lafuente[1] (1. Universidad Nacional Autonoma de Mexico (Mexico))

[P2-08]

Effects of simultaneity and arm posture on tactile time perception in young and older adults

*Chika Goto[1], Naoya Tachibana[1], Shogo Sugiyama, Yuko Yotsumoto[1] (1. the University of Tokyo (Japan))

[P2-09]

Hand proximity enhances visual encoding via anticipatory processing

*Ankit Maurya[1,3], Tsukasa Kimura[2,3], Minto Hashimoto[4,3], Masamichi J. Hayashi[3,4], Tony Thomas[1] (1. Department of Humanities and Social Sciences, Indian Institute of Technology Roorkee, Roorkee (India), 2. Graduate School of Human Sciences, The University of Osaka, Suita (Japan), 3. Center for Information and Neural Networks (CiNeT), Advanced ICT Research Institute, National Institute of Information and Communications Technology, Suita (Japan), 4. Graduate School of Frontier Biosciences, The University of Osaka, Suita (Japan))

[P2-10]

Role of Supplementary Motor Areas in temporal estimation using tDCS.

*Claire TERRAN[1], Laurence CASINI[1] (1. CRPN - Centre for Research in Psychology and Neuroscience, AMU, CRNS (France))

[P2-11]

Duration Underestimation in Peripheral Visual Field

*YUHUI ZHOU[1], Sae Kaneko[1] (1. Hokkaido University (Japan))

[P2-12]

Embodying the expanded moment: the role of bodily awareness in temporal production during meditation-like attentional states

*Ludovica Ortame[1,2], Michele Pellegrino[2], Joseph Glicksohn[3,4], Patrizio Paoletti[2], Fabio Marson[5], Stafno Lasaponara[1,6], Maria Sofia Romano[1], Fabrizio Doricchi[1,6], Filippo Carducci[1], Tal Dotan Ben-Soussan[2] (1. Sapienza University of Rome (Italy), 2. Research Institute of Neuroscience, Education and Didactics (RINED) (Italy), 3. Bar-Ilan University (Israel), 4. The Leslie and Susan Gonda (Goldschmied) Multidisciplinary Brain Research Center, Bar-Ilan University, Ramat Gan (Israel), 5. University of Milano-Bicocca (Italy), 6. RCCS Fondazione Santa Lucia (Italy))

[P2-13]

Temporal unfolding contributes to interocular comparison for motion-in-depth perception in peripheral vision

*Ikuya Murakami[1] (1. The University of Tokyo (Japan))

[P2-14]

Assessing Temporal Resolution in Amblyopic and Fellow Eyes Using the Two-Flash Fusion Paradigm

*Aysha Hamkari[1], Gianluca Marsicano[1], Katja Cundric[1], David Melcher[1] (1. New York University Abu Dhabi (United Arab Emirates))

[P2-15]

Neural Bases of the Audiovisual Temporal Binding Window Using TMS

*Solène Leblond[1], Tutea Atger[1], Franck-Emmanuel Roux[1,2], Robin Baurès[1], Céline Cappe[1] (1. CerCo (Centre de Recherche Cerveau et Cognition), CNRS UMR 5549, University Toulouse (France), 2. Pôle neurochirurgie, CHU Purpan, Toulouse (France))

[P2-16]

Temporal Binding Across Timing Domains: Behavioural Evidence and a Protocol for Causal Manipulation via Transcranial Direct Current Stimulation

*Gustavo Brito de Azevedo[1], André Mascioli Cravo[2] (1. Graduate Program in Neuroscience and Cognition, Federal University of ABC (UFABC) (Brazil), 2. Center for Mathematics, Computing and Cognition, Federal University of ABC (UFABC) (Brazil))

[P2-17]

Modality-Specific Temporal Assimilation in a Bisection Task

*Gabriel Cafeu Brandão[1], Gustavo Brito de Azevedo[1], Peter Maurice Erna Claessens[1], André Mascioli Cravo[1] (1. Center for Mathematics, Computing and Cognition, Federal University of ABC (UFABC) (Brazil))

[P2-18]

Serial dependence between duration and numerosity perception

*Takuma Hashimoto[1,2], Yuko Yotsumoto[1] (1. The University of Tokyo (Japan), 2. Research Fellow of Japan Society for the Promotion of Science (Japan))

[P2-19]

Effects of attentional orienting on the production of temporal durations: an eye-tracking study

*Mariagrazia Ranzini[1], Sebastiano Cinetto[3], Sara Noacco[1], Zaira Romeo[2], Mario Bonato[4], Marco Zorzi[4], Giovanna Mioni[1] (1. Department of General Psychology (DPG), Univ. of Padova (Italy), 2. Neuroscience Institute, National Research Council, Padova (Italy), 3. Padova Neuroscience Center (PNC), Univ. of Padova (Italy), 4. Department of General Psychology (DPG) and Padova Neuroscience Center (PNC), Univ. of Padova (Italy))

[P2-20]

Retrospective Passage of Time Judgments in a Population of Parkinson’s Disease Patients: A Matter of Self-Projection in Time

*Florie MONIER[1], Michael DAMBRUN[1], Pierre-Michel LLORCA[2], Sylvie DROIT-VOLET[1] (1. Université Clermont-Auvergne (France), 2. Université Clermont-Auvergne, CHU clermont-ferrand (France))

[P2-21]

Cardiac Rhythms, Interoception and Temporal Counting: Dynamic Interactions across Time Ranges

*Mai Sakuragi[1,2], Elisa M. Gallego Hiroyasu[1,2], Satoshi Umeda[1] (1. Keio University (Japan), 2. Japan Society for the Promotion of Science (Japan))

[P2-22]

When do we perceive our heartbeats? Exploring temporal dynamics in interoception

*Yusuke Haruki[1], Keisuke Suzuki[2], Yuri Terasawa[3], Kenji Ogawa[4], Olaf Blanke[5], Yuko Yotsumoto[1] (1. Department of Life Sciences, The University of Tokyo (Japan), 2. Center for Human Intelligence, Artificial Intelligence, and Neuroscience, Hokkaido University (Japan), 3. Department of Psychology, Keio University (Japan), 4. Department of Psychology, Hokkaido University (Japan), 5. Laboratory of Cognitive Neuroscience, Ecole Polytechnique Federal de Lausanne (Switzerland))

[P2-23]

Distributional Variability Increases Uncertainty in Mean Duration Judgments

*Taku Otsuka[1,2], Hakan Karsilar[1], Hedderik van Rijn[1] (1. University of Groningen (Netherlands), 2. The University of Tokyo (Japan))

[P2-24]

Image Memorability Shapes 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))

[P2-25]

Effects of Network Topology and Goals on Interpersonal Synchronization in a Virtual ‘Rhythm Network’

*Jonathan Kirsh[1], Sharanya Badalera[1], John Rehner Iversen[1] (1. McMaster University (Canada))

[P2-26]

EEG Correlates of Movement-Induced Enhancements of Beat Timing

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

[P2-27]

The effect of repetitive transcranial magnetic stimulation (rTMS) over the supplementary motor area on the groove experience

*Takahide Etani[1,2,3], Mitsuaki Takemi[4,5], Tomohiro Samma[6], Jun Nitta[7], Saki Homma[6,8], Kenta Ueda[6], Keigo Yoshida[9,6], Kenjun Hayashida[4,5], Tatsuro Fujimaki[4], Sotaro Kondoh[6,9,10], Kazutoshi Kudo[7], Shinya Fujii[9] (1. Keio Research Institute at SFC (Japan), 2. Keio Univ. Hospital (Japan), 3. Japanese Red Cross Ashikaga Hospital (Japan), 4. Graduate School of Science and Technology, Keio Univ. (Japan), 5. Graduate School of Advanced Science and Engineering, Hiroshima Univ. (Japan), 6. Graduate School of Media and Governance, Keio Univ. (Japan), 7. Graduate School of Arts and Sciences, The Univ. of Tokyo (Japan), 8. Department of Neuropsychiatry, Keio Univ. School of Medicine (Japan), 9. Faculty of Environment and Information Studies, Keio Univ. (Japan), 10. Japan Society for the Promotion of Science (Japan))

[P2-28]

Timing Difficulties in Developmental Language Disorder and Stuttering: A planned study on the Role of Dysfunctional Synchronization of Brain Rhythms

*Christian A. Kell[1], Lars Meyer[2], Joachim Gross[2], Katrin Neumann[2] (1. Goethe University (Germany), 2. Muenster University (Germany))

[P2-29]

Contributions of cognitive abilities and attention to Motor Timing in Parkinson’s Disease

*Elisa M. Gallego Hiroyasu[1], Yuko Yotsumoto[2], Giovanna Mioni[3] (1. Keio University (Japan), 2. The University of Tokyo (Japan), 3. Universita di Padova (Italy))

[P2-30]

Exploring the role of rhythmicity for infant word learning by entrainment of brain and behaviour in social contexts: A preliminary study

*Erica Flaten[1], Cristina Conati[2], Janet Werker[1] (1. Department of Psychology, University of British Columbia (Canada), 2. Department of Computer Science, University of British Columbia (Canada))

[P2-31]

Pre-motor and auditory processing for inner and overt speech

*Lachlan James Hall[1], Thomas J Whitford[2], Mike E Le Pelley[2], Bradley N Jack[1] (1. Australian National University (Australia), 2. University of New South Wales (Australia))

[P2-32]

Neural correlates of changes of mind and confidence in the judgement of elapsed time

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

[P2-33]

Metacognition of Time Discrimination

*Valdas Noreika[1], Stefano Arlaud[1] (1. Queen Mary University of London (UK))

[P2-34]

Timing Control of Upper Body Movements in Playground Swing Pumping: The Role of External Forces

*Chiaki Hirata[1], Shun'ichi Kitahara[1] (1. Jumonji University (Japan))

[P2-35]

Social modulation of sense of responsibility and subjective time experience in semi-automated motor tasks

*Sayako Ueda[1,2] (1. Japan Women's University (Japan), 2. RIKEN CBS (Japan))

[P2-36]

When Time Stands Still: Altered spatiotemporal experiences in depersonalization

*Julia Ayache[1], Malika Auvray[2], Anna Ciaunica[3,4] (1. EuroMov Digital Health in Motion, Univ. Montpellier IMT Mines Alès, Montpellier (France), 2. Institut des Systèmes Intelligents et de Robotique, Sorbonne Université, CNRS, Paris (France), 3. GAIPS INESC-ID, Instituto Superior Tecnico, University of Lisbon, Lisbon (Portugal), 4. Institute of Cognitive Neuroscience, University College London, London (UK))

[P2-37]

Recalibrating perceptual time through motor learning

*Nicola Binetti[1], Federico Mancinelli[3], Marco Zanon[2], Domenica Bueti[2] (1. Università degli studi di Roma Tor Vergata (Italy), 2. International School for Advanced Studies (Italy), 3. University of Bonn (Germany))

[P2-38]

Beyond Pacemaker Speed: A Planned Investigation into Atemporal Perceptual Processes Underlying Differences in Auditory-Visual Duration Judgments

*Valtteri Arstila[1], Jarno Tuominen[1] (1. University of Turku (Finland))

[P2-39]

Influence of turn-taking regularity on respiratory activity in human conversation

*Mirei Kin and Hiroki Koda (Graduate School of Arts and Sciences, The University of Tokyo)

[P2-40]

Female gibbons' great calls change tempo in the presence of their offspring

*Yoichi Inoue[1], Waidi Sinun[2], Kazuo Okanoya[1] ([1]Teikyo University, [2]Research and Development Division, Yayasan Sabah Group)

TRF

Sat. Oct 18, 2025 8:00 AM - 10:00 AM JST | Fri. Oct 17, 2025 11:00 PM - 1:00 AM UTC TCVB tour

[T04] TCVB tour @ Zazen Experience

TRF

Sat. Oct 18, 2025 5:45 PM - 8:30 PM JST | Sat. Oct 18, 2025 8:45 AM - 11:30 AM UTC Shibuya

[T05] Conference Dinner

Sun. Oct 19, 2025

Invited | Other

Sun. Oct 19, 2025 4:15 PM - 5:15 PM JST | Sun. Oct 19, 2025 7:15 AM - 8:15 AM UTC Room 2(West B1)

[K3] Keynote : Masaki Tanaka

Chair:Hugo Merchant(Universidad Nacional Autónoma de México)

4:15 PM - 5:15 PM JST | 7:15 AM - 8:15 AM UTC

[K-01]

Decoding subcortical mechanisms of temporal prediction of periodic events

*Masaki Tanaka[1] (1. Hokkaido University (Japan))

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))

Oral | Language, Animal

Sun. Oct 19, 2025 10:45 AM - 12:15 PM JST | Sun. Oct 19, 2025 1:45 AM - 3:15 AM UTC Room 3(East B1)

[O8] Oral 8: Language, Animal

Chair:Hiroki Koda(The University of Tokyo)

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

[O8-01]

Towards Differentiating Endogenously and Exogenously Driven Rhythms in the Brain: Syntax, Prosody and Delta-Band Activity

*Leonardo Zeine[1,2], Peter Donhauser[1], David Poeppel[3] (1. Ernst Strüngmann Institute for Neuroscience (Germany), 2. Max Planck School of Cognition (Germany), 3. New York University (United States of America))

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

[O8-02]

Reversible inactivation of insular and prelimbic cortices in a temporal decision-making task in rats

*Marcelo S Caetano[1], Estela B Nepomoceno[2] (1. Universidade Federal do ABC (UFABC) (Brazil), 2. Universidade São Caetano do Sul (USCS) (Brazil))

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

[O8-03]

Temporal Strategies and Cue Integration in Rats: Evidence from Operant and T-Maze Midsession Reversal Tasks

*Marcelo Bussotti Reyes[1], Marcelo Salvador Caetano[1], Armando Machado[2] (1. Universidade Federal do ABC (Brazil), 2. University of Aveiro (Portugal))

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

[O8-04]

Implicit timing in a group of freely behaving Guinea baboons

*Jennifer T Coull[1], Nicolas Claidière[1,2], Adrien Meguerditchian[1,2], Siham Bouziane[1] (1. Centre for Research in Psychology & Neurosciences, CNRS & Aix-Marseille University (France), 2. Station de Primatologie-Celphedia, UAR846, CNRS, Rousset (France))

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

[O8-05]

Spontaneous temporal predictions in Guinea Baboons: Insights from a sequential variable foreperiod paradigm

*Siham Bouziane[1], Adrien Meguerditchian[1,2], Nicolas Claidière[1,2], Jennifer T Coull[1] (1. Centre de Recherche en Psychologie et Neurosciences (France), 2. Station de Primatologie-Celphedia UAR846 CNRS - Rousset France (France))

12:00 PM - 12:15 PM JST | 3:00 AM - 3:15 AM UTC

[O8-06]

An evolutionary model of vocal accelerando in African penguins

*Yannick Jadoul[1,2,3], Taylor A. Hersh[2,4], Elias Fernández Domingos [3,5], Marco Gamba[6], Livio Favaro[6], Andrea Ravignani[1,2,7,8] (1. Department of Human Neurosciences, Sapienza University of Rome, Rome (Italy), 2. Comparative Bioacoustics Group, Max Planck Institute for Psycholinguistics, Nijmegen (Netherlands), 3. Artificial Intelligence Lab, Vrije Universiteit Brussel, Brussels (Belgium), 4. Marine Mammal Institute, Oregon State University, Newport, Oregon (United States of America), 5. Machine Learning Group, Université Libre de Bruxelles, Brussels (Belgium), 6. Department of Life Sciences and Systems Biology, University of Turin, Turin

(Italy), 7. Center for Music in the Brain, Department of Clinical Medicine, Aarhus University, Aarhus (Denmark), 8. Research Center of Neuroscience "CRiN-Daniel Bovet", Sapienza University of Rome, Rome (Italy))

Oral | Motor, Music

Sun. Oct 19, 2025 9:00 AM - 10:30 AM JST | Sun. Oct 19, 2025 12:00 AM - 1:30 AM UTC Room 2(West B1)

[O7] Oral 7: Motor, Music

Chair:Ségolène M. R. Guérin(Université du Littoral Côte d'Opale)

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

[O7-01]

Phase-dependent encoding of motor memory

*Yuto Makino[1], Masaya Hirashima[1] (1. National Institute of Information and Communications Technology (Japan))

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

[O7-02]

Mapping Time and Space in Social Interactions with the Mirror and Rock-Paper-Scissor Games

*Julia Ayache[1,2], Marta Bieńkiewicz[2], Simon Pla[2], Pierre Jean[2], Alexander Sumich[1,3], Nadja Heym[1], Benoit G. Bardy[2] (1. NTU Psychology, Nottingham Trent University, Nottingham (UK), 2. EuroMov Digital Health in Motion, Univ. Montpellier IMT Mines Alès, Montpellier (France), 3. Department of Psychology, Auckland University of Technology, Auckland (New Zealand))

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

[O7-03]

Sharing Timing in Physical and Virtual Spaces

*Julien Laroche[1], Julia Ayache[1], Marco Coraggio[2], Angelo di Porzio[2], Francesco de Lellis[3], Anna Katharina Hebborn[4], Andreas Panayiotou[5], Lyam Pepin[6], Panayiotis Charalambous[5], Simon Pla[1], Pierre Jean[1], Mario di Bernardo[2,3], Didier Stricker[4], Benoît Bardy[1] (1. EuroMov DHM, Univ. Montpellier, IMT Alès (France), 2. Scuola Superiore Meridionale (Italy), 3. Univ. Napoli "Federico II" (Italy), 4. German Research Center for Artificial Intelligence (Germany), 5. CYENS (Cyprus), 6. Univ. Paul Valery Montpellier, (France))

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

[O7-04]

Juggling on the Moon: Adaptation of complex motor skills to simulated low-gravity enabled changes in tempo

*John Rehner Iversen[1], Akilesh Sathyakumar[1], Hyeonseok Kim[2], Makoto Miyakoshi[2], Wanhee Cho[3], Hirokazu Tanaka[4], Takahiro Kagawa[5], Makoto Sato[3], Scott Makeig[7], Hiroyuki Kambara[6], Natsue Yoshimura[3] (1. McMaster University (Canada), 2. Cincinnati Children's Hospital Medical Center (United States of America), 3. Institute of Science Tokyo (Japan), 4. Tokyo City University (Japan), 5. Aichi Institute of Technology (Japan), 6. Tokyo Polytechnic University (Japan), 7. University of California San Diego (United States of America))

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

[O7-05]

Culture-Driven Plasticity and Imprints of Body-Movement Pace on Musical Rhythm Processing

*Ségolène M. R. Guérin[1,2], Emmanuel Coulon[2], Tomas Lenc[2,3], Rainer Polak[4], Peter Keller[5], Laurie Gallant[2], Antoine Boveroux[2], Sylvie Nozaradan[2] (1. URePSSS, Université du Littoral Côte d'Opale (France), 2. Institute of Neuroscience (IoNS), Université Catholique de Louvain (UCLouvain) (Belgium), 3. Basque Center on Cognition, Brain, and Language (BCBL) (Spain), 4. RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo (Norway), 5. Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg (Denmark))

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

[O7-06]

Evidence for neural categorization of rhythm in human newborns

*Francesca M. Barbero[1], Tomas Lenc[1,2], Alban Gallard[3], Nori Jacoby[4,5], Rainer Polak[6,7], Arthur Foulon[3], Sahar Moghimi[3], Sylvie Nozaradan[1,8] (1. Institute of Neuroscience (IoNS), University of Louvain (UCLouvain), 1348 Louvain-la-Neuve (Belgium), 2. Basque Center on Cognition, Brain and Language (BCBL), Donostia-San Sebastian (Spain), 3. Groupe de Recherches sur l'Analyse Multimodale de la Fonction Cérébrale (GRAMFC, Inserm UMR1105), Université de Picardie, 80054 Amiens (France), 4. Computational Auditory Perception Group, Max Planck Institute for Empirical Aesthetics, Grüneburgweg 14, 60322 Frankfurt am Main (Germany), 5. Department of Psychology, Cornell University, Ithaca, NY 14853 (United States of America), 6. RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo (Norway), 7. Department of Musicology, University of Oslo (Norway), 8. International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal (Canada))

Oral | Timing & Time Perception

Sun. Oct 19, 2025 10:45 AM - 12:15 PM JST | Sun. Oct 19, 2025 1:45 AM - 3:15 AM UTC Room 2(West B1)

[O9] Oral 9: Timing & Time Perception

Chair:Sae Kaneko(Hokkaido University)

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

[O9-01]

How each heartbeat shapes neural processing of duration?

*Irena Arslanova[1], Magda Jaglinska[2], Manos Tsakiris[1] (1. Royal Holloway University of London (UK), 2. University College London (UK))

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

[O9-02]

Mechanisms of Time Perception: Roles of Time-Frequency Power and Cross-Frequency Coupling

*Tereza Nekovarova[1,2], Veronika Rudolfova[1,2], Kristyna Maleninska[1], Ondrej Skrla[1], Jakub Svoboda[1], Jana Koprivova[1,3], Martin Brunovsky[1,3], Vlastimil Koudelka[1] (1. National Institute of Mental Health (Czech Republic), 2. Faculty of Natural Science, Charles University (Czech Republic), 3. 3rd Faculty of Medicine (Czech Republic))

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

[O9-03]

Intra- and inter-individual variability in body-brain-behavioral rhythms: a multimodal study with smart wearables

*Antonio Criscuolo[1], Michael Schwartze[1], Sonja Kotz[1,2] (1. Maastricht University (Netherlands), 2. Max Planck Institute for Human Cognitive and Brain Sciences (Germany))

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

[O9-04]

Ontogeny of rhythmic performances and contribution of motor and perceptual rhythmic preferences

*Pier-Alexandre Rioux[1], Nicola Thibault[1,2], Daniel Fortin-Guichard[3], Émilie Cloutier-Debaque[4], Simon Grondin[1] (1. Laval University (Canada), 2. CERVO, Brain Research Center (Canada), 3. McGill University (Canada), 4. University of Montreal Hospital Center (Canada))

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

[O9-05]

Representational dynamics of subjective duration in the human brain

*Camille L. Grasso[1], Ladislas Nalborczyk[2], Virginie van Wassenhove[1] (1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris-Saclay, Gif/Yvette, 91191 France (France), 2. Aix Marseille University, CNRS, LPL (France))

12:00 PM - 12:15 PM JST | 3:00 AM - 3:15 AM UTC

[O9-06]

Mouse Strain Differences in Time Estimation are Related to Impulsive Behavior

*MARIELENA EUDAVE-PATIÑO[1], JONATHAN BURITICÁ[2], JAIME EMMANUEL ALCALÁ TEMORES [2] (1. UNIVERSIDAD AUTÓNOMA DE AGUASCALIENTES (Mexico), 2. UNIVERSIDAD DE GUADALAJARA (Mexico))

Oral | EEG, MRI, TMS

Sun. Oct 19, 2025 1:00 PM - 2:30 PM JST | Sun. Oct 19, 2025 4:00 AM - 5:30 AM UTC Room 3(East B1)

[O10] Oral 10: EEG, MRI, TMS

Chair:Masamichi J Hayashi(Center for Information and Neural Networks (CiNet))

1:00 PM - 1:15 PM JST | 4:00 AM - 4:15 AM UTC

[O10-01]

Common EEG connectivity patterns between time reproduction and working memory

*Sergio Rivera-Tello[1], Julieta Ramos-Loyo[1] (1. University of Guadalajara (Mexico))

1:15 PM - 1:30 PM JST | 4:15 AM - 4:30 AM UTC

[O10-02]

Perception of short, but not long, time intervals is modality-specific: Converging electroencephalography evidence from vibrotactile and auditory modalities

*Nicola Thibault[1,2], Pier-Alexandre Rioux[1], Andréanne Sharp[1,2], Philippe Albouy[1,2,3], Simon Grondin[1] (1. Université Laval (Canada), 2. CERVO Brain Research Centre (Canada), 3. International Laboratory for Brain (Canada))

1:30 PM - 1:45 PM JST | 4:30 AM - 4:45 AM UTC

[O10-03]

Orthogonal Codes for Time and Decision in Human Temporal Perception

*Andre Mascioli Cravo[1], Mateus Silvestrin[3], Peter Maurice Erna Claessens[1], Nicholas Myers[2] (1. Universidade Federal do ABC (UFABC) (Brazil), 2. School of Psychology, University of Nottingham, UK (UK), 3. Federal University of the São Francisco Valley (Brazil))

1:45 PM - 2:00 PM JST | 4:45 AM - 5:00 AM UTC

[O10-04]

Shared spectral fingerprints of temporal memory precision and representation of the temporal structure of complex narratives

*Matteo Frisoni[1], Pierpaolo Croce[2], Annalisa Tosoni[2], Filippo Zappasodi[2], Carlo Sestieri[2] (1. University of Bologna (Italy), 2. University D'Annunzio Chieti Pescara (Italy))

2:00 PM - 2:15 PM JST | 5:00 AM - 5:15 AM UTC

[O10-05]

Defining a functional hierarchy of millisecond time: from visual stimulus processing to duration perception

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

2:15 PM - 2:30 PM JST | 5:15 AM - 5:30 AM UTC

[O10-06]

The chronometry of time processing in visual and premotor areas

*Domenica Bueti[1] (1. International School for Advanced Studies (SISSA) (Italy))

Poster | Other

Sun. Oct 19, 2025 12:45 PM - 2:45 PM JST | Sun. Oct 19, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P3] Poster: Day 3

[P3-01]

Perceiving Time in Sleep: Links between Misperception, REM Sleep, and Depressivity in Insomnia

*Jana Koprivova[1,2], Julie Siskova[1], Karolina Janku[1] (1. National Institute of Mental Health, Klecany (Czech Republic), 2. Third Faculty of Medicine, Charles University, Prague (Czech Republic))

[P3-02]

Implicit, but not explicit, timing is perturbed in schizophrenia

*Jennifer T Coull[1], Laurie Ladame[1], Mounira Taghdouini Kaddour[1], Tiffanie Zemour[1], Hélène Wilquin[1] (1. Centre for Research in Psychology & Neuroscience, CNRS & Aix-Marseille University (France))

[P3-03]

A Deep Reinforcement Learning Approach to Modeling Rat Behavior in Peak Interval Procedure

*S. Ruiz de Aguirre[1], Gloria Ochoa-Zendejas[2], Jonathan Buriticá[2] (1. Independent (Mexico), 2. Lab. of Cognition and Comparative Learning, Univ. of Guadalajara-CEIC, Guadalajara (Mexico))

[P3-04]

Complex impact of stimulus envelope on motor synchronization to sound

*Yue Sun[1,2], Georgios Michalareas[1,2,3], Oded Ghitza[4], David Poeppel[3,5,6] (1. Cooperative Brain Imaging Center (CoBIC), Goethe University Frankfurt (Germany), 2. Ernst Strüngmann Institute for Neuroscience (Germany), 3. Max Planck Institute for Empirical Aesthetics (Germany), 4. Department of Biomedical Engineering & Hearing Research Center, Boston University (United States of America), 5. Department of Psychology, New York University (United States of America), 6. Center for Language, Music, and Emotion (CLaME) (United States of America))

[P3-05]

Entrainment in Low- and High-Level Ventral Visual Regions Does Not Affect Temporal Overestimations

*Amirmahmoud Houshmand Chatroudi1,2, Yuko Yotsumoto1 (1. The University of Tokyo (Japan), 2. Sony Computer Sciences Laboratories (Japan))

[P3-06]

Does Semantic Modulation Induce Time Dilation? The Role of Flicker Frequency and Visual Saliency

*Takeya Oda1, Amirmahmoud Houshmand Chatroudi2, Yuko Yotsumoto1 (1. The University of Tokyo (Japan), 2. Sony Computer Science Laboratories (Japan))

[P3-07]

Top-Down Control of Alpha-Band Phase as a Mechanism of Interval Temporal Prediction: Direct Test and Preliminary Evidence

*Christina Bruckmann[1,2], Assaf Breska[1] (1. Max Planck Institute for Biological Cybernetics (Germany), 2. University of Tübingen (Germany))

[P3-08]

Aging effect on temporal processing: an ongoing study on retrospective timing and spontaneous oscillatory bursts.

*Florentine Fricker[1], Giulia Buzi[1], Maëlys Morantin[1], Franck Doidy[1], Patrice Clochon[1], Raphaël Bordas[2], Virginie van Wassenhove[2], Thomas Hinault[1] (1. Université de Caen Normandie, INSERM, EPHE-PSL, PSL University, CHU de Caen, GIP Cyceron, U1077, NIMH, 14000 Caen, France. (France), 2. Cognitive Neuroimaging Unit, INSERM, CEA, Université Paris-Saclay, NeuroSpin, 91191 Gif/Yvette, France. (France))

[P3-09]

Neural Oscillatory Entrainment in Non-Deterministic Continuous Environments, decoupled from Bayesian Interval Learning

*Elmira Hosseini[1,2], Assaf Breska[1] (1. Max-Planck Institute for Biological Cybernetics (Germany), 2. Tübingen University (Germany))

[P3-10]

Perceived time shapes the course of physical fatigue

*Pierre-Marie Matta[1,2,3], Robin Baurès[1,2], Julien Duclay[1,3], Andrea Alamia[1,2] (1. University of Toulouse (France), 2. Centre de Recherche Cerveau et Cognition, CNRS (France), 3. Toulouse NeuroImaging Center, INSERM (France))

[P3-11]

Sequential Brain Activity for subsecond-lagged Sensory and Motor events: Investigation using Temporal High-Resolution fMRI at 9.4 Tesla

*Nikolas Philipp Klein[1,2], Sebastian Mueller[2], Klaus Scheffler[2,3], Assaf Breska[1] (1. Research Group Cognitive Neuroscience of Dynamic Cognition, Max Planck Institute for Biological Cybernetics (Germany), 2. Department High-field Magnetic Resonance , Max Planck Institute for Biological Cybernetics (Germany), 3. Deparment of Biomedical Magnetic Resonance, Eberhard Karls University Tuebingen (Germany))

[P3-12]

The effect of temporal regularity on neural activity during perceptual and motor timing

*Mitsuki Niida[1], Kenji Ogawa[1] (1. Hokkaido University (Japan))

[P3-13]

Time on my hands: Examination of overlapping rhythmic synchronization mechanisms across sensory modalities

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

[P3-14]

Impact of Retrosplenial Cortex Resection on Temporal Estimation in CD1 Mice

*Tania Campos-Ordoñez[1], Marielena Eudave-Patiño[2,3], Emmanuel Alcalá[2], Jonathan Buriticá[2] (1. Departamento de Biología Celular y Molecular, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara (Mexico), 2. Centro de Estudios e Investigaciones en Comportamiento, Universidad de Guadalajara (Mexico), 3. Universidad Autónoma de Aguascalientes (Mexico))

[P3-15]

Statistical analysis of small-integer ratios in bioacoustics and music

*Yannick Jadoul[1], Tommaso Tufarelli, Chloé Coissac[1], Marco Gamba[2], Andrea Ravignani[1,3,4] (1. Department of Human Neurosciences, Sapienza University of Rome, Rome (Italy), 2. Department of Life Sciences and Systems Biology, University of Turin, Turin (Italy), 3. Center for Music in the Brain, Department of Clinical Medicine, Aarhus University, Aarhus (Denmark), 4. Research Center of Neuroscience “CRiN-Daniel Bovet”, Sapienza University of Rome, Rome (Italy))

[P3-16]

Rat Model of Schizophrenia: A Comparative Study of NMDA Antagonists Using the Peak Interval Task

*Veronika Rudolfová[1,2], Kristýna Malenínská[1,3], Štěpán Wenke[1,4], Anastasia Popova[1], Tereza Nekovářová[1,2] (1. National Institute of Mental Health, Topolová 748, 250 67, Klecany (Czech Republic), 2. Faculty of Science, Charles University, Department of Zoology, Viničná 7, 128 44, Prague (Czech Republic), 3. Czech Academy of Sciences, Institute of Physiology, Vídeňská 1083, 142 20, Prague (Czech Republic), 4. Aging Research Center, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Stockholm (Sweden))

[P3-17]

Strategic use of temporal cues (timing) in reversal learning: A comparative study in CD1 and C57BL/6 mice

*Jonathan Buritica[1], Ana Patricia Orozco Coles[1], Tania Campos Ordoñez[2] (1. Universidad de Guadalajara (Mexico), 2. 2.Departamento de Biología Celular y Molecular, Centro Universitario de Ciencias Biológicas y Agropecuarias. Universidad de Guadalajara, México (Mexico))

[P3-18]

Rock with Me: How Social Interaction Shapes Spontaneous Motor Tempo in Baboons' stone rubbing

*Siham Bouziane[1], Anne Bobin-Bègue[3], Jennifer T Coull[1], Adrien Meguerditchian[1,2] (1. Centre de Recherche en Psychologie et Neurosciences (France), 2. Station de Primatologie-Celphedia UAR846 CNRS - Rousset France (France), 3. Laboratoire Éthologie Cognition Développement, Paris-Nanterre, France (France))

[P3-19]

The effect of visual perceptual load on EEG and behavioural measures of sensory time perception in vision and audition

*Keying Wang[1], Nilli Lavie[1] (1. University College London (UK))

[P3-20]

Temporal Jitter in Music Reveals Robust Early Stream Formation and Enhanced Attentional Selection via Attention Recruitment

*Shu Sakamoto[1,2], Emily Wood[1,2], Harris Miller[1], Ellia Baines[1], Kevin Yang[1], Lily Eshraghi[1], Laurel J. Trainor[1,2] (1. Department of Psychology, Neuroscience, and Behavior, McMaster University (Canada), 2. McMaster Institute of Music and the Mind (Canada))

[P3-21]

Valence and arousal lengthen time for subsequent neutral events

*Nedim Goktepe[1], Müge Cavdan[2], Knut Drewing[2] (1. INM- Leibniz Institute for New Materials (Germany), 2. Department of Psychology Justus-Liebig-University Giessen (Germany))

[P3-22]

What do the eyes tell us about emotional temporal distortion? An exploratory study

*Luigi Micillo[1], Mariagrazia Capizzi[2,3], Andrea Zangrossi[1], Giovanna Mioni[1] (1. Department of General Psychology - University of Padova (Italy), 2. Department of Experimental Psychology - University of Granada (Spain), 3. Mind, Brain and Behavior Research Center (CIMCYC) - University of Granada (Spain))

[P3-23]

Auditory Object Formation in Temporally Complex Acoustic Scenes

*Berfin Bastug[1,2,3], Yue Sun[1,5], Erich Schröger[2,3], David Poeppel[2,4] (1. Ernst Strüngmann Institute for Neuroscience, Frankfurt am Main (Germany), 2. Max Planck School of Cognition (Germany), 3. Wilhelm-Wundt-Institute of Psychology, Leipzig University, Leipzig (Germany), 4. New York University, New York (United States of America), 5. Cooperative Brain Imaging Center (CoBIC), Goethe University Frankfurt (Germany))

[P3-24]

Effect of Image Compressibility and Internal Model on Time Perception (Data Collection Forthcoming)

*Maxim Zewe[1], Domenica Bueti[1], Eugenio Piasini[1] (1. International School for Advanced Studies (SISSA) (Italy))

[P3-25]

Reference Frame Effects on Non-Spatial Tactile Decisions: Evaluation with a Drift Diffusion Model

*Naoya Tachibana[1], Yuko Yotsumoto[1] (1. University of Tokyo (Japan))

[P3-26]

Postdictive suppression of visible stimuli in backward masking: Dissociation between initial and postdictive perception

*Shosuke Nishimoto[1] (1. The University of Tokyo (Japan))

[P3-27]

Indifference Interval and Central Tendency in Temporal Reproduction: A Comparative Study of Auditory and Visual Modalities

*Kristýna Malenínská[1], Veronika Rudolfová[1,2], Kateřina Dorflová[1,3], Tereza Nekovářová[1,2] (1. National Institute of Mental Health, Topolová 748, 250 67, Klecany (Czech Republic), 2. Faculty of Science, Charles University, Department of Zoology, Viničná 7, Prague (Czech Republic), 3. Third Faculty of Medicine, Charles University, Ruská 87, Prague (Czech Republic))

[P3-28]

Simulated Gravitational Physics Shapes Time Perception in Virtual Reality

*Amir Jahanian-Najafabadi[1], Carolyn Kroger[2], Ningyuan Sun[3], Jean Botev[3], Christoph Kayser[1] (1. Department of Cognitive Neuroscience, Bielefeld University (Germany), 2. Kresge Hearing Research Institute, Department of Otolaryngology - Head and Neck Surgery, University of Michigan (United States of America), 3. VR/AR Lab, Department of Computer Science, University of Luxembourg, Esch-sur-Alzette (Luxembourg))

[P3-29]

Warped videos, twisted time: The cognitive impact of altered playback speeds

*Judit Castellà[1], Elsa Ferrer[1], Estefanía Rajó[1], Diana Ruano[1], Laura Serra[1] (1. Autonomous University of Barcelona UAB (Spain))

[P3-30]

Effects of non-temporal auditory features on timing judgments in healthy adults and cochlear-implant users

*Carolyn Kroger[1], Deborah R. Fu[1], Renee Banakis Hartl[1], Ruth Y. Litovsky[2], Anahita H. Mehta[1] (1. University of Michigan (United States of America), 2. University of Wisconsin - Madison (United States of America))

[P3-31]

L-Dopa and STN-DBS modulate the neural encoding of rhythmic auditory stimulation in Parkinson’s

*Antonio Criscuolo[1], Michael Schwartze[1], Sonja Kotz[1,2] (1. Maastricht University (Netherlands), 2. Max Planck Institute for Human Cognitive and Brain Sciences (Germany))

[P3-32]

Two topological axes for temporo-spatial processing in visuomotor control

*Christian A. Kell1, Christina Nissen1 (1. Goethe University (Germany))

[P3-33]

EEG reveals how space acts as a late heuristic of timekeeping

*Fabrizio Doricchi1,2, Sara Lo Presti1,2, Stefano Lasaponara1,2, Massimo Silvetti3 (1. Universita' La Sapienza - Roma (Italy), 2. Fondazione Santa Lucia IRCCS - Roma (Italy), 3. Institute of Cognitive Sciences and Technologies, National Research Council (CNR) - Italy (Italy))

[P3-34]

Lag adaptation and Bayesian calibration in tactile simultaneity perception

*Kyuto Uno1, Kaoru Amano1 (1. The University of Tokyo (Japan))

[P3-35]

The modulating role of saccadic and oculomotor behavior during a temporal reproduction task

*Khaled Bagh1, Christoph Kayser1, Amir Jahanian Najafabadi1 (1. Bielefeld University (Germany))

[P3-36]

Perceptual timing precision in complex sound sequences is shaped by context-target similarity

*Charlotte M. Mock1,2,3, Leon Ilge1,4, Yulia Oganian1,2,3 (1. Centre for Integrative Neuroscience, University Medical Center Tübingen (Germany), 2. International Max Planck Research School for The Mechanisms of Mental Function and Dysfunction (Germany), 3. Graduate Training Centre of Neuroscience Tübingen (Germany), 4. Department of Biology, University of Tübingen (Germany))

[P3-37]

Timing in peripersonal space beyond internal clock model

*Haeran Jeong1,2 (1. University of Turku (Finland), 2. Heinrich Heine University Düsseldorf (Germany))

[P3-38]

Sensory–motor mirror neurons in the basal ganglia support temporally precise song imitation in Bengalese finches.

*Yuka Suzuki1,2, Hiroki, Koda1, Kazuo Okanoya2, & Shin Yanagihara2 (1: The University of Tokyo, Japan, 2: Teikyo University, Japan)

[P3-39]

Vocal timing and social affiliation: A comparative study in rats of same and different strains.

*Miki Kamatani[1,2,3], Shiomi Hakataya[3,4], Genta Toya[5], Shinya Yamamoto[1], Kazuo Okanoya[2,6] ([1]Kyoto University, [2]Teikyo University, [3]Research Fellow, Japan Society for the Promotion of Science, [4]University of the Ryukyus, [5]Institute of Science Tokyo, [6]The University of Tokyo)

[P3-40]

Tracking vocal turn-taking and inter-brains synchrony in human interactions

*Mami Terao1, Kazuo Okanoya1,2 (1. Teikyo University, 2. The University of Tokyo)

TRF

Sun. Oct 19, 2025 3:30 PM - 4:15 PM JST | Sun. Oct 19, 2025 6:30 AM - 7:15 AM UTC Room 2(West B1)

[T] Community Meeting

TRF

Sun. Oct 19, 2025 1:30 PM - 5:00 PM JST | Sun. Oct 19, 2025 4:30 AM - 8:00 AM UTC TCVB tour

[T06] TCVB tour: Meiji Shrine & harajuku Walking Tour

Invited | Timing & Time Perception

Fri. Oct 17, 2025 11:00 AM - 12:00 PM JST | Fri. Oct 17, 2025 2:00 AM - 3:00 AM UTC Room 1(Mathematical Science Building)

[K1] Keynote : Kalanit Grill-Spector

Chair:Domenica Bueti(International School for Advanced Studies (SISSA))

A key goal of cognitive neuroscience is to generate an understanding of the functional neuroanatomy of cortical systems. fMRI and computational modeling have transformed our understanding of the human brain. In the visual system, modeling population receptive fields (pRF) led to discoveries of multiple maps of pRF eccentricity, polar angle, and size as well as explained cognitive phenomena like spatial attention and the face inversion effect. However, due to the low temporal resolution of fMRI and the low spatial resolution of EEG/MEG it is unknown what is the nature of spatiotemporal computations in the human brain
Using computational encoding models and the visual system as a model system, I will describe recent empirical and computational innovations that have advanced understanding of key cognitive neuroscience questions. Specifically, I will describe a new empirical and computational framework for estimating from fMRI data the spatiotemporal population receptive field (st-pRF) of each voxel in the visual system in units of visual degrees and milliseconds. I will start by showing how we tested and validated the sp-pRF framework vs. ground truth data. Then, we use this framework to elucidate the spatiotemporal computations across the human visual system for the first time, finding that spatial and temporal windows as well as compressive nonlinearities increases systematically across the visual hierarchy. With this understanding in hand, we then assess how simple, bottom-up computations by st-pRFs may affect visual capacity and explain elusive phenomena like why neural responses are suppressed when multiple visual stimuli are presented at once compared to one after the other in sequence. I will end by the discussing the relevance of this powerful spatiotemporal pRF framework for understanding other sensory and cognitive systems in the brain.

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

[K1-01]

Understanding cognitive processing in the human visual system using spatiotemporal population receptive fields

*Kalanit Grill-Spector[1] (1. Stanford University (United States of America))

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*Kalanit Grill-Spector[1]

1. Stanford University

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Keywords: Computational Modeling, Human Visual System, Spatiotemporal Population Receptive Fields

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.
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.

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]

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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

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.

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

Oral | Timing & Time Perception

Fri. Oct 17, 2025 1:00 PM - 2:30 PM JST | Fri. Oct 17, 2025 4:00 AM - 5:30 AM UTC Room 3(East B1)

[O1] Oral 1: Timing & Time Perception

Chair:Nedim Goktepe(INM- Leibniz Institute for New Materials)

1:00 PM - 1:15 PM JST | 4:00 AM - 4:15 AM UTC

[O1-01]

Affective modulation of temporal binding using linguistic stimuli

*Felipe Toro Hernández[1], Theresa Moraes Ramalho[2], André Mascioli Cravo[2], Peter M. E. Claessens[2] (1. Graduate Program in Neuroscience and Cognition, Federal University of ABC (UFABC), São Paulo, Brazil (Brazil), 2. Center for Mathematics, Computing and Cognition, Federal University of ABC (UFABC), São Paulo, Brazil (Brazil))

1:15 PM - 1:30 PM JST | 4:15 AM - 4:30 AM UTC

[O1-02]

Causality Judgments and temporal order in individuals with Schizophrenia: a new case of time re-ordering

*Anne Giersch[1,2], Brice Martin[4,3], Cristina Rusu[1,2], Hager Guendouze[1,2] (1. INSERM (France), 2. University of Strasbourg (France), 3. Hôpital du Vinatier, Lyon (France), 4. Centre Hospitalier Drôme Vivarais (France))

1:30 PM - 1:45 PM JST | 4:30 AM - 4:45 AM UTC

[O1-03]

The human propensity for regularity extraction requires us to reconsider how we construct randomly timed stimuli

*Jelle van der Werff[1], Tommaso Tufarelli[1], Laura Verga[1], Andrea Ravignani[1] (1. Sapienza University of Rome (Italy))

1:45 PM - 2:00 PM JST | 4:45 AM - 5:00 AM UTC

[O1-04]

Moments or Continuum? Testing the Temporal Resolution of Human Anticipation

*GEORGIOS MICHALAREAS[1,2,3], David Poeppel[4], Matthias Grabenhorst[3,2] (1. Cooperative Brain Imaging Center (CoBIC), Goethe University Frankfurt (Germany), 2. Max-Planck-Institute for Empirical Aesthetics, Frankfurt (Germany), 3. Ernst Strüngmann Institute for Neuroscience in Cooperation with Max Planck Society, Frankfurt (Germany), 4. New York University (United States of America))

2:00 PM - 2:15 PM JST | 5:00 AM - 5:15 AM UTC

[O1-05]

Spatial tool use modulates time perception in near and far space

*Amir Jahanian-Najafabadi[1], Argiro Vatakis[2], Christoph Kayser[1] (1. Department of Cognitive Neuroscience, Bielefeld University (Germany), 2. Department of Psychology, Panteion University of Social and Political Sciences (Greece))

2:15 PM - 2:30 PM JST | 5:15 AM - 5:30 AM UTC

[O1-06]

Generalizing temporal perception in humans: learning transfer across interval categorization and interval identification tasks

*German Mendoza[1], Hugo Rey Andrade-Hernandez[2], Hugo Merchant[1] (1. Instituto de Neurobiología, UNAM (Mexico), 2. Maestría en Ciencias (Neurobiología), UNAM. (Mexico))

Oscillatory Entrainment in Non-Deterministic Continuous Environments, Independent of Bayesian Interval Learning: Computational and Behavioral Evidence

*Elmira Hosseini[1,2], Assaf Breska[1]

1. Max-Planck Institute for Biological Cybernetics, 2. Tübingen University

Temporal prediction is essential for efficient interaction with our continuously changing environment, but previous research has focused on deterministic contexts such as isochronous rhythms, linking it to Oscillatory Entrainment (OE). However, real-world continuous streams typically lack deterministic temporal regularities (e.g. speech). Temporal prediction in uncertain environments was mostly studied for isolated intervals, supporting a Distributional Learning (DL) process. Whether and how OE or DL mechanisms drive temporal prediction in non-deterministic continuous streams remains unclear. To address this, we combined computational modeling of OE, using a simple harmonic coupled oscillator, and DL, using ideal Bayesian observer, with human behavioral experiments. Model simulations showed that in non-deterministic environments, the greater the temporal variability, the more the predictions and prediction certainties of the two models were differentiated. We designed continuous streams with low (25%) and high (50%) degrees of variability (mean rate = 1.25 Hz), for which the two models led to different predicted timepoints. In a speeded response task, we presented these streams to participants with the targets occurring at either of these predicted timepoints, an intermediate timepoint, or a late timepoint to account for hazard effects. We observed a general reduction in reaction times for later targets (hazard effect), and, critically, additional reduction in the 25% relative to 50% condition, but only for targets presented at the OE-predicted timepoint. This pattern was replicated in a second experiment in which the mean rate of the stream varied between trials (1 or 1.66 Hz), ruling out learning across trials. Overall, our findings highlight the inherent differences between the two mechanisms in handling uncertainty, and reveal the flexibility of OE in adapting to partial irregularities, and its independence from Bayesian DL.

Keywords: Temporal Prediciton, Oscillatory Entrainment, Bayesian Learning, Computational Modelling, Behavioral Study

Causality Judgments and temporal order in individuals with Schizophrenia: a new case of time re-ordering

*Anne Giersch[1,2], Brice Martin[4,3], Cristina Rusu[1,2], Hager Guendouze[1,2]

1. INSERM, 2. University of Strasbourg, 3. Hôpital du Vinatier, Lyon, 4. Centre Hospitalier Drôme Vivarais

Temporal order (TO) helps to establish causal relationships between events, but can also be reversed to match perceived causality. We explored whether mechanisms related with conscious causality-inference can induce TO reversal, by studying the relation between temporal order and causality in both neurotypicals and patients with schizophrenia (SZ). Those patients have difficulties to order events in time and often emit aberrant causality judgements. We adapted our task from the Michotte paradigm to impose distinct causality judgements.
The tasks all entailed the same trials, but different judgements. On each trial a square moved towards a second static square, which was displayed at various delays before or after the stop of the moving square (-512 ms to +512 ms). In one block participants judged to which amount the static square stopped the moving square. In another block participants judged whether the moving square caused the appearance of the static square. In a last temporal order judgement task participants pressed to the side of the first event: the stop of the moving square or the onset of the static square.
Patients with SZ (28 vs. 21 controls) were impaired at judging temporal order. In addition, neurotypicals, but not individuals with SZ, were biased to answer that the onset of the static square was the first event. Follow-up experiments in 54 neurotypicals showed this (large) bias to occur only after decisions about the static square stopping the moving one. Additional data showed the persistence of the bias after one week.

This study confirms a difficulty in temporal order processing in SZ. Most importantly, neurotypicals, but not patients with SZ, adjusted temporal order perception to causality. Given (1) the robustness of this effect, (2) the task-imposed causality (rather than causality emerging naturally), and (3) known impairments in schizophrenia, we suggest that an active re-organization of information in vision leads to temporal re-ordering.

Keywords: Temporal order judgement, causality, visual organization, schizophrenia

The human propensity for regularity extraction requires us to reconsider how we construct randomly timed stimuli

*Jelle van der Werff[1], Tommaso Tufarelli, Laura Verga, Andrea Ravignani[1]

1. Sapienza University of Rome

Rhythm as a concept is notoriously hard to define, yet all definitions seem to presuppose a categorical distinction between rhythm and its converse, temporal randomness. The two are commonly juxtaposed as separate conditions in experiments, where it is sometimes assumed that the conditions are maximally contrastive. However, different methods exist for creating temporal randomness, and so we asked: can humans distinguish between the resulting different types of randomness? And can we mathematically model how they do it?

In a finger-tapping experiment we tested humans' synchronization performance for two types of highly irregular sequences that differed only in the amount of autocorrelation between adjacent intervals. Autocorrelations are often—and sometimes unwittingly—introduced in random sequences as a result of the jittering (i.e. offsetting) of event onsets. To avoid this, one can randomly sample the intervals between event onsets, which does not result in correlated intervals.

Subjects tapped closer to the sequence tempo for event-jittered (autocorrelated) sequences than for interval-sampled (uncorrelated) ones. They also tapped more regularly in response to them. However, they did not tap more accurately for either type. The subjects thus seemed to regularize their taps towards the sequence tempo, leveraging the autocorrelations to improve their tempo estimate.

We then modelled how tempo estimation of random sequences might work for both types of sequences. Using linear statistical estimators we were able to show that the statistical advantage that the autocorrelated intervals brings when estimating tempo occurs after only two or three intervals, and that this advantage stabilizes after that.

When designing experiments, we may need to more carefully consider how temporal randomness is constructed, as temporal randomness does not seem to be unitary entity. Rather, it is a fuzzy set created by artificial methodological choices.

Keywords: temporal randomness, rhythmicity, time perception

Moments or Continuum? Testing the Temporal Resolution of Human Anticipation

*GEORGIOS MICHALAREAS[1,2,3], David Poeppel[4], Matthias Grabenhorst[3,2]

1. Cooperative Brain Imaging Center (CoBIC), Goethe University Frankfurt, 2. Max-Planck-Institute for Empirical Aesthetics, Frankfurt, 3. Ernst Strüngmann Institute for Neuroscience in Cooperation with Max Planck Society, Frankfurt, 4. New York University

When we predict *when* something will occur, do we sweep a continuous timeline or focus on a handful of privileged instants? We addressed this question in a Set-Go paradigm that orthogonally manipulated two factors. First, we shaped the time-to-event (Go-time) probability over a 0.4–1.4s time interval so that it rose linearly, fell linearly, or remained flat. Second, we discretised this time interval into 3, 5, 9, or 15 Go-time sampling points, parameterising temporal granularity from coarse to fine.

Because humans rapidly internalise a probability-density function (PDF)[1] we expected all participants to learn the rising, falling, or flat probability trend. Against this backdrop, three rival hypotheses were tested by the different sampling resolutions.First, according to the **"selective-gain hypothesis"**, widely spaced Go-times—beyond the scalar noise of interval timing (≈10 % of the interval)[2]—allow the brain to spotlight individual time points, yielding faster responses there. In contrast, the **"chunking-cost hypothesis"** suggests that sparse Go-times lead to discrete attentional episodes[3]. Transitioning between these episodes adds cognitive load and slows down responses. Finally, the **"resolution-invariant hypothesis"** proposes that the brain relies solely on the continuous PDF, regardless of sampling resolution[3].

We tested the effect of temporal granularity in both visual and auditory modalities. The results showed that Reaction Times were highly similar across sampling conditions—arguing against selective-gain or chunking processes, in the case of a small number of sampling points. Temporal anticipation was primarily driven by the event probability distribution, highlighting the importance of the macroscale characteristics of event probabilities over their temporal microstructure.

References

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4. A.C. Nobre, F. van Ede, *Nat. Rev. Neurosci.* **19**, 34–48 (2018).

Keywords: Temporal resolution, Anticipation, Event probability, Sampling, Interval timing

Spatial tool use modulates time perception in near and far space

*Amir Jahanian-Najafabadi[1], Argiro Vatakis[2], Christoph Kayser[1]

1. Department of Cognitive Neuroscience, Bielefeld University, 2. Department of Psychology, Panteion University of Social and Political Sciences

In our recent research, we found that time estimation is mildly influenced by spatial distance and tool-use training in both young and older adults, using a visual time reproduction task. These findings supported the notion that time perception is linked to spatial processing and sensorimotor interactions within and beyond the peripersonal space, with effects that appear to be age-dependent. In the present study, we aimed to replicate and extend these findings by investigating whether spatial influences on time perception are task-specific and sensitive to stimulus duration. Twenty young adults performed two temporal judgment tasks (time reproduction, time bisection) before and after tool-use training. During training, participants used a mechanical grabber to grasp and move 100 objects located at a distance of 120 cm toward their body. Time stimuli, consisting of eight durations (2100–2900 ms), were presented at three distances from the body: 60 cm, 120 cm, and 240 cm. In the reproduction task, participants reproduced the durations; in the bisection task, they judged whether durations were shorter or longer than a learned standard. The results revealed consistent underestimation of intervals presented at 60 cm (near space), indicated by a reduced proportion of "long" responses compared to the 120 cm and 240 cm (far space) conditions. This suggests a distance-dependent modulation of perceived time, with time appearing to be perceived as shorter in near space. Notably, tool-use training shifted these baseline biases, indicating that sensorimotor experience can influence temporal judgments across space. These findings reinforce the idea that time perception is not purely internal but is shaped by the spatial context of sensory events and by our capacity to interact with objects in space, suggesting the plasticity of time perception in response to action and space around us.

Keywords: time perception, spatial distance, tool-use training, peripersonal space, action-perception coupling

Generalizing temporal perception in humans: learning transfer across interval categorization and interval identification tasks

*German Mendoza[1], Hugo Rey Andrade-Hernandez[2], Hugo Merchant[1]

1. Instituto de Neurobiología, UNAM, 2. Maestría en Ciencias (Neurobiología), UNAM.

Perceiving the elapse of time in the sub-second to second range is an essential ability of humans and other animal species, yet its neural bases are not well known. Some experimental paradigms have been designed to understand this cognitive function, including interval categorization and identification. The former requires assigning the intervals of a test set to short- or long-duration categories. The latter requires differentiating all the intervals based on their different durations. An intuitive idea is that the brain uses the same neural mechanism to measure time elapsed to solve both tasks. Nevertheless, some neurophysiological observations, including ours, suggest this is not the case. To analyze this possibility, we designed a learning transfer paradigm. One group of participants was intensively trained in identifying each of eight different intervals. Then, it was tested by categorizing the same intervals as short or long before and after the training. Another group was intensively trained in categorizing the intervals and was tested in identifying them before and after the training. We found that participants showed statistical trends and significant changes in performance, reaction time, accuracy, and sensitivity to certain intervals depending on the trained task. The asymmetrical effects suggested differences in the neural mechanisms recruited to categorize and identify intervals. Based on these observations and previous neurophysiological findings in humans and non-human primates, we propose neural mechanisms for interval categorization and identification.

Keywords: timing, categorization, identification, learning transfer, human psychophysics

Oral | Development, Clinical

Fri. Oct 17, 2025 3:30 PM - 5:00 PM JST | Fri. Oct 17, 2025 6:30 AM - 8:00 AM UTC Room 3(East B1)

[O2] Oral 2: Decelopment, Clinical

Chair:Rafael Román-Caballero(Universidad de Granada & McMaster University)

3:30 PM - 3:45 PM JST | 6:30 AM - 6:45 AM UTC

[O2-01]

“Past is Present, and Present is Past for Me": A case report of a 21-year-old female with autism spectrum disorder and enhanced episodic memory

*Ryuta Ochi[1,2], Shigeru Kitazawa[3], Mitsuru Kawamura[2] (1. Department of Psychology, Graduate School of Letters, CHUO University (Japan), 2. Division of Neurology, Department of Internal Medicine, School of Medicine, Showa Medical University (Japan), 3. Dynamic Brain Network Laboratory, Graduate School of Frontier Biosciences, The University of Osaka (Japan))

3:45 PM - 4:00 PM JST | 6:45 AM - 7:00 AM UTC

[O2-02]

Time attitudes and psychological distress: Exploring the interface between temporal representation and affect

*Thiago Bonifácio[1], André Mascioli Cravo[1] (1. Federal University of ABC (Brazil))

4:00 PM - 4:15 PM JST | 7:00 AM - 7:15 AM UTC

[O2-03]

Victims living in the now: A developmental glimpse on time perspectives through a criminological lense

*Sebastian L. Kübel[1,2,3] (1. University of Bern (Switzerland), 2. Max Planck Institute for the Study of Crime, Security and Law (Germany), 3. University of Leiden (Netherlands))

4:15 PM - 4:30 PM JST | 7:15 AM - 7:30 AM UTC

[O2-04]

Visual attention of infants in early interactions: Comparing early processing of music and language

*Rafael Román-Caballero[1,2], Maya Psaris[2], Betania Y. Georlette[3], Mohammadreza Edalati[3], Barbara Tillmann[4], Sahar Moghimi[3], Gabriel (Naiqi) Xiao[2], Laurel J. Trainor[2], Juan Lupiáñez[1] (1. Universidad de Granada (Spain), 2. McMaster University (Canada), 3. Université de Picardie (France), 4. Université de Bourgogne (France))

4:30 PM - 4:45 PM JST | 7:30 AM - 7:45 AM UTC

[O2-05]

Visual causality detection capabilities in individuals treated for prolonged early-onset blindness

*Marin Vogelsang[1], Lukas Vogelsang[1], Priti Gupta[2], Stutee Narang[2], Purva Sethi[2], Suma Ganesh[2], Pawan Sinha[1] (1. MIT (United States of America), 2. Dr Shroff’s Charity Eye Hospital (India))

4:45 PM - 5:00 PM JST | 7:45 AM - 8:00 AM UTC

[O2-06]

Performance of late-sighted children on the temporal order judgement task

*Lukas Vogelsang[1], Priti Gupta[2], Marin Vogelsang[1], Naviya Lall[2], Manvi Jain[2], Chetan Ralekar[1], Suma Ganesh[2], Pawan Sinha[1] (1. MIT (United States of America), 2. Dr Shroff’s Charity Eye

Hospital (India))

“Past is Present, and Present is Past for Me": A case report of a 21-year-old female with autism spectrum disorder and enhanced episodic memory

*Ryuta Ochi[1,2], Shigeru Kitazawa[3], Mitsuru Kawamura[2]

1. Department of Psychology, Graduate School of Letters, CHUO University, 2. Division of Neurology, Department of Internal Medicine, School of Medicine, Showa Medical University, 3. Dynamic Brain Network Laboratory, Graduate School of Frontier Biosciences, The University of Osaka

Introduction:
Some individuals with Autism Spectrum Disorder (ASD) experience sudden recall of past events, known as the “time-slip phenomenon." This phenomenon has been reported in individuals with ASD who show preserved intellectual function and exceptional memory abilities (Sugiyama 1994, 2016). Here, we report the case of a 21-year-old female with ASD and enhanced episodic memory who exhibited a unique perception of time passage.
Case Information:
The patient was a 21-year-old right-handed university student. She had a history of eating disorders since age 16 and was diagnosed with ASD at 21. Since high school, she had noticed her time perception differed from others. She described two main features: 1) past events appeared as discrete, isolated episodes, not as a continuous flow; and 2) past events felt as if they were occurring in the “present.' She also experienced involuntary, immersive recollections, as if reliving those scenes. Results:
Neuropsychological testing revealed above-average intelligence on the WAIS-IV (Full IQ: 136, VCI: 122, PRI: 118, WMI: 131, PSI: 149) and above-average memory performance on the WMS-R (General Memory: 128, Verbal Memory: 128, Visual Memory: 112, Attention: 116, Delayed Recall: 125). In a task requiring memorization of numbers randomly placed in 52 squares (Luria 1968), she encoded them within ten minutes and recalled 85% after one month. In a McTaggart’s A series task (Tang et al. 2021; Futamura et al. under review), she correctly recognized tense differences but classified both past and future sentences as close to the "present," disregarding temporal distance. Discussions:
The patient had difficulty sensing the flow of time and distinguishing past from present. Her strong episodic memory suggests that insufficient forgetting—potentially associated with persistent focus on outdated memories and reduced adaptability (Awasthi et al., 2019)—may also disrupt the normal perception of time passage from past to present.

Keywords: perception of time passage, autism spectrum disorder, episodic memory

Time attitudes and psychological distress: Exploring the interface between temporal representation and affect

*Thiago Bonifácio[1], André Mascioli Cravo[1]

1. Federal University of ABC

This study explored the relationships between time-related attitudes, emotion regulation strategies, and psychological distress in a Brazilian sample (N = 625) using online self-report measures. Participants completed the Adolescent and Adult Time Attitudes Scale, Time Meaning and Metaphors Questionnaires, Regulation of Emotion Systems Survey, and the Depression, Anxiety, and Stress Scale (DASS-21). Bootstrapped correlation analyses showed strong positive associations between negative time attitudes, rumination, and psychological distress, especially depression. Present-negative attitudes were most strongly linked to depressive symptoms ($r = 0.62$, $p < .05$), along with general negative views of time (Meaning: $r = 0.48$; Metaphors: $r = 0.33$; *ps* < .05). In contrast, positive time attitudes correlated negatively with distress and positively with cognitive reappraisal ($r = 0.28$, $p < .05$). Random Forest regression analyses predicted psychological outcomes with modest accuracy: $R^2 = 0.24$ for anxiety (RMSE = 3.57), 0.50 for depression (RMSE = 3.91), and 0.27 for stress (RMSE = 3.46), all outperforming baseline models. Feature importance analyses identified key predictors: For anxiety: past-negative attitudes, age, and negative time metaphors. For depression: present-negative and present-positive attitudes, and general affective time evaluations. For stress: present-negative attitudes, affective time evaluations, and rumination. These results highlight the relevance of time attitudes, especially those related to the present, in the psychological well-being of adults. We suggest that time attitudes likely reflect rather than cause distress. Based on our findings, we propose two hypotheses: (1) the early marker hypothesis, where negative time attitudes may precede other symptoms; and (2) the open-window hypothesis, where time-related attitudes or beliefs offer a less stigmatizing path to early mental health interventions.

Keywords: Time attitudes, Psychological distress, Emotion regulation, Mental health

Victims living in the now: A developmental glimpse on time perspectives through a criminological lense

*Sebastian L. Kübel[1,2,3]

1. University of Bern, 2. Max Planck Institute for the Study of Crime, Security and Law, 3. University of Leiden

The prioritization of the present has for long been considered in Criminology as the most important individual-level predictor of crime. However, time perspectives were proposed as a relatively stable personality trait. Therefore, the discipline has neglected the investigation of factors that shape such a present orientation.

Inspired by current developments in psychology, this work set out to identify environmental factors that contribute to increases in present orientation. This is done using longitudinal data from a big representative sample of Swiss adolescents.

The results identify that victims of violent crimes report more present orientation and decreased future orientation. Mediation analyses show that these changes in time perspective in response to victimization are, in turn, associated with an increased risk to commit crime.

The prioritization of the present can thus explain the prominent criminological observation that victims are more likely to offend themselves. Peer processes following victimization appear to promote the increased focus on the present. Revealing these mechanisms in the development of time perspectives that contribute to crime can inform practical interventions to reduce crime.

Keywords: time perspective, present orientation, development, crime, person-environment interactions, longitudinal structural equation models

Visual attention of infants in early interactions: Comparing early processing of music and language

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1. Universidad de Granada, 2. McMaster University, 3. Université de Picardie, 4. Université de Bourgogne

Given the immature cognitive development of newborns, caregivers naturally engage with them using distinctive ways of speaking and singing, with modified acoustic characteristics compared to adult-directed productions. These early interactions play a crucial role in building emotional and social connections and language development, although the core aspects of such interactions between infants and caregivers remain understudied. Recent evidence suggests that the rhythm of infant-directed (ID) songs helps guide infants' attention to emotionally and socially relevant facial regions. In fact, infants are more likely to look at the caregiver's eyes at the time of the strong beats of the song. In the present longitudinal study, we examined the extension of this phenomenon to ID speech and ID songs in native and non-native languages with different rhythmic patterns (stress-timed vs. syllable-timed languages; e.g., English and Spanish) throughout the first year of life (at 4, 6, and 12 months of age). Eye tracking while infants watched videos of ID speaking and singing revealed that four-month-olds' eye movements were entrained to temporal regularities in both ID songs and ID speech, in native and non-native languages. Time histograms showed that infants were more likely to look at the eyes during the beat/stressed vowels. In addition, we observed oculomotor tracking of the ID productions with time response function models. We are now examining how this rhythm tracking changes when infants are 6 and 12 months old, and how it relates to electroencephalography measures of auditory rhythm tracking. This study contributes to our understanding of the role of auditory and visual rhythmic entrainment in early language acquisition and social-affective skills.

Keywords: infant-directed singing, infant-directed speech, rhythm, visual attention, eye-tracking

Visual causality detection capabilities in individuals treated for prolonged early-onset blindness

*Marin Vogelsang[1], Lukas Vogelsang[1], Priti Gupta[2], Stutee Narang[2], Purva Sethi[2], Suma Ganesh[2], Pawan Sinha[1]

1. MIT, 2. Dr Shroff’ s Charity Eye Hospital

The ability to identify causal relationships between visual objects critically depends on the detection of temporal regularities in the environment. Albert Michotte’ s pioneering studies demonstrated that certain relationships between visual events lead observers to perceive them as causally linked. The ability to attribute causality in such displays emerges early in development. This raises important questions about the roots of this proficiency. Specifically, does this capacity depend on early visual experience with inter-object interactions, or is it resilient to prolonged early-onset visual deprivation? Here, we studied a unique group of children from rural India who were born blind and received sight-restoring surgeries late in childhood. These children viewed animations akin to Michotte’ s, designed to assess their ability to discriminate causal from non-causal interactions. Stimuli included one causal event ("direct launching", where one moving disk hits another, causing it to immediately continue along the same trajectory) and three non-causal events, introducing a spatial gap, a temporal gap, or both between the disks. Participants viewed one causal and one non-causal animation and selected the sequence depicting the causal interaction. Results reveal low performance immediately post-surgery but rapid and marked improvements within the first postoperative month. Interestingly, a similar trajectory of rapid improvement was observed in a separate experiment conducted with the same children, probing their sensitivity to the Gestalt principle of common fate, in which they judged the direction of visual elements moving together. To sum, these findings highlight the resilience of visual causality detection based on temporal regularities to early-onset visual deprivation, underscore the remarkable plasticity of the visual system into late childhood, and suggest a possible role for temporal processing in facilitating rapid visual development post-surgery.

Keywords: causality detection, spatiotemporal processing, late sight onset, congenital blindness

Performance of late-sighted children on the temporal order judgement task

*Lukas Vogelsang[1], Priti Gupta[2], Marin Vogelsang[1], Naviya Lall[2], Manvi Jain[2], Chetan Ralekar[1], Suma Ganesh[2], Pawan Sinha[1]

1. MIT, 2. Dr Shroff’ s Charity Eye Hospital

Determining whether visual events occur simultaneously or sequentially critically impacts perceptual inference. Simultaneity has been shown to aid object discovery, a capacity essential for newborns in making sense of their sensory environment. Here, we examined whether early visual experience is necessary to acquire temporal order judgment capabilities in the visual domain. To this end, we studied individuals with prolonged visual deprivation due to congenital cataracts who received sight-restoring surgeries later in childhood. We examined two groups: 15 late-sighted individuals assessed several years after surgery, and 13 tested pre-operatively, then one week and one month post-operatively. Additionally, 22 normally sighted, approximately blur-matched controls completed the same experiment. Participants indicated which of two briefly presented visual bars appeared first, with temporal gaps between 17 and 500ms. The results reveal that, several years post-surgery, late-sighted participants performed comparably to controls. However, performance one week and one month following surgery was indistinguishable from pre-operative levels and remained significantly below that of the long-term follow-up group. Thus, proficiency in temporal judgments develops gradually with continued visual exposure. The data also suggest that the mechanism of time-based binding may contribute to the visual learning that the late-sighted undergo. Taken together, these findings reveal that early experience is not critical for acquiring temporal order judgment capabilities and highlight the feasibility of acquiring such capabilities despite early-onset, prolonged visual deprivation. This indicates that neural plasticity for developing this ability remains available into late childhood, with important implications for understanding temporal processing, perceptual organization, and rehabilitation prospects for children treated for early blindness.

Keywords: temporal order judgements, simultaneity, late sight onset, congenital blindness, temporal processing

Oral | Attention, Multisensory, Time Perception

Fri. Oct 17, 2025 3:30 PM - 5:00 PM JST | Fri. Oct 17, 2025 6:30 AM - 8:00 AM UTC Room 2(West B1)

[O3] Oral 3: Attention, Multisensory, Time Perception

Chair:Yuki Murai(National Institute of Information and Communications Technology)

3:30 PM - 3:45 PM JST | 6:30 AM - 6:45 AM UTC

[O3-01]

Discrete vs. continuous timer bars: How visual segmentation shapes the perception of time "running out"

*Jasmindeep Kaur[1], Jiaying Zhao[1], Joan Danielle Ongchoco[1] (1. The University of British Columbia (Canada))

3:45 PM - 4:00 PM JST | 6:45 AM - 7:00 AM UTC

[O3-02]

Neural Dynamics of Motor-Induced Attention during the Encoding and Retention of Temporal Intervals

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

4:00 PM - 4:15 PM JST | 7:00 AM - 7:15 AM UTC

[O3-03]

The priority accumulation framework – attention in time and space

*Mor Sasi[1], Daniel Toledano[1], Shlomit Yuval-Greenberg[1,2], Dominique Lamy[1,2] (1. Tel Aviv University (Israel), 2. Sagol school of neuroscience (Israel))

4:15 PM - 4:30 PM JST | 7:15 AM - 7:30 AM UTC

[O3-04]

Multisensory Integration and Delay Adaptation in Sensorimotor Timing

*Lingyue Chen[1], Loes C.J. van Dam[1], Zhuanghua Shi[2] (1. Technische Universität Darmstadt (Germany), 2. Ludwig-Maximilians-Universität München (Germany))

4:30 PM - 4:45 PM JST | 7:30 AM - 7:45 AM UTC

[O3-05]

Memory encoding for new information, not autobiographical memory load, predicts age-related acceleration in subjective time passage over the last decade

*Alice Teghil[1,2], Sebastian Wittmann[3], Adele Lifrieri[1], Sophia Saad[3], Maddalena Boccia[1,2], Marc Wittmann[3] (1. Department of Psychology, Sapienza University of Rome (Italy), 2. Cognitive and Motor Rehabilitation and Neuroimaging Unit, IRCCS Fondazione Santa Lucia, Rome (Italy), 3. Institute for Frontier Areas of Psychology and Mental Health, Freiburg (Germany))

4:45 PM - 5:00 PM JST | 7:45 AM - 8:00 AM UTC

[O3-06]

Interference between time and space in advanced age

*Cindy Jagorska[1], Isa Steinecker[1], Martin Riemer[1] (1. Technical University Berlin (Germany))

Discrete vs. continuous timer bars: How visual segmentation shapes the perception of time "running out"

*Jasmindeep Kaur[1], Jiaying Zhao[1], Joan Danielle Ongchoco[1]

1. The University of British Columbia

Our lives are flooded with visual reminders of time slipping away —from ticking clocks to countdowns timers, that all depict a sense of time "running out". In time perception, the same duration can feel longer or shorter as a function of various factors (e.g., attention, predictability) —but we know less about the factors that influence the perception of how much time is left. In visual processing, a key discovery is that while sensory input may be a continuous wash of light, what we experience —what the mind parses —are discrete objects and events. Here we explored how discreteness structures our sense of time running out. Observers completed a multi-item localization (MILO) task, where they clicked on multiple targets in a sequence. In every trial, there was a black-bordered rectangular 'timer-bar' initially filled with a color that emptied over a period (e.g., 3 seconds) to visually depict the passage of time. The color diminished either *continuously*, gradually and evenly depleting throughout, or *discretely*, in which the bar was segmented into discrete chunks that disappeared at regular intervals. To measure perceived urgency of time 'running out', we examined inter-click latencies (i.e., the time between clicks). Results revealed longer inter-click latencies for discrete (compared to continuous) timer-bars, suggesting greater urgency in the continuous case. This difference disappeared in a separate experiment, where the bar was instead filled over time continuously or discretely, with a reliable interaction between experiments —suggesting that effects could not simply have been a function of one condition being more distracting than another. Thus, discreteness may have distinct effects on our sense of time running out versus time accumulating. Segmentation in visual depictions of time depletion may make time feel more "manageable," altering our sense of urgency in time-sensitive tasks.

Keywords: event perception, time scarcity

Neural Dynamics of Motor-Induced Attention during the Encoding and Retention of Temporal Intervals

*Lorenzo Guarnieri[1], Ayelet Nina Landau[1,2]

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

Accurate timing is essential for perception, decision-making, and action. Theories ranging from pacemaker-accumulator models to population dynamics converge on a key role for attention in modulating time perception. For instance, the Attentional Gate Theory (Zakay & Block, 1994) proposes that perceived duration increases with attentional allocation. Yet, how attention operates across encoding and retention phases, especially under momentary motor demands, remains less understood. To investigate this, we used a time reproduction paradigm while recording EEG, manipulating attentional load through continuous force exertion. Participants reproduced three interval durations (2, 3, or 4 seconds) under both force and no-force conditions. Linear mixed-effects modeling revealed that reproduced durations scaled with interval length ($p < .001$), indicating accurate encoding. However, reproductions were overall shorter under force ($p < .001$), especially at longer intervals (interaction $p = .002$), suggesting under-reproduction due to heightened attentional load. Variability increased with interval length ($p < .001$), in line with Weber's Law, but was not modulated by force. EEG analyses showed that alpha (8–12 Hz) desynchronization increased with interval length, peaking just before interval offset ($p < .0001$), consistent with temporal anticipation (Rohenkohl & Nobre, 2011). Crucially, alpha desynchronization during both encoding and retention predicted the reproduced durations, particularly for longer intervals ($p < .001$). Moreover, encoding under force elicited greater alpha desynchronization in EEG channels ipsilateral to the effector hand ($p < .01$). These findings suggest that alpha oscillations mark temporal attention and support the encoding and maintenance of time across both visual and motor regions. Our results extend timing theories by showing that sustained alpha desynchronization under motor load reflects the dynamic allocation of attentional resources during temporal processing.

Keywords: Timing, Memory, Alpha desynchronization, Force exertion, EEG

The priority accumulation framework –attention in time and space

*Mor Sasi[1], Daniel Toledano[1], Shlomit Yuval-Greenberg[1,2], Dominique Lamy[1,2]

1. Tel Aviv University, 2. Sagol school of neuroscience

Most visual-search theories assume that our attention is automatically allocated to the location with the highest priority at any given moment. The Priority Accumulation Framework (PAF) challenges this assumption. It suggests that attention-guiding factors determine both when and where attention is deployed. Accordingly, some events are more likely to trigger shifts of attention (“when” dimension), and the spatial distribution of these shifts depends on the priority weights that have accumulated at each location based on past and present events.
In four experiments, we tested the predictions of this hypothesis against competing accounts. We examined overt attention by recording first saccades in a free-viewing spatial cueing task. We manipulated search difficulty, cue salience, spatially specific vs. non-specific events, as well as the time interval between events.
Consistent with PAF’s predictions, only a minority of first saccades occurred early in response to the irrelevant event (attentional capture), and most occurred later, in response to the action-relevant event. In addition, we showed that for all types of events, the spatial distribution of first saccades depended on the priority accumulated at each location from previous and current events (e.g., previous target locations, cue, target-distractor similarity), with the weight of previous events increasing with search difficulty.
Our findings provide strong support for the critical predictions of PAF. By offering a mechanistic account of how visual attention is allocated in space and in time, PAF provides an integrative and parsimonious account of attentional behavior that resolves enduring controversies about the factors that guide our attention.

Keywords: Visual-search, Eye-tracking, Attention, Capture

Multisensory Integration and Delay Adaptation in Sensorimotor Timing

*Lingyue Chen[1], Loes C.J. van Dam[1], Zhuanghua Shi[2]

1. Technische Universität Darmstadt, 2. Ludwig-Maximilians-Universität München

Subjective time perception can shift based on how the brain integrates sensory and motor signals. When temporal discrepancies occur between an action and its sensory feedback, the brain adjusts to maintain a coherent temporal experience. Using an adaptation-test paradigm, we investigated how humans adapt to delays between actions and feedback (visual or tactile), and how the brain weights these inputs in unimodal and bimodal contexts.
Across six experiments, we introduced delays between a button press and the resulting feedback. In the adaptation phase, participants experienced either no delay or a fixed 150 ms delay. In Experiment 1 and 2, the test phase tested the after-effect with 0ms delay trials, while in Experiment 3 to 6, the delay in the test trials varied from 0 to 150 ms. We manipulated whether feedback was visual, tactile, or both. Experiments 1 and 2 investigated uni-modal adaptation to visual delays and showed that participants implicitly incorporated 40% of the 150 ms visual delay into their reproduction. Experiments 3 and 4 focussed on uni-modal tactile or visual delays and participants incorporated 69% of the delay for tactile adaptation and 48% for visual adaptation. This demonstrates a greater reliance on tactile than visual feedback in the time domain. Experiments 5 and 6 extended these findings to a bimodal visuotactile context. Here, tactile feedback again dominated when a temporal conflict was introduced between tactile and visual feedback: participants adjusted to tactile delays even when visual feedback was synchronized with the action, and vice versa no adjustment to visual delays was observed when tactile feedback was synchronized with the action.
These results suggest that delay adaptation is partial and modality-dependent, with stronger reliance on tactile feedback in both uni- and bimodal contexts. These findings indicate an integration mechanism where the brain prioritizes tactile over visual input in sensorimotor timing.

Keywords: Multisensory Integration, Delay Adaptation, Sensorimotor Timing

Memory encoding for new information, not autobiographical memory load, predicts age-related acceleration in subjective time passage over the last decade

*Alice Teghil[1,2], Sebastian Wittmann[3], Adele Lifrieri[1], Sophia Saad[3], Maddalena Boccia[1,2], Marc Wittmann[3]

1. Department of Psychology, Sapienza University of Rome, 2. Cognitive and Motor Rehabilitation and Neuroimaging Unit, IRCCS Fondazione Santa Lucia, Rome, 3. Institute for Frontier Areas of Psychology and Mental Health, Freiburg

The widely observed phenomenon that the perceived speed of time passage over the past decade increases with chronological age has been consistently replicated across several studies in different countries. The present study aimed to investigate potential mechanisms underlying this effect, examining the role of autobiographical memory and cognitive functioning. A sample of 120 individuals aged 20-91 was assessed on subjective time perception for the preceding year and decade, the quantity and significance of autobiographical memories from those periods, and overall cognitive status. Results confirmed the age-related increase in perceived temporal acceleration over the past decade. However, no significant association was found between perceived time passage and the number or subjective value of retrieved autobiographical memories. Contrary to prevailing assumptions, older adults reported more vivid and personally meaningful recollections. Instead, reduced cognitive functioning, and specifically lower ability to form new memories as assessed through delayed memory recall, emerged as a significant mediator of accelerated time perception with age. Findings suggest that age-related cognitive decline leading to reduced ability to encode novel memories, rather than diminished autobiographical memory content, is a critical factor in the subjective experience of time compression in older adults.

Keywords: Time perception, Passage of time, Age, Cognitive functioning, Autobiographical memory

Interference between time and space in advanced age

*Cindy Jagorska[1], Isa Steinecker[1], Martin Riemer[1]

1. Technical University Berlin

Perceptual interference between time and space has been reported in neonates, infants, children and young adults, but to date it is unknown how space-time interference develops in advanced age. This is unfortunate, because aging is accompanied by cognitive decline, typically encompassing spatial as well as temporal processing. Moreover, changes in temporal as well as spatial perception have been associated with pathological aging. However, as primary deficits in time and space perception could be concealed by substitution strategies, space-time interference provides an indirect way for detecting these deficits. To bridge this research gap, we conducted an experiment by testing these interference effects in older (60+) and younger (18-35) participants. For that, we asked our participants to reproduce the temporal duration or the spatial size of realistic 3D stimuli and of abstract 2D stimuli. The results show that space judgments of older versus younger adults are more affected by irrelevant temporal information (time-on-space effect), whereas the reverse space-on-time effect was not significantly different between age groups. Together, our findings provide first knowledge on the healthy development of space-time interference in advanced age.

Keywords: space-time interference, aging, virtual reality

Poster | Other

Fri. Oct 17, 2025 12:45 PM - 2:45 PM JST | Fri. Oct 17, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P1] Poster: Day 1

[P1-01]

Development of the Japanese Version of the Adult Hyperfocus Questionnaire and Examination of Its Reliability and Validity (in progress)

*Kazutoshi Tamura[1], Akira Midorikawa[2] (1. Department of Psychology, Graduate School of Letters, Chuo University (Japan), 2. Department of psychology, Faculty of Letters, Chuo University (Japan))

[P1-02]

Timing alterations in ADHD: Combining a scoping review with a planned empirical study of Temporal Binding

*Veronica Casagrande[1], Grace Isaura Durkin[2], Vanessa de Andrade[3], Tiemi Thais Tomonaga[3], Patricia Cibelle Pinto de Oliveira[3], Lucas Correia Signorini[3], Claudia Berlim de Mello[4], Gustavo Melo de Andrade Lima[3], André Mascioli Cravo[5] (1. Graduate Program in Neuroscience and Cognition, Federal University of ABC (UFABC), São Paulo, Brazil (Brazil), 2. Graduate Program in Psychobiology, Federal University of São Paulo (UNIFESP), São Paulo, Brazil (Brazil), 3. Center for Education and Research on Brain Aging, Federal University of São Paulo (UNIFESP), São Paulo, Brazil (Brazil), 4. Psychobiology Department, Federal University of São Paulo (UNIFESP), São Paulo, Brazil (Brazil), 5. Center for Mathematics, Computing and Cognition, Federal University of ABC (UFABC), São Paulo, Brazil (Brazil))

[P1-03]

Interval timing in children with ADHD: Pilot study on timing differences

*Kateřina Dörflová[1,2], Veronika Rudolfová[3,2], Kristýna Malenínská[2], Tereza Nekovářová[2,3] (1. Third Faculty of Medicine, Charles University, Neurosciences (Czech Republic), 2. National Institute of Mental Health in Czechia (Czech Republic), 3. Faculty of Science, Charles University, Department of Zoology (Czech Republic))

[P1-04]

Neuronal signals in the primate cerebellum underlying the detection of rhythmic deviations

*Masashi Kameda[1], Masaki Tanaka[1] (1. Hokkaido university graduate school of medicine (Japan))

[P1-05]

Temporally distorted cortical neural dynamics of explicit timing following cerebellar dysfunction

*Chiara Zanonato[1,2], Richard Ivry[3,4], Assaf Breska[1,3] (1. Max Planck Institute for Biological Cybernetics, Tübingen (Germany), 2. University of Tübingen (Germany), 3. Department of Psychology, University of California, Berkeley, CA (United States of America), 4. Helen Willis Neuroscience Institute, University of California, Berkeley, CA (United States of America))

[P1-06]

Entrainment of periodic neural activity for rhythmic temporal prediction may involve cerebellar learning

*Ken-ichi Okada[1], Masaki Tanaka[1] (1. Hokkaido Univ. (Japan))

[P1-07]

Disentangling spatiotemporal correlates of time cognition: an ongoing investigation of the effects of cognitive aging and depressive symptoms

*Giulia Buzi[1], Florentine Fricker[1], Laura Masson[1], Francis Eustache[1], Thomas Hinault[1] (1. (1)Normandy Univ, UNICAEN, PSL Université Paris, EPHE, Inserm, U1077, CHU de Caen, Centre Cyceron, Neuropsychologie et Imagerie de la Mémoire Humaine, 14000 Caen, France. (France))

[P1-08]

Comparing Neural Oscillations During Cued and Uncued Rhythmic Movement Using Simultaneous Intracranial Basal Ganglia and Cortical Recordings: An Ongoing Study

*Bar Yosef[1], Jingtong Lin[1], Ausaf Bari[1], Kathryn Cross[1] (1. University of California, Los Angeles (United States of America))

[P1-09]

Temporal Expectation and Dopamine: Insights from Omission Oddball Paradigm in Rats

*Riko Iizuka[1], Ryotaro Yamaki [1], Tomoyo Shiramatsu-Isoguchi[1], Shota Morikawa [2], Yuji Ikegaya [3], Hirokazu Takahashi [1] (1. Graduate School of Information Science and Technology, The University of Tokyo (Japan), 2. Graduate School of Science and Faculty of Science, University of Tokyo (Japan), 3. Graduate School of Pharmaceutical Sciences & Faculty of Pharmaceutical Sciences, The University of Tokyo (Japan))

[P1-10]

Effects of voluntary actions on temporal preparation in different temporal contexts: an ongoing study.

*Alexandre de Pontes Nobre[1], André Mascioli Cravo[1] (1. Center for Mathematics, Computing and Cognition, Federal University of ABC. (Brazil))

[P1-11]

Time, space and Temporal momentum: an online replication and beyond

*Mario Bonato[1], Manuel Vencato[1], Mariagrazia Ranzini[1], Marco Zorzi[1,2] (1. Department of General Psychology, University of Padua, Italy (Italy), 2. IRCCS San Camillo Hospital, Lido Venice (Italy))

[P1-12]

Temporal competition and temporal promotion effects of visual arousal on visual search task

*Mizuki Mori[1], Makoto Ichikawa[2] (1. Graduate School of Science and Engineering, Chiba University (Japan), 2. Graduate School of Humanities, Chiba University (Japan))

[P1-13]

Emotional Modulation of Time: The Role of Arousal, Valence, and Subjective Activation in an Immersive VR

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

[P1-14]

Aggression May Accelerate Passage of Time Regardless of Physiological Arousal

*Ryohei Mimura[1,2], Makoto Ichikawa[1] (1. Chiba University (Japan), 2. Hyogo prefectural police H.Q. (Japan))

[P1-15]

Learning to feel vibrations: Associatively learned boredom but not stress modulates time perception

*Müge Cavdan[1], Bora Celebi[1], Knut Drewing[1] (1. Justus Liebig University Giessen (Germany))

[P1-16]

Behavioral Evidence for Precision-Weighted Prediction Updating in the Sub-Second Range: A Pilot Study

*Maki Uraguchi[1], Hideki Ohira[1] (1. Nagoya University (Japan))

[P1-17]

Investigating the Modulation of Prior Formation in a Multisensory 2AFC Temporal Judgment Task

*Natsuki Ueda[1], Mitsunari Abe[1] (1. National Center of Neurology and Psychiatry (Japan))

[P1-18]

Modelling timing processes in motor imagery

*Ladislas Nalborczyk[1], Camille Grasso[2] (1. Aix Marseille Univ, CNRS, LPL (France), 2. Cognitive Neuroimaging Unit, CEA DRF/I2BM, INSERM, Université Paris-Sud, Université Paris-Saclay, NeuroSpin Center, Gif/Yvette (France))

[P1-19]

Characterising the spatial and temporal neural dynamics of temporal predictions in audition

*Clara Driaï-Allègre[1,2], Sophie Herbst[1] (1. Cognitive Neuroimaging Unit, INSERM, CEA, NeuroSpin (France), 2. Université Paris-Saclay (France))

[P1-20]

Beyond probability: Temporal prediction error shapes performance across development

*LOUIS-CLÉMENT DA COSTA[1], Sylvie Droit-Volet[2], Katherine Johnson[3], Jennifer T Coull[1] (1. CRPN, CNRS and AMU, UMR 7077, Marseille (France), 2. CNRS and Université Clermont Auvergne, UMR 6024, Clermont-Ferrand (France), 3. Melbourne School of Psychological Sciences, Melbourne (Australia))

[P1-21]

Interaction between timing, stimulus control of light and sound, and its effects on anticipatory responses in multiple and mixed fixed interval schedules in rats (Preliminary Results)

*Paulina Citlali Montoya Barragán[1], Heber Zapata[2], Jonathan Buriticá[1] (1. CEIC, UDG (Mexico), 2. UACH (Mexico))

[P1-22]

How ensemble temporal statistics influence duration perception of visual events

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

[P1-23]

Temporal Reward Prediction in the Visual Corticostriatal Circuit

*Rebekah Yidan Zhang[1,2], Lianne Saussy[1], Marshall Hussain Shuler[1,2] (1. Johns Hopkins University (United States of America), 2. Kavli Neuroscience Discovery Institute (United States of America))

[P1-24]

Exploring the effects of rhythmic vibratory stimuli on time perception

*Yoshihiko Watanabe[1], Sae Kaneko[2] (1. Graduate School of Humanities and Human sciences, Hokkaido University (Japan), 2. Faculty of Humanities and Human Sciences, Hokkaido University (Japan))

[P1-25]

How facial features affect time perception: from the perspective of race and eye contact.

*Yuki Ogawa[1], Yusuke Moriguchi[2], Mitsuhiko Ishikawa[1] (1. Hitotsubashi University (Japan), 2. Kyoto University (Japan))

[P1-26]

Seeking the internal clock: Does the modality effect exist in retrospective timing and if so, is it multiplicative as in prospective timing?

*Ruoyu Zhang[1], Luke Jones[1], Ellen Poliakoff[1] (1. the University of Manchester (UK))

[P1-27]

The Interaction Between Timing, Impulsive Choice, and Risk Taking in Children with ADHD: Exploring the Role of Pharmacological Treatment

*Gloria Ochoa-Zendejas[1], Ivette Vargas-de la Cruz[2], Cristiano Valerio dos Santos[3], Jonathan Buriticá[1] (1. Lab. of Cognition and Comparative Learning, Univ. of Guadalajara-CEIC, Guadalajara. (Mexico), 2. Universidad de Guadalajara, Departamento de Neurociencias, Centro Universitario de Ciencias de la Salud (Mexico), 3. Universidad de Guadalajara, Centro de Estudios e Investigaciones en Comportamiento (Mexico))

[P1-28]

Assessing domain-generality of temporal metacognition: behavioral and electrophysiological insights

*Nathalie Pavailler[1], Antoine Vaglio[1], Nathan Faivre[3], Tadeusz Kononowicz[2], Virginie van Wassenhove[1] (1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris-Saclay, Gif/Yvette, 91191 (France), 2. Université Paris-Saclay, CNRS, Institut des Neurosciences Paris-Saclay (NeuroPSI), 91400 Saclay (France), 3. Université Grenoble Alpes, Université Savoie Mont Blanc, CNRS, LPNC, Grenoble (France))

[P1-29]

Retrieving sequence of duration(s) from working memory

*Yunyun SHEN[1], Sophie K Herbst[1], Virginie van Wassenhove[1] (1. CEA, DRF/Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; CNRS; Université Paris-Saclay, F-91191 Gif/Yvette, France (France))

[P1-30]

Investigating heart–eye coupling during active visual search in early infancy: a planned study

*Akane Hisada[1], Tomoko Isomura[1] (1. Nagoya University (Japan))

[P1-31]

Temporal Binding and Sense of Agency in Oculomotor Control

*Lynn Huestegge[1], Julian Gutzeit[1] (1. University of Wuerzburg (Germany))

[P1-32]

What’s the difference between a premature and a timed anticipatory movement ?

*Marcus Missal[1], Dominika Drazyk[1] (1. Université catholique de Louvain, Institute of Neuroscience (Belgium))

[P1-33]

Revealing rhythm categorization in human brain activity

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[P1-34]

Memory traces of duration and location in the right intraparietal sulcus

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[P1-35]

Neural Correlates of Perceptual Biases in Visual Duration Estimation

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[P1-36]

Uncovering the neuroanatomical substrates of impulsive behaviour induced by the temporal predictability of events: an fMRI-EMG investigation

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[P1-37]

Basic mechanism underlying the audio-visual temporal recalibration for the long stimuli

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[P1-38]

Understanding Discomfort Caused by Audiovisual Temporal Asynchrony: Insights from Egg Cracking and Grissini Breaking Videos

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Unconscious motor–visual temporal recalibration occurs in both active and passive movements

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[P1-40]

The sound octave equivalence in a songbird as shown by the event-related brain potentials and the operant behavior.

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Development of the Japanese Version of the Adult Hyperfocus Questionnaire and Examination of Its Reliability and Validity (in progress)

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Background: Adults with Attention-Deficit/Hyperactivity Disorder (ADHD) occasionally experience "hyperfocus", a state of intense and sustained concentration that causes them to lose track of time. Hupfeld et al. (2019) developed the Adult Hyperfocus Questionnaire (AHQ), which comprehensively assesses each of the three hyperfocus settings (school, hobbies, screen time) and six hyperfocus dimensions (losing track of time, failing to notice the world around you, failing to attend to personal needs, difficulty stopping and moving on to a new task, feeling totally engrossed in the task, and getting "stuck" on small details). In the same study, Hupfeld et al. (2019) demonstrated that individuals with higher ADHD symptomatology reported more frequent experiences of hyperfocus. However, no reliable and valid scale to assess hyperfocus has yet to be developed in Japan. **Aims:** The aim of this study is to develop a Japanese version of the AHQ and to validate reliability and validity. Furthermore, this study aims to investigate the relationship between ADHD and hyperfocus in Japan. **Methods:** With the original author’ s permission, we translated the original version of AHQ into Japanese and the Japanese version was confirmed by back-translation. We plan to conduct a questionnaire survey of 500 Japanese adults. In this study, we will use the Japanese version of AHQ and Adult ADHD Self-Report Scale (ASRS) to evaluate ADHD symptoms. We also plan to include scales for flow and internet addiction to examine whether hyperfocus is a distinct construct from these related behaviors. This study is currently in the planning stage. Data collection is scheduled to take place between June and July 2025.**References:** Hupfeld, K. E., Abagis, T. R., & Shah, P.(2019). Living "in the zone": hyperfocus in adult ADHD. *ADHD Attention Deficit and Hyperactivity Disorders*, *11*, 191-208.

Keywords: Hyperfocus, ADHD, Flow, Internet Addiction, Time Blindness

Timing alterations in ADHD: Combining a scoping review with a planned empirical study of Temporal Binding

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Time perception involves two distinct abilities: duration estimation (interval timing) and temporal order processing (sequencing). While temporal order deficits are well-documented in clinical conditions like schizophrenia (Coull & Giersch, 2022), individuals with Attention-Deficit/Hyperactivity Disorder (ADHD) also show impaired time perception compared to neurotypical controls (Metcalfe et al., 2024). However, it remains unclear which specific aspects of time perception are affected in ADHD. This study addresses that gap through a two-part approach: (1) a scoping review of existing literature on duration and temporal order processing in ADHD, and (2) an planned empirical investigation of Temporal Binding—the perceived compression between cause and effect (Hoerl et al., 2020)—in adults with ADHD. Participants will complete two tasks: a temporal order task using the Libet Clock (Haggard et al., 2002) and an interval estimation task (Humphreys & Buehner, 2009). This design allows us to assess both timing and causality judgments. Our findings aim to clarify how time perception is altered in ADHD and contribute to a broader understanding of how neurological differences shape temporal experience.

Keywords: ADHD, Time perception, Temporal Binding, Duration estimation, Temporal order processing

Interval timing in children with ADHD: Pilot study on timing differences

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Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder often associated with significant deficits in time perception. However, the precise mechanisms underlying these temporal impairments remain unclear. This pilot study investigated interval timing in 17 children with ADHD (mean age 8.9 years) and 16 age-matched neurotypical children (mean age 8.8 years) to explore group differences, the effect of age, and connections to particular cognitive domains. Participants completed a battery of cognitive tasks (assessing attention, working memory, and executive functions) alongside three distinct temporal tasks: time reproduction (1200 ms; 3000 ms; 4200 ms; 5500 ms; 7000 ms), a bisection task (short/long anchors 1200 ms; 7000 ms), and a finger-tapping task (400 ms; 1200 ms, spontaneous tempo). Our findings revealed a significant group difference exclusively in the reproduction of the 3000 ms interval (Mann-Whitney U test: $p = 0.046$; Cohen's $d = 0.184$), where children with ADHD were less accurate and consistently underestimated the duration. This observation aligns with the hypothesis of a faster internal clock in individuals with ADHD. Notably, no other significant group differences were observed across the temporal tasks, nor were there significant age-related differences in timing performance. Distinct underlying mechanisms might be involved in processing various interval lengths, as we generally found no correlation between accuracy and precision across different temporal tasks. However, a correlation was observed within the finger-tapping task, between 400 ms and spontaneous tempo ($p = 0.033$). Despite the preliminary nature and small sample size, this pilot study provides insights into the timing deficits often registered in ADHD. It underscores the importance of continued research with larger cohorts to resolve existing inconsistencies in this field of study.

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Keywords: ADHD, children, time perception, interval timing

Neuronal signals in the primate cerebellum underlying the detection of rhythmic deviations

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When we are feeling the rhythm, we often notice any subtle deviation. This ability relies on accurate prediction of periodic event timing. The cerebellum, known for its role in motor control, is also implicated in sensory timing prediction. Previous studies in our lab showed that neurons in the cerebellar dentate nucleus (DN) exhibit periodic firing modulation during the missing oddball detection task, in which animals were required to detect omissions of regularly presented visual stimuli (Ohmae et al., 2013). These neurons also showed greater directional modulation by stimulus location, suggesting a role in sensory rather than motor processing (Kameda et al., 2023). However, it remains unclear whether they contribute to the detection of subtle rhythmic deviations independently of movement.To address this point, we trained monkeys to detect slight changes in rhythm and examined the relationship between their behavioral performance and the activity of DN neurons. In the modified oddball detection task, a slightly longer interstimulus interval was introduced within a series of visual stimuli presented at regular 400-ms intervals. Monkeys were rewarded for responding with a hand movement to either a delayed stimulus (Hit) or subsequent omission (Miss). During recording sessions in two monkeys, we presented delays of 60–160 ms and compared neuronal activity between Hit and Miss trials. The firing rate immediately before the delayed stimulus was significantly greater in Hit than Miss trials (paired t-test; $p < 10^{-7}$, $n = 37$), while the activity at the time of the preceding stimulus showed no difference ($p = 0.65$). We also optogenetically manipulated neuronal activity in the DN to elucidate its causal role in behavior. After expressing ChR2 specifically in Purkinje cells of the cerebellar clus lobules, we illuminated their terminals within the DN to suppress neuronal activity. Optical stimulation immediately before the delayed stimulus significantly reduced Hit rate for delays that originally produced a Hit rate between 30% and 70% ($p < 0.05$, $n = 23$). These findings suggest that periodic neuronal activity in the DN encodes sensory timing predictions and contributes to the detectability of rhythmic deviations.

Keywords: Rhythm, Prediction, Non-human primate, Cerebellum

Temporally distorted cortical neural dynamics of explicit timing following cerebellar dysfunction

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The ability to quantify temporal intervals, known as explicit timing, relies on a distributed brain network, with the cerebellum playing a key role, as suggested by brain stimulation and neuropsychology studies. Yet, how the cerebellum impacts cortical dynamics of explicit timing, and at which stage of temporal information processing, remains unexplored. Here, we addressed this using scalp electroencephalography (EEG) in cerebellar ataxia (CA) patients (N=15) and healthy controls (N=10) performing a temporal discrimination task. In separate blocks, participants judged whether the duration of a fixed standard (700ms or 1200ms) matched or differed from that of a subsequent comparison spanning between the short and long standard durations. This design allowed us to dissociate comparison judgments anchored to the standard from those anchored to the comparison set’s bisection point (BP). Behaviorally, temporal sensitivity was reduced in patients, replicating previous studies. Neurally, during the comparison interval, the contingent negative variation (CNV) potential failed to show adjusted ramping based on the standard interval in both groups. Instead, the CNV in controls peaked at the BP and resolved afterwards, in line with a BP mechanism. Conversely, in CA patients, it continued ramping negatively beyond the BP, indicating a lack of sensitivity to this anchor. Analysis of delta-band activity (0.54-2.18Hz) phase dynamics in the same time period revealed increased phase alignment before the earliest possible comparison in both groups. However, this was stronger in controls than in patients, consistent with previous findings in implicit timing. Importantly, evoked responses to standard onset were comparable between groups, ruling out group differences due to noisy or generally reduced brain responsivity in patients. Overall, these results uncover the cerebellar role in shaping cortical dynamics of explicit timing, specifically through the adjustment of anchor-dependent anticipatory activity

Keywords: explicit timing, interval timing, cerebellum, cerebellar ataxia, EEG

Entrainment of periodic neural activity for rhythmic temporal prediction may involve cerebellar learning

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The cerebellum plays a pivotal role in rhythmic movement and rhythmic perception. We previously showed that neurons in the cerebellar dentate nucleus gradually synchronize their activity in response to periodically presented visual stimuli in the absence of movement. Given that the dentate nucleus receives GABAergic projections from Purkinje cells (PCs) in the cerebellar cortex, and the interaction between simple spikes (SSs) and complex spikes (CSs) in PCs is central to cerebellar learning, we examined PC activity to understand how rhythmic neuronal activity is generated. Animals were trained to respond to the omission or color change of isochronically presented visual stimulus, depending on the color of the fixation point. Detection of stimulus omission required temporal prediction, whereas that of color change did not. The periodic activity of 112 well-isolated PCs has been recorded from the crus lobules in 3 monkeys. Neurons were classified into 3 groups based on the time course of SS and CS activities in trials with a 400-ms interstimulus interval. Cluster #1 (32%, n = 36) showed a SS peak around 300 ms following each stimulus and a transient CS for repetitive visual stimulus but not for the omission. Cluster #2 (40%, n = 45) showed an early SS peak and exhibited predictive CS around the time of the repetitive visual stimulus, which was sometimes enhanced following stimulus omission. Cluster #3 (28%, n = 31) showed a clear SS peak, but no evident CS response was observed. In all clusters, the magnitude of periodic SS activity was greatly diminished in the color change condition, indicating that neuronal activity reflects temporal prediction. Importantly, CS in Clusters #1 and 2 also decreased during color detection, indicating that CS occurrence is highly context-dependent. As expected, CS-triggered averaging of SS activity revealed a transient pause in SS in all PCs. Clusters #1 and 2 showed two additional decreases in SS activity, one occurring just before the CS and the other after the stimulus cycle. Contrary to the prevailing negative feedback model of the cerebellum, our results suggest the presence of a positive feedback circuit that amplifies a time-specific decrease in SS activity. This cerebellar learning mechanism may contribute to entrain SS activity to rhythm through the context-dependent occurrence of CSs.

Keywords: nonhuman primate, rhythm perception

Disentangling spatiotemporal correlates of time cognition: an ongoing investigation of the effects of cognitive aging and depressive symptoms

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Processing temporal information is a fundamental feature of our brain and cognitive functions. Timing capacities are known to become less precise and more variable with advancing age, yet not homogenously across individuals. One of the factors explaining this inter-individual variability could be the presence of depressive symptoms, which could hasten cognitive decline but also impact prospective timing of short durations. To investigate the interweaving between cognitive aging, brain temporal processing and depressive symptoms, we are enrolling 50 younger and 80 older adults to assess their cognitive abilities and quantify their depressive symptoms. While undergoing simultaneous EEG-fMRI recording, participants perform a temporal generalization task (e.g., 600, 900, 1250, 1750, 2400 ms) to a reference duration (1500ms). The Full Width at the Half Maximum (FWHM) of the generalization gradient of the OA group (n= 5, M_{age} = 67.2) was found to be larger ($FWHM_{OA}$ = 2160.36 ms) compared to its younger counterpart (n=5, M_{age}= 23.8, $FWHM_{YA\,=}$ 1252.38 ms), suggesting a reduced temporal precision in older adults. Time/Frequency source maps of the difference between the two groups, showed lower Theta (5-7 Hz) magnitude in cingulate (t=-7.105, p<0.001) and Insular cortices (t = -4.970, p<0.001), together with higher gamma (30-59 Hz) rhythms in parietal (t= 6,0086, p<.005), frontal (t=5.019, p<0.05), and cingulate gyrus (t=4.547, p<0.005) in older adults. Although this oscillatory imbalance in frontal-parietal network hubs has previously been linked to disruptions of top-down attention and working memory in aging, we hypothesize that it could reflect an inefficient compensatory mechanism in sub and supra-seconds timing tasks. Further investigation on links between cognitive performance, depressive symptom’s intensity and dissimilarity matrices of the theta-gamma Phase Amplitude Coupling and fMRI connectivity maps, as well as dynamic network modes (DyNeMo) of the fronto-parietal network time series, would help disentangle the spatiotemporal dynamics temporal processing changes with aging.

Keywords: Time cognition, Temporal processing , Cognitive aging , Subclinical depression, EEG-fMRI

Comparing Neural Oscillations During Cued and Uncued Rhythmic Movement Using Simultaneous Intracranial Basal Ganglia and Cortical Recordings: An Ongoing Study

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Rhythmic auditory stimulation (RAS) is a promising therapy for improving gait in Parkinson’s Disease (PD) patients. By providing external rhythmic cues, such as metronomes or music, RAS may compensate for impaired internal timing and improve motor coordination. However, the electrophysiological mechanisms underlying RAS remain unclear. Rhythmic cues may facilitate the impaired basal ganglia-cortical loop in PD or engage alternative compensatory circuits. Beta-band activity (13–30 Hz), which is linked to movement and might be modulated by rhythmic auditory stimuli, particularly in motor cortical areas, may play a key role. We hypothesize that auditory cues facilitate movement-related beta modulation in the basal ganglia-cortical loop. In the current study, we simultaneously recorded local field potentials from the globus pallidus internus (GPi) and cortex using subdural electrodes (ECoG) in 10 PD patients undergoing deep brain stimulation surgery. Patients performed a rhythmic tapping task with auditory tones presented at isochronous subsecond intervals under three conditions: passive listening (tones only), cued tapping (tones with tapping), and uncued tapping (tapping without ongoing auditory cues). Preliminary analyses show canonical movement-related beta suppression in the motor cortex during tapping compared to passive listening, confirming prior evidence that these signals are movement driven. However, auditory cues during tapping did not affect trial-averaged beta power in the GPi or motor cortex at the group level. Interestingly, auditory cues did affect average beta power in patients with ECoG over prefrontal and auditory cortices, suggesting that these regions may differentially engage in processing rhythmic cues versus internally generated timing. We are conducting ongoing analyses to assess finer temporal dynamics by examining tap-locked beta changes over time and evaluating whether auditory cueing is associated with changes in GPi-cortical connectivity. Understanding how rhythmic cues modulate brain dynamics in PD may reveal compensatory mechanisms beyond the motor system and inform the development of more personalized, neurophysiologically-targeted RAS therapies.

Keywords: rhythmic movement, Parkinson's disease, intracranial electrophysiology, auditory cueing, basal ganglia

Temporal Expectation and Dopamine: Insights from Omission Oddball Paradigm in Rats

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Dopamine plays a crucial role in perceiving time, with evidence suggesting that increases or decreases in dopamine levels can speed up or slow down the internal clock. Alongside its apparent influence on time perception, dopamine encodes reward, punishment, and motivation. This multifaceted nature makes it challenging to fully understand how dopamine affects time perception in different contexts. Furthermore, dopamine responds to neutral stimuli, such as white noise, that do not have positive or negative valence. Given that many time perception studies used neutral stimuli to investigate how each sensory modality perceives time, it is important to examine dopamine's response to these stimuli for accurate interpretation of previous research.

We focused on the effects of auditory stimuli's temporal expectations on dopamine. White noise was presented to rats, and dopamine was measured in vivo with high temporal resolution using fibre photometry. The omission oddball paradigm was used to manipulate temporal expectation. It has been suggested that neural activity during omission reflects a prediction error, as the standard stimuli create a temporal expectation for stimulus input.

Our results showed that dopamine increased phasically immediately after the sound onset, followed by a decrease, forming a wave pattern without repetition-induced suppression. When stimuli were omitted at unexpected timings, dopamine showed a gradual tendency to increase. Notably, with the typical oddball paradigm of standard and deviant defined by the frequency of stimuli, the amplitude of dopamine response was more significant in deviant stimuli. This phenomenon supports the theory that dopamine influences time perception and aligns with the previous reports of duration dilation for unpredictable stimuli. Furthermore, the fact that dopamine is affected by manipulating temporal expectancies, even for non-rewarding sensory stimuli, supports the view that time perception and dopamine are tightly involved.

Keywords: Dopamine, Oddball, In Vivo

Effects of voluntary actions on temporal preparation in different temporal contexts: an ongoing study.

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Temporal preparation is shaped by the temporal context of preparatory intervals (foreperiods), as reflected in differences in the slopes of foreperiod durations ×reaction time (RT) curves under distinct distributions of foreperiod durations. Recently, it has been shown that initiating foreperiods with voluntary actions influences temporal preparation. In this study, we investigate whether the effect of actions on preparation is related to differences in how foreperiod distributions are learned when intervals are self-initiated. We are conducting a choice-RT experiment using a variable foreperiod design. Participants indicate the orientation of a Gabor presented after a foreperiod of 0.6, 1.2, or 1.8 s. Participants are assigned to one of two conditions. In the action condition, foreperiods are initiated with a voluntary keypress. In the external condition, they are initiated automatically after a random interval. Across eight blocks, we manipulate the distributions of foreperiods. In the uniform distribution, all three foreperiod durations occur with equal frequency; in the exponential distribution, frequency decreases with duration; in the flipped exponential distribution, frequency increases with duration. Exponential and flipped exponential blocks are intermixed with uniform blocks. To examine whether the effect of actions on temporal preparation is related to the temporal context of foreperiods, we will compare slopes of RT curves between conditions for each distribution. Additionally, to investigate if actions influence learning of different distributions across blocks, we will compare transfer effects —operationalized as the slopes of RT curves in uniform blocks preceded by exponential blocks compared to uniform blocks preceded by flipped exponential blocks —between conditions. The results will contribute to the understanding of how voluntary actions influence timing and temporal preparation.

Keywords: Temporal preparation, Voluntary actions, Foreperiod, Temporal learning

Time, space and Temporal momentum: an online replication and beyond

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Performing mental arithmetic on brief temporal durations has been recently shown to induce operation-specific distortions. In a time reproduction task the request to add short durations resulted in longer responses while subtraction resulted in shorter responses than the correct, purely mathematical, outcome (Bonato et al., 2021, Cognition). This effect has been named "temporal momentum" in analogy with the representational momentum found when representing the position of moving objects as it mirrors the operational momentum charactering mental arithmetic. It suggests that our representation of time includes some features resembling closely those involved in spatial processing. In Experiment 1 we assessed the reliability of the temporal momentum effect in the first direct replication of Bonato et al.'s temporal arithmetic task by using an online procedure for data collection. In Experiment 2 we also tested whether the under-estimation found in subtraction is due to a longer operand being always presented first in the original study. The results showed a reliable temporal momentum effect that was virtually indistinguishable from previous, laboratory-based, experiments. Moreover, in Experiment 2 under-estimation in subtraction was still present when participants had to compute an order-independent difference between two operands, thereby excluding that the temporal momentum in subtraction is due to the specific ordering of stimuli used. This new evidence coming from a pre-registered study further demonstrates that the temporal momentum effect is a robust and reliable marker of manipulation in the domain of temporal durations.

Keywords: Temporal momentum, Operational momentum, Time-space interaction, Duration, Time reproduction

Temporal competition and temporal promotion effects of visual arousal on visual search task

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We investigated the temporal characteristics of the effect of emotional responses on performance in visual search task. Previous studies have shown that interfering effects of emotional responses evoked by viewing emotional picture on cognitive processing (temporal competition effect) would be strongest immediately after the presentation of the emotional picture, and it will decay within a short period. However, no systematic studies with various temporal conditions for stimuli have examined how the emotional response would affect the performance of the visual search task. In the present study, we presented the emotional pictures (neutral, or fearful) for 500 ms to evoke the emotional response, and then presented the stimulus for the visual search task. We prepared five conditions for the ISI between the emotional picture and stimulus for the visual search task (0, 120, 240, 360 and 480 ms), and three conditions for the duration of the visual search stimulus (100, 300, and 500 ms). In each trial, 45 participants conducted the visual search task after viewing the emotional pictures. In addition, they observed the same emotional pictures, and rated their emotional valence and arousal. Participants were divided equally into three groups in terms of their ratings for the arousal scale in viewing the fearful pictures. We found that the performance of the visual search task dropped with the ISI of 0 ms and 120 ms for the participant group who rated the fearful pictures as highly arousal while it significantly elevated with the ISI of 0 ms, 120 ms, and 480 ms for the participant groups who rated the fearful pictures as lowly arousal. These results suggest that there are two directions of effects of emotional response on the visual search (interfering, or promotion), and that the direction of effects would be determined by the individual emotional sensitivity.

Keywords: selective attention, emotional sensitivity, Individual Differences, ISI, accuracy

Emotional Modulation of Time: The Role of Arousal, Valence, and Subjective Activation in an Immersive VR

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Temporal ability and human existence are closely intertwined. Yet, temporal processing is a delicate function, susceptible to various influences. One notable example is the way emotional experiences can distort our perception of time—an effect traditionally attributed to arousal. However, a clear understanding of this relationship remains elusive. The present study aims to deepen this knowledge by examining the specific contributions of physiological arousal, perceived activation, and emotional valence to temporal distortions. To this end, 41 participants (mean age = 22.93, SD = 1.82) completed three temporal tasks—free tapping, time production, and retrospective judgment—while viewing three emotional videos (negative, neutral, and positive) presented in an immersive virtual reality environment. To assess emotional valence and perceived activation, we employed the Self-Assessment Manikin (SAM), while physiological arousal was measured using electrocardiography (ECG) and electrodermal activity (EDA). The results showed that emotional videos significantly affected valence ratings but not perceived activation. Nonetheless, physiological data revealed sustained sympathetic activation during both emotional conditions, as indicated by elevated skin conductance levels (SCL). Regarding temporal performance, no significant effects were observed for the retrospective judgment or free tapping tasks. However, in the time production task, participants tended to overestimate durations during negative videos and underestimate them during positive ones—an effect modulated by the order of video presentation. Taken together, these findings highlight the importance of considering both subjective and physiological factors in understanding how emotionally induced arousal influences time perception.

Keywords: Time Perception, Valence, Emotions, Physiological Arousal, Perception of Activation

Aggression May Accelerate Passage of Time Regardless of Physiological Arousal

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Impulsive and aggressive individuals tend to perceive time more quickly than it actually passes (Dougherty et al., 2007; Gorlyn et al., 2005). However, the mechanisms underlying such timing distortions remain unclear. Previous research suggested that higher levels of aggression were associated with lower resting physiological arousal (Scarpa et al., 2000) and increased arousal during tasks (Armstrong et al., 2019). Moreover, increased arousal levels accelerate subjective time perception (Droit-Volet & Meck, 2007; Gibbon et al., 1984; Treisman, 1963; Zakay & Block, 1997). This study investigated whether higher aggression levels would accelerate the subjective time passage, and whether the relationship between the aggression and subjective time passage could be mediated by physiological arousal. Participants completed the Japanese version of the Buss-Perry Aggression Questionnaire and subsequently performed a time estimation task. In each of the 10 trials, they estimated one of five randomly presented target durations (10, 20, 40, 60, or 90 seconds). Participants were instructed to count the target duration and press a key when they believed the time had passed. Heart rate, as an index of physiological arousal, was continuously recorded from the end of the questionnaire until the conclusion of the task. Results show that the more aggressive the participants were, the shorter they estimated the elapsed time. A mediation analysis, with aggression as the independent variable, physiological arousal as the mediator, and estimated time as the dependent variable, revealed that higher aggression levels accelerated the subjective time passage regardless of physiological arousal. These findings suggest that mechanisms other than arousal-related factors contribute to the effect of aggression on time perception. We are proposing that cognitive, affective, or motivational factors specific to aggressive traits may contribute to time perception.

Keywords: Aggression, Time Perception, Physiological Arousal

Learning to feel vibrations: Associatively learned boredom but not stress modulates time perception

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Emotional states influence our perception of time; for instance; time feels shorter when we are stressed about meeting a deadline but drags when we are bored, such as while waiting in a doctor’s office. Associative learning allows pairing emotional states with a neutral stimulus through repeated exposure. Here, in the context of time perception, we investigated whether neutral stimuli such as vibrations acquire emotional value when linked with stress or boredom, potentially influencing the experience of time presented alone. First, we ascertained the efficiency of stress (multitask framework, public speech with counting) and boredom (peg turning and video from Markey et al., 2014) induction tasks. In the main experiment using a within-subjects design, individuals underwent stress learning, boredom learning, and no learning sessions across three days. During the learning phase, individuals performed either boredom or stress tasks while exposed to a neutral vibration pattern every 5 seconds via a custom multimodal haptic vest (Celebi et al., 2023). After the tasks, participants completed questionnaires on their anxiety and boredom (State-Trait-Anxiety-Inventory and short version of State-Boredom-Scale). Following a 1-hour break, participants performed a temporal bisection task. They first familiarized to discriminate between anchor durations of dots –400 ms (short) and 700 ms (long). Subsequently, they judged whether the duration of a dot on the screen, lasting 400-700 ms, resembled the previously learned short or long one while the associated vibration patterns were presented. Boredom-associated vibration patterns made time feel longer, while the stress-associated vibration pattern had no significant effect on time perception.

Keywords: haptic perception, associative learning, time perception , timing, boredom

Behavioral Evidence for Precision-Weighted Prediction Updating in the Sub-Second Range: A Pilot Study

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Predictive processing theory posits that perception involves continuously updating internal models to minimize prediction error, with the rate of updating depending on the relative precision of predictions and sensory inputs. When predictions are highly precise, they are more resistant to change. This study aimed to provide behavioral evidence for this precision-weighted updating hypothesis. We hypothesized that repeated exposure to the standard would enhance the precision of temporal predictions, thereby reducing prediction updating. Participants (120 adults) performed a temporal generalization task using 500 Hz pure tones. After memorizing a 600 ms standard, participants judged whether comparison intervals (420–780 ms) matched the standard. During the learning phase, half of the participants (repetition group) received three additional presentations of the standard, while the rest (control group) encountered it only at the beginning. In the subsequently administered test phase, the longest stimulus was presented more frequently in both groups, encouraging prediction updating toward longer durations. The repetition group exhibited smaller shifts in the weighted mean of the generalization gradient compared to the control group, indicating reduced updating of the internal standard. This supports the idea that greater prediction precision dampens updating, consistent with the principle of precision-weighted inference. We also examined response entropy during the learning phase as a potential marker of prediction uncertainty. The repetition group showed a higher group-mean entropy for the 660 ms stimulus compared to the control group. While this may reflect increased response variability due to a limited number of trials, it could also indicate a dynamic adjustment process—where participants were actively refining their predictions in response to repeated exposure. These findings raise the possibility that entropy may capture transitional stages in the formation of high-precision predictions, though further validation is needed.

Keywords: predictive processing, precision-weighted updating, temporal generalization task

Investigating the Modulation of Prior Formation in a Multisensory 2AFC Temporal Judgment Task

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The human brain integrates uncertain sensory inputs with prior expectations to enable efficient interaction with the environment. Previous studies showed that, in a temporal reproduction task, a single prior tends to be formed across different sensory modalities, while distinct priors emerge when stimuli are associated with different motor responses. This suggests that the structure of prior formation may depend more on motor output than on sensory modality. This study aims to investigate whether similar principles apply to perceptual decision tasks using a two-alternative forced choice (2AFC) paradigm. Participants will judge which of two sequentially presented stimuli is longer in duration. We will manipulate sensory modality (vision vs. audition) and response mode (button press vs. vocal response), along with the statistical distribution of stimulus durations (short-centered vs. long-centered), to examine how priors are formed and generalized across conditions. This research will clarify whether prior representations in temporal perception are structured based on sensory input, motor output, or both. By using a perceptual comparison task with minimal motor demands, this study provides novel insights into the sensorimotor organization of prediction.

Keywords: Prediction, Sensorimotor organization, Multi modal integration

Modelling timing processes in motor imagery

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Behavioural, electrophysiological, and neuroimaging evidence suggests that the motor system is involved in simulating execution during motor imagery. Perhaps not surprisingly then, mental chronometry data revealed that the timing of imagined actions follows the timing of executed actions. However, the timing of imagined actions also conforms to timing laws such as the central tendency effect or the scalar property, according to which the (trial-to-trial) variability of imagined movement times grows linearly with the average movement times. What could account for both the motor and timing properties of imagined actions? We recently developed an algorithmic model of motor imagery, which provides a simplified overarching description of the involvement of the motor system over time during motor imagery and predicts the onset and duration of imagined actions. We previously showed that this model provides an excellent fit to extant data and reliable parameter estimates. Here, we ask whether it can reproduce and account for the timing properties of motor imagery. Using various simulations, we show that the scalar property of motor imagery can be explained by assuming that the onset and duration of imagined actions are gated by a noisy threshold to conscious access. In other words, trial-to-trial variability in *when* and for *how long* motor imagery accesses consciousness suffices to account for the scalar property of motor imagery. In addition to providing an excellent fit to data, this model generates several novel predictions, thus opening new research avenues on the neural and cognitive mechanisms underlying the timing of motor imagery.

Keywords: motor imagery, scalar property, algorithmic modelling

Characterising the spatial and temporal neural dynamics of temporal predictions in audition

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Predicting *when* future events will happen helps us focus and respond effectively, especially when our attentional capacity is limited. Here, I will present results from two studies (one finished, one with data acquisition in progress) that investigate the neural dynamics of temporal prediction for auditory perception using a statistical learning approach. To characterise how temporal regularities are internalised, we employ Bayesian observer models to capture the learning process over trials. In a recent EEG study (n=27), we were able to demonstrate that humans learn temporal statistics in a Bayesian manner. Specifically, target-evoked responses (P3) reflected Bayesian surprise as measured by Shannon's information. Furthermore, we will present preliminary results from an ongoing study using fMRI and MEG (acquisitions in progress). Participants perform a simple reaction time task in a foreperiod paradigm, in two separate sessions, one for fMRI and one for MEG (1-3 weeks apart), and we manipulate the mean and dispersion of the foreperiod distributions. Bayesian observer models will be fitted to reaction times to quantify participants' temporal predictions per trial. By combining these two modalities, and informing the analyses with the information-theoretic parameters obtained from the Bayesian model (prediction error, surprise), we aim to uncover the spatial and temporal dynamics of the neural processes involved, particularly how learning to anticipate temporal probabilities enhances attentional focus over time, and how prediction error and surprise contribute to refining temporal predictions on subsequent trials. The combined fMRI-MEG approach allows us to consider cortical and subcortical brain areas, including the cerebellum, for which prior evidence suggests an implication in timing and predictive processing. By integrating neural and computational approaches, this work seeks to advance our understanding of how the brain encodes and utilises temporal statistical regularities.

Keywords: temporal prediction, Bayesian observer, fMRI, MEG, temporal statistics

Beyond probability: Temporal prediction error shapes performance across development

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We have previously shown that although children are significantly less precise than adults in explicit timing tasks, their performance is equivalent to adults in implicit timing tasks. However, the dynamic way in which the temporal prior is constructed in implicit timing tasks may nevertheless be subject to developmental change. Here, we adopted a more fine-grained analytical approach by tracking changes in temporal probabilities across trials and using a Bayesian learning algorithm to capture the emergence of the temporal prior throughout the session.
Speeded reaction times (RTs) were recorded in 47 young children (5-7 years), 58 older children (7-11 years), and 48 adults during a variable foreperiod (FP) paradigm (240-960ms FPs). The 600ms FP was much more probable (~36% of trials) than the six other shorter or longer FPs, which were themselves equiprobable (~9% each). We also included catch trials (~9%) to mitigate the effects of the hazard function on performance. For each participant, we calculated dynamic changes in FP probability (Pb) and temporal prediction error (pE) across trials. The pE was defined as the absolute difference between the FP predicted by a Bayesian learner (i.e. the moment at which the prior was maximal) and the actual FP of that trial.
We analysed the influence of FP duration, Pb and pE on RTs to the target. Performance varied as a function of FP duration and all three groups responded fastest to targets appearing after the most probable FP. Strikingly, RTs showed a U-shaped profile, getting gradually slower as FP duration got increasingly shorter or longer than 600ms, even though these FPs were all equally probable. Indeed, linear mixed-model analyses showed a significant main effect of pE on RTs, indicating that performance is guided by the temporal distance between the prior and the actual FP, rather than FP probability per se. Nevertheless, the influence of pE on performance emerged gradually during childhood, with younger children having a less temporally precise prior than older children.
These findings confirm that all participants demonstrated temporal statistical learning, and that temporal prediction error plays a key role in explaining implicit timing performance across development.

Keywords: temporal attention, implicit timing, foreperiod, prediction error, expectation, children

Interaction between timing, stimulus control of light and sound, and its effects on anticipatory responses in multiple and mixed fixed interval schedules in rats (Preliminary Results)

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The post-reinforcement pause has been studied using fixed-ratios in mixed and multiple schedules. The results showed long pauses in the multiple schedule with the long component and short pauses in the mixed schedule for both components, suggesting that the pause is a function of the upcoming ratio. This study aimed to analyze timing in rats under mixed and multiple fixed-interval (FI) reinforcement schedules with short and long intervals, using the same methodology of the fixed ratio comparisons, to replicate that pauses are anticipatory in the FI schedules as well and to collect evidence about how the behavioral patterns under control of the stimuli may facilitate timing. In Experiment 1, four rats underwent four phases of 20 sessions, alternating between mixed and multiple schedules. One component in each schedule was FI-60 s (short) and the other FI-240 s (long), presented in a semi-random sequence. The reinforcement was 5 seconds of access to water. Experiment 2 followed a similar procedure with five rats, using FI-30 s (short) and FI-120 s (long). The sessions were recorded for analysis. Additionally, two phases with peak trials were included. The results suggest differences in response rate between FIs, as well as between schedules and components. Stimulus control was observed in the multiple schedule (by the interaction of time and sound/light) and mixed schedules (by time). Furthermore, the pause's duration increased with the interval's length. It is concluded that the pause is an anticipatory phenomenon and that the rats use elapsed time as a signal to anticipate the delivery of the reinforcer; they combine such information with the stimulus to more effectively time appropriate durations. Additionally, videos were automatically analyzed using a deep learning model to track behavioral patterns. The results and conclusions of this study are preliminary.

Keywords: post-reinforcement pause, fixed intervals, discriminative stimuli, timing, rats

How ensemble temporal statistics influence duration perception of visual events

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The human ability to reproduce the duration of brief sensory events is shaped by the statistical distribution of recently experienced durations, referred to as the temporal context. For example, when the same physical duration is presented within different duration ranges, its reproduction tends to be systematically biased toward the mean of the respective range, leading to different reproductions across contexts. Temporal context also changes when we are exposed to a fixed set of durations that vary in their frequency of occurrence, though the effects of such context remain less well understood. At the neural level, functional MRI (fMRI) studies have shown that the processing of brief visual durations is supported by tuning mechanisms that change across the cortical hierarchy—from monotonic tuning in early visual areas to unimodal tuning in downstream regions. However, it remains unclear how and where these tuning properties adapt to contextual biases. In this study, 30 participants reproduced 8 visual durations presented under either a uniform or a positively skewed distribution. To investigate the neural underpinnings of this contextual manipulation, a separate group of 15 participants performed the same task while undergoing ultra-high-field (7T) fMRI. Behavioral data showed that, under the skewed condition, all durations were reproduced as longer, suggesting a repulsive effect of temporal statistics on behavioral responses. Representational similarity analysis further revealed a systematic forward shift in reproductions: responses under the skewed condition became more similar to those of the next longer duration in the uniform condition, indicating a fine-grained adjustment of timing performance driven by temporal statistics. For the neural data, we plan to use neuronal model-based analysis to estimate monotonic and unimodal responses to durations. This approach will be instrumental in characterizing tuning differences between statistical conditions and linking them to behavioral outcomes. Overall, this work may advance our understanding of the neural mechanisms underlying context-driven temporal distortions.

Keywords: temporal context, duration tuning, 7T-fMRI

Temporal Reward Prediction in the Visual Corticostriatal Circuit

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Accurate prediction of reward timing is critical for adaptive decision-making, yet the neural mechanisms underlying temporal reward expectations remain poorly understood. We investigate how the visual corticostriatal circuit (VC>DS) encodes and transmits reward timing signals to guide time-investment behavior. While the visual cortex (VC) traditionally is regarded to simply processes sensory information, a growing body of work demonstrates its role in encoding both reward timing and action timing. Complementing this, the dorsal striatum (DS) is known to integrate motor timing and action valuation. We propose that VC transforms sensory cues into temporal reward predictions, which DS then translates into timed behavioral policies.To test this hypothesis, we developed a novel behavioral paradigm where head-fixed mice optimize waiting durations to maximize reward rates. Mice were divided into two groups and trained with different reward regimes of distinct background delays (1s vs. 5s), requiring strategic adjustment of wait times. Behavioral data reveal precise adaptation, with mice waiting significantly longer under longer background delays (3.84s vs. 1.95s; n=26 mice; 604,837 trials; p-value < 10e-28). Simultaneous neural recordings using Neuropixels 1.0 probes identified DS and VC neurons exhibiting wait time-dependent firing patterns, with peak activity prior to decision to end waiting scaling either positively or negatively with wait duration.Current findings support a model where VC computes reward timing expectations that DS utilizes to guide action selection. Future work will employ circuit-specific perturbations to test the causal role of VC>DS projections in timing behavior. This study provides mechanistic insights into how sensory-motor circuits integrate temporal information to guide decisions—a process impaired in Parkinson’s disease and addiction. By elucidating computational principles of the VC>DS circuit, we advance our understanding of predictive timing in adaptive behavior.

Keywords: Reward timing, Corticalstriatal circuit, Neuropixels, Decision making, Reinforcement learning

Exploring the effects of rhythmic vibratory stimuli on time perception

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This study examined whether the time perception can be manipulated by presenting periodic tactile vibration. Previous research suggested that the vibration frequency (at around 1 Hz) applied while people are sitting passively distorts the perceived speed of time; higher frequencies make us perceive the passage of time faster than lower frequencies. (Iizuka & Yotsumoto, 2019). In this study, we presented vibration while participants were actively engaged in a task. After engaging in a task for 7.5 min, participants reported the subjective speed of the time passed, the amount of boredom during the task, and the estimated length of the time using a visual-analogue scale. In Experiment 1, participants solved arithmetic problems. Subjects were randomly assigned to one of three vibration conditions: none (control), 54 beats per minute (BPM), or 66 BPM. In Experiment 2, to investigate whether the effect of vibration stimuli is influenced by attention, participants counted the number of vibrations, with 54 BPM and 66 BPM assigned between subjects. In both experiments, significant negative correlation was found between perceived duration of time and the amount of boredom, replicating Witowska et al. (2020). However, neither perceived duration nor the subjective speed of time differed across vibration conditions, indicating no detectable effect of the tactile stimulation. These findings suggest that vibration-based modulation of time perception operates only under restricted circumstances. Future work should vary cognitive load and stimulus characteristics to clarify the detailed conditions under which external periodic stimulation influences human time perception.

Keywords: Time Perception, Tactile perception, Vibration Stimuli, Time distortion, Time judgement

How facial features affect time perception: from the perspective of race and eye contact.

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Previous studies have shown that eye contact alters time perception. However, inconsistent findings have been reported regarding whether eye contact leads to an underestimation (Burra & Kerzel. 2021) or overestimation of time (Ren et al. 2023). One possible reason for these discrepancies is the variation in facial stimuli and participants' racial backgrounds across studies. The current study investigated how the race of facial stimuli influences time perception during eye contact among Japanese university students.In Experiment 1, participants completed a temporal bisection task using static images of Japanese and Caucasian faces with either direct or averted gaze. The results showed no significant effect of gaze direction but a significant effect of race: participants perceived the duration of Japanese faces as shorter. This suggests that static direct gaze alone is insufficient to induce an eye-contact effect on time perception.In Experiment 2, we created a pseudo eye-contact situation by dynamically presenting sequential face images with different gaze directions. In this presentation method, the sequence of an averted gaze followed by a direct gaze and then another averted gaze made the eye movement more salient, enhancing the perception of eye contact. The results revealed that participants were more likely to perceive time as longer when the gaze was directed toward them, indicating a clear eye-contact effect.These findings suggest that the method of facial image presentation influences time perception. While static direct gaze may direct attention to overall facial features, leading to a stronger racial effect, dynamic gaze shifts may enhance the perception of eye contact, thereby modulating time perception. This study highlights the role of facial race and stimulus presentation methods in shaping time perception during eye contact.

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Burra & Kerzel 2021 *Cognit.*, 212, 104734.Ren et al. 2023 *Frontier in Psycho*l., 13, 967603.

Keywords: Time perception, Gaze direction, Race, Attention

Seeking the internal clock: Does the modality effect exist in retrospective timing and if so, is it multiplicative as in prospective timing?

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Time duration judgements are typically categorised into prospective, and retrospective time judgements. Solid evidence supports the internal clock model as a mainstream mechanism for prospective timing. The Storage Size Model proposed that retrospective timing judgement is instead based on the amount of information processed, but inconsistent experiment results have questioned the validity or purity of this underlying mechanism. A possible explanation of this inconsistency is that both types of time judgement are based on the internal clock, but they differ in the amount of attention allocated to timing the event. In the current study, we conducted two experiments with different stimuli durations in both the visual and auditory modalities to test the potential modality effect in a retrospective timing condition. The ‘verbal estimation of duration’ task was used. The two experiments differed only in the range of durations used. Experiment 1 used a range from 281 - 909 ms, and Experiment 2 used a range of 595 - 3107 ms. Results of both experiments revealed a significant longer verbal estimation of duration for auditory stimuli than that for visual stimuli, which suggests a modality effect. The regression analysis found a significant intercept effect between modalities, but no slope effect. The problem of the division of types of time judgement are also discussed in the article. This large scale investigation involved over 600 participants and represents the first investigation of the possibility of a modality effect in retrospective timing.

Keywords: Retrospective time judgement, Time duration perception, Internal-clock model, Slope effect

The Interaction Between Timing, Impulsive Choice, and Risk Taking in Children with ADHD: Exploring the Role of Pharmacological Treatment

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Impulsive choice is choosing a smaller, immediate reward over a larger, delayed one, even when the delayed option is objectively optimal. Research in animal models evidences interaction between impulsive choice and timing precision (Smith et al., 2015), consistent withs studies with human adults suggesting a relationship between impulsivity, time perception, and risk-taking behavior (Baumann & Odum, 2012). It has been proposed that precise temporal estimation might underlie reductions in impulsive behavior, particularly in intervention studies with animals. However, this hypothesis remains untested. Individuals diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) often display heightened impulsive choice, perceive time as passing quickly, and show less precision in estimating temporal durations. Despite this, few studies have examined how these processes relate in children with ADHD, or how pharmacological treatment may influence them. This study aims to evaluate the performance of children with ADHD on tasks assessing impulsive choice, temporal bisection, time reproduction, and risk-taking, and to explore how pharmacological treatment may impact behavior in such tasks. Participants will be children aged 8 to 10 years with a confirmed ADHD diagnosis by a neurologist. The procedure will include three phases. In the pre-test, conducted before starting medication, participants will complete four tasks: temporal bisection, time reproduction, temporal discounting, and probability discounting, two weeks later, caregivers will complete a short telephone survey about medication adherence. Approximately one month after the initial assessment, participants will repeat the same set of tasks. This study is currently underway. We anticipate the results will contribute to a better understanding of the interaction between timing, impulsive choice, and risk-taking in children with ADHD, and will provide insights into the potential role of medication in modulating these behaviors. These findings may inform the development of more effective intervention strategies.

Keywords: Timing, ADHD, Impulsive Choice, Risk Taking, Pharmacological Treatment

Assessing domain-generality of temporal metacognition: behavioral and electrophysiological insights

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Temporal metacognition, the ability to evaluate one’ s own timing performance, remains a relatively understudied aspect of self-monitoring. Recent findings from temporal reproduction tasks in both humans and rodents (Oztel & Balci, 2024) suggest that individuals can access information about the magnitude and direction of their timing errors, pointing to a capacity for metacognitive evaluation in the temporal domain. However, it remains unknown whether temporal metacognition is supported by shared mechanisms also contributing to other perceptual and cognitive tasks or whether it is highly specific to the time domain. This question builds on a broader debate in the metacognition literature: does metacognitive monitoring rely on domain-general or domain-specific mechanisms? Prior research has primarily addressed this by comparing metacognitive performance across sensory modalities or between domains such as perception and memory, yielding mixed evidence for both shared and distinct processes (Rouault et al., 2018). To extend this line of inquiry into the temporal domain, we adapted a confidence forced-choice paradigm (de Gardelle & Mamassian, 2014, 2016) to compare metacognitive judgments across a temporal and a visual bisection task. Participants performed pairs of trials and indicated which response they felt more confident about. Preliminary results show an increase in psychophysical sensitivity for trials selected as more confident, in both tasks. Moreover, participants were able to compare confidence across domains, suggesting the presence of a domain-general format for confidence. To investigate the underlying cerebral mechanisms, EEG recordings are being conducted in a second study. We hypothesize that temporal metacognition might involve domain-general readout mechanisms acting on task-specific network dynamics. This work aims to provide new insights into whether temporal metacognition is integrated within a unified self-monitoring system or operates independently from other domains.

Keywords: Temporal metacognition , Confidence, Domain-generality, EEG

Retrieving sequence of duration(s) from working memory

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Cognition critically relies on both, working memory (WM) and temporal information. However, how our brain processes temporal information in WM remains largely unresolved. Previous studies have shown that WM load, but not attention, affects the reproduction of time intervals (Church, 1984; Herbst et al., 2025; Teki et al., 2014). Herein, we used a delayed n-item reproduction task in which participants hear a sequence of empty time intervals that they have to reproduce after a retention period. We asked (1) how the length of the retention period affects the reproduction of a stored duration, and (2) whether multiple durations (sequence) interfere with each other in WM.In the first experiment, we manipulated the ratio between the time interval to be reproduced and the retention period. Our data showed that both the retention period and the ratio of the time interval and retention affected WM performance. In the second experiment, we explored the interference between the durations in the sequence by adding a cue indicating whether one interval in the sequence (first or second) or the full sequence of intervals had to be reproduced. The cue could be presented before (pro-cueing) or after (retro-cueing) the retention period. We found that a primacy effect on reproduction precision only occurs when retro-cueing for a long duration: the reproduced long duration was more precise in the first position. Additionally, our results show that participants initiated their reproduction faster for the first interval in the sequence than for the second one, independently of their durations. Overall, our study suggests that both the retention period and interference with other remembered intervals can affect the representation of duration in working memory.

Keywords: time perception, duration, order, working memory, precision

Investigating heart–eye coupling during active visual search in early infancy: a planned study

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Humans actively explore and perceive their environment. Recent studies suggest that the timing of exploratory movements and subsequent sensory processing is regulated by a predictive mechanism tied to the cardiac cycle, whereby the central nervous system uses internally generated baroreceptor signals conveying blood-pressure information to modulate external sensory processing (Galvez-Pol et al., 2020). In our recent study, using eye movements as a proxy for exploratory and perceptual behavior, we found that rapid eye movements for exploration (saccades) tend to occur immediately after a heartbeat (during systole), whereas sustained fixations associated with perception predominantly occur during the subsequent diastolic phase (Hisada & Isomura, in prep).

To investigates the developmental emergence of this heart–eye coupling, we adapted our adult task into an infant-friendly, non-verbal visual search task. Infants were presented with an attractive image that was initially covered with a black mask, and spontaneously uncovered it by directing their gaze to masked region, revealing the underlying image. We simultaneously recorded the infants' electrocardiogram (ECG) during the task. We hypothesize that heart-eye coupling emerges in parallel with the development of primitive self-processing in the first year of life. Data collection with early infants is ongoing, and will be complete by the time of the conference. We will present the results of circular-phase analyses of eye-movement timing relative to the cardiac cycle, and discuss our findings in terms of baroreceptor-mediated self-related processing.

Keywords: Eye movements, Cardiac cycle, Baroreceptor, Systole, Saccades

Temporal Binding and Sense of Agency in Oculomotor Control

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We investigated sense of agency (SoA) for saccades using explicit and implicit agency measures, including temporal binding. Participants moved their eyes towards on-screen stimuli that subsequently changed color. Participants then either reproduced the temporal interval between saccade and color-change or reported the time points of these events via an auditory Libet clock to measure temporal binding. Crucially, participants were either made to believe to exert control over the color change or not, thereby establishing an agency manipulation. Explicit ratings indicated that the manipulation of causal beliefs and hence agency was successful. However, temporal binding was only evident for caused effects, and only when a sufficiently sensitive procedure was used, that is, an auditory Libet clock. This suggests a feebler connection between temporal judgements and SoA than previously assumed. The results also provide evidence in favor of a fast acquisition of sense of agency for previously never experienced types of action-effect associations. Oculomotor temporal effect binding as addressed in the present study is theoretically informative given the lower degree of voluntariness involved in eye movement control as compared to more standard effector systems (e.g., manual) typically utilized in temporal binding research.

Keywords: Sense of Agency, Eye Movements, Temporal Binding

What’ s the difference between a premature and a timed anticipatory movement ?

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Imagine yourself in a car race waiting for the traffic light to go green. Impulsivity could push you to accelerate prematurely when the light is red, causing a false start. In contrast, cognitively driven anticipation could lead you to accelerate right at the time the traffic light goes green and give you some advantage. Whether these two types of responses interact or are independent is an open question. Independent neural processes could be reflected in different characteristics like latency distribution, velocity and/or amplitude of the movement.The independence hypothesis was tested using an oculomotor task with a constant delay between a warning and an imperative visual stimuli. Delay duration was either 400, 900, 1400 or 1900 ms in blocks of 120 trials. Through repetition, subjects (n=27) implicitly learn the timing of the imperative stimulus. On average, 10% of experimental trials were associated with a response before the ‘go’ signal. The latency distribution of eye saccades during the delay before the ‘go’ signal was composed of two modes. With increasing delay duration, we found that: 1) The number of 1st mode saccadic responses decreased whereas the number of 2nd mode responses remained approximately constant; 2) The variance of 1st mode response latencies remained constant whereas the variance of 2nd mode responses increased; 3) The maximum velocity of 1st mode responses remained constant whereas it decreased for 2nd mode responses.These results show that collectively referring to movements before the ‘go’ stimulus as ‘anticipatory’ is inaccurate. There are probably two independent processes taking place before the ‘go’ stimulus: an unintentional release of inhibition evoking a premature saccade and an anticipatory process temporally guided. Premature saccades could be subcortically initiated whereas anticipatory saccades could be under the dependence of the cortical eye fields.

Keywords: Temporal preparation, Eye movements, Anticipation, Impulsivity

Revealing rhythm categorization in human brain activity

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Human experience of musical rhythm is fundamentally determined by the ability to map the infinite variety of possible rhythmic sensory inputs onto a finite set of internal rhythm categories. However, the underlying nature and neural mechanisms of rhythm categorization are still not well understood. Here, we present a novel approach allowing to reveal rhythm categories from brain activity using scalp electroencephalography (EEG) combined with frequency-domain and representational similarity analysis (fRSA).

Using this approach, we provide first direct evidence for neural categorization of rhythm in humans. We show that EEG activity elicited by a set of two-interval rhythms goes beyond mere tracking of acoustic temporal features and, instead, reflects two discrete categories that encompass small integer ratio rhythms reported in prior behavioral work. Importantly, we show that these neural categories are remarkably similar to the categorical structure captured in sensorimotor reproduction of the same stimuli, yet they can emerge automatically, without a related explicit task, thus independently from motor, instructional or decisional biases.

To go a step further, we investigated whether the automaticity of this phenomenon could be related to an early emergence of rhythm categories in the subcortical auditory regions based on lower-level physiological properties of neural assemblies. To test this, we used a functional localizer allowing to isolate EEG activity originating from higher-level cortical vs. subcortical auditory sources. Preliminary results indicate that while the categorical representations observed at the cortical level cannot be fully explained by subcortical responses, rudiments of rhythm categorization might already emerge in the early stages of the ascending auditory pathway.

Together, these results and methodological advances constitute a critical step towards elucidating the fundamental constituents and biological substrates of musical rhythm, particularly the interplay between universal neurobiological constraints shared across individuals and species, and the plasticity of categorization processes developing through life experience.

Keywords: Musical behavior, Representational similarity analysis, Perceptual categorization, Rhythm perception and production, Electroencephalography

Memory traces of duration and location in the right intraparietal sulcus

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1. Technical University Berlin, 2. DZNE Magdeburg, 3. University of Groningen

Time and space form an integral part of every human experience, and for the neuronal representation of these perceptual dimensions, previous studies point to the involvement of the right-hemispheric intraparietal sulcus and structures in the medial temporal lobe. Here we used multi-voxel pattern analysis (MVPA) to investigate long-term memory traces for temporal and spatial stimulus features in those areas. Participants were trained on four images associated with short versus long durations and with left versus right locations. Our results demonstrate stable representations of both temporal and spatial information in the right posterior intraparietal sulcus. Building upon previous findings of stable neuronal codes for directly perceived durations and locations, these results show that the reactivation of long-term memory traces for temporal and spatial features can be decoded from neuronal activation patterns in the right parietal cortex.

Keywords: space-time interference, spatial cognition, intraparietal sulcus, MVPA, fMRI

Neural Correlates of Perceptual Biases in Visual Duration Estimation

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

1. International School for Advanced Studies

Our perception of stimulus duration expands and compresses under the influence of multiple factors such as stimulus features, our physiological state or attentional focus. However, the neuronal mechanisms underlying temporal distortions are not yet well characterized. In the visual system, processing of stimulus duration is supported by distinct tuning profiles: early visual areas exhibit monotonic responses that scale with stimulus duration, whereas downstream cortical regions show unimodal tuning, whereby brain responses peak at preferred durations. In this study, we sought to identify how changes in these tuning profiles relate to biases in duration estimation. Using ultra-high field fMRI, we recorded brain activity of 15 participants engaged in a duration discrimination task under two experimental manipulations known to induce biases in duration judgements. In one session, we modulated perceived duration by altering stimulus speed, which is known to expand the perceived duration of faster stimuli. In a separate session, we employed a duration adaptation protocol, where repeated exposure to a short duration led participants to overestimate the duration of subsequently presented stimuli. Critically, although both manipulations produced similar perceptual biases, they are hypothesized to affect different stages of the neural tuning hierarchy: speed-driven biases are expected to modulate tuning in early visual areas, while adaptation-induced biases are more likely to impact duration tuning in higher-order regions. Using neuronal model-based analysis we aim to identify commonalities and differences in how our experimental manipulations shape duration tuning and its topographical organization. Preliminary results suggest that the two experimental manipulations differentially modulate duration tuning across distinct stages of duration processing within the cortical hierarchy. Overall, our findings might provide new insights into the flexible nature of the neural mechanism underlying our subjective experience of stimulus duration.

Keywords: duration perception, duration tuning, 7T-fMRI

Uncovering the neuroanatomical substrates of impulsive behaviour induced by the temporal predictability of events: an fMRI-EMG investigation

*Inga Korolczuk[1,2], Boris Burle[2], Bruno Nazarian[3], Marion Royer D' Halluin[2,4,5], Franck Vidal[4], Jennifer T Coull[2]

1. Department of Psychology, Medical University of Lublin, 2. Centre for Research in Psychology and Neuroscience (UMR7077), Aix-Marseille University & CNRS, 3. Aix-Marseille Université, UMR 7289 CNRS, Institut de Neurosciences de la Timone, Marseille, Provence-Alpes-Côte d'Azur, 13005, France, 4. CHU Sainte-Justine Research Center, Montréal, Québec, Canada, 5. Department of Neurosciences, Université de Montréal, Montréal, Québec, Canada

Previous research has revealed that the temporal predictability of events enhances response speed but exacerbates impulsive responses during conflict tasks. We used fMRI coupled with EMG to investigate the neuroanatomical correlates underlying this impulsivity 24 healthy participants performed a temporally cued Simon conflict task. Temporal predictability was manipulated by visual pre-cues that either indicated (temporal cue) or not (neutral cue) target onset time. Participants responded to target shape (+/x) with left- or right-hand responses. Critically, the spatial location of the targets (left/right) was either compatible or incompatible with the required response hand, inducing response conflict. Behavioural data replicated previous findings: temporal cues increased the number of fast impulsive errors to incompatible targets. FMRI analysis revealed that temporal predictability, activated left inferior parietal cortex (IPC) and left premotor cortex irrespective of response hand laterality or target (in)compatibility. Conversely, response incompatibility activated right putamen and right premotor cortex, independent of cue type. Notably, an interaction effect—reflecting increased impulsivity to temporally predictable targets—was associated with enhanced activation in left IPC. This region is implicated in temporal attention and sensorimotor integration, and may accelerate motor preparation based on temporal expectations, boosting activation of both correct and incorrect responses. This anticipatory mechanism likely sharpens readiness but also leaves the system vulnerable to prepotent, task-irrelevant activations. Indeed, behavioural errors represent only part of the underlying impulsive processes during conflict. EMG recordings revealed that 16% of correct responses to incompatible targets were preceded by subthreshold EMG bursts in the incorrect response hand—so-called 'partial errors' - which are rapidly suppressed. Temporal predictability heightened this covert motor activation, with partial errors occurring more often after temporal cues than neutral ones. Our next steps include identifying brain regions linked to these partial errors to understand how temporal predictability affects the neural circuits modulating covert impulsive actions.

Keywords: Temporal predictability, Impulsivity, EMG, fMRI, Response conflict

Basic mechanism underlying the audio-visual temporal recalibration for the long stimuli

*Yaru Wang[1], Makoto Ichikawa[1]

1. Chiba University

When audio-visual stimuli are presented with a consistent temporal asynchrony for a few minutes, the perceived asynchrony between the stimuli would be reduced (audio-visual temporal recalibration). The present study aims to examine the mechanism underlying the audio-visual temporal recalibration for the stimuli whose onsets are distinguishable from their offsets. In Experiment 1, we investigated the responsibility of the onset-offset channel, which independently processes the onset and offset of stimuli, for the audio-visual temporal recalibration. Participants were exposed to either asynchronous onsets or offsets with a constant temporal lag (±240ms; negative lag means that the visual stimulus followed the audio stimulus) in the adaptation phase, and then made temporal order judgments for the offsets in the test phase. We found no temporal recalibration. In Experiment 2, we investigated the responsibility of the subject binding between the onset (offset) of the audio stimulus and the offset (onset) of the visual stimulus, for the audio-visual temporal recalibration. Participants were exposed to asynchronous onsets and offsets with a constant temporal lag (0, ±240ms; the audiovisual stimuli overlapped with each other only in the negative lag condition) in the adaptation phase, and then made temporal order judgments for the offset and onset of audio-visual stimuli in the test phase. We found the temporal recalibration only for the -240ms condition. In Experiment 3, we investigated the necessity of overlap between the audio-visual stimuli, for the audio-visual temporal recalibration. Participants were exposed to synchronous onsets and offsets with a constant temporal lag (-240ms) in the adaptation phase, and then made temporal order judgments for the offset and onset of the stimuli in the test phase. We found no temporal recalibration. These results suggest that the audio-visual temporal recalibration depends upon subjective binding between the onset and offset of audio-visual stimuli.

Keywords: Multiple sensory processing, Audio-visual stimuli, Temporal order judgement, Temporal lag, Awareness

Understanding Discomfort Caused by Audiovisual Temporal Asynchrony: Insights from Egg Cracking and Grissini Breaking Videos

*Mayuka Hayashi[1], Waka Fujisaki[1]

1. Japan Women’s Univ.

This study investigated how a sense of discomfort may be triggered by a time lag between visual and auditory stimuli under conditions that resemble everyday experiences. We conducted a psychophysical experiment using videos in which audio-visual time lags were manipulated across seven levels (±0 ms, ±133 ms, ±266 ms, ±400 ms). Participants (N = 15) were asked to judge whether the auditory and visual stimuli were simultaneous (simultaneity judgment) and whether they felt discomfort (discomfort judgment), using a two-alternative forced choice (2 AFC) method. The stimuli featured two everyday actions: cracking an egg and breaking a breadstick (grissini).

We proposed three hypotheses to explain the emergence of discomfort. Hypothesis 1 suggested that discomfort and simultaneity judgments yield identical psychometric functions, implying that discomfort results directly from perceived asynchrony. Hypothesis 2 posited that the psychometric function is narrower for discomfort than for simultaneity, indicating that even without conscious awareness of asynchrony, subtle temporal discrepancies may still be subconsciously perceived, eliciting discomfort. Hypothesis 3 predicted the opposite—that the discomfort function is broader than the simultaneity function—implying that a certain degree of asynchrony is perceptible but not necessarily unpleasant.

The study’s results support hypothesis 3. The temporal window is wider for discomfort judgments than for simultaneity judgments, suggesting that audiovisual asynchrony can be detected without causing discomfort. This finding aligns with Fujisaki et al. (2004), who identified a perceptual category of “not simultaneous but related” using a three-alternative simultaneity task. Adaptation effects were also observed within this category. The similarity between our discomfort window and Fujisaki’s “related” window suggests that the perception of cross-modal relatedness, rather than synchrony alone, plays a key role in the emergence of audiovisual discomfort.

Keywords: Audiovisual temporal asynchrony, simultaneity judgment, discomfort judgment, temporal window, psychophysical experiment

Poster | Other

Fri. Oct 17, 2025 12:45 PM - 2:45 PM JST | Fri. Oct 17, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P1] Poster: Day 1

[P1-39] Unconscious motor–visual temporal recalibration occurs in both active and passive movements

*Masaki Tsujita (Faculty of Child Studies, Kamakura Women’s University)

Keywords：temporal lag adaptation、sensorimotor adaptation、method of constant stimuli、Arduino、cerebellum

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Simultaneity judgments between motor actions and visual flashes are adaptively recalibrated after repeated exposure to a motor–visual temporal lag. It remains unclear whether this recalibration is specifically attributed to the temporal processing of an intersensory pair (e.g. tactile–visual) or to the temporal processing of the causal relationship between active movements and sensory outcomes. A previous study reported that motor–visual simultaneity judgments are recalibrated even when observers are unaware of the adapted temporal lag. We examined whether this unconscious temporal recalibration also occurs in passive movements. Given that self-generated sensory outcomes are automatically distinguished from externally generated sensory events on the basis of the temporal prediction by an efference copy, we predicted that unconscious temporal recalibration would require active movements. Participants were randomly assigned to either of two groups: in the active movement group, participants actively pressed a key; in the passive movement group, a DC solenoid moved their finger up and down as if pressing a key. Adaptation flashes were presented with a 0 ms lag in the first half and a 150 ms lag in the second half of the session. After the experiment, participants were asked whether they were aware of the temporal lag in the second half. Contrary to our prediction, among participants who were unaware of the temporal lag, the point of subjective simultaneity between movements and visual flashes shifted significantly in response to the adapted temporal lag, regardless of whether the movements were active or passive. These results suggest that an automatic temporal recalibration system is implemented in the temporal processing of both intersensory pairs and action–outcome relationships.

Poster | Other

Fri. Oct 17, 2025 12:45 PM - 2:45 PM JST | Fri. Oct 17, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P1] Poster: Day 1

[P1-40] The sound octave equivalence in a songbird as shown by the event-related brain potentials and the operant behavior.

*Rin Ito[1], Yukino Shibata[1,2], Kazuo Okanoya[1] (1. Teikyo University, 2. Hokkaido University)
Keywords：songbirds、octave、operant conditioning、event-related potentials

Octave equivalence is a psychological phenomenon in which two sounds that have the relation of doubling of wavelength are perceiving as being similar to each other. This is one of the fundamentals in music perception related with timing and pitch. We asked whether a species of songbirds, the Bengalese finch, perceives such relations in sounds. Because Bengalese finches sing complex songs with multiple syllables comprising of harmonics, we hypothesized they might possess such perceptual mechanisms. We tackled the question by the event-related brain potentials and the operant behavior. We first measured local field potentials from the higher order auditory area of the finches. We used the oddball task in obtaining the miss-match negativities (MMNs) from novel sounds over familiar sounds. We used the latencies and the negative voltages of the MMNs to construct a cross-correlation matrix and then analyzed it by a hierarchical clustering. We found birds placed sounds in the octave relations in proximity than the one with 1/2 octave relation, suggesting the possibility that they are perceiving the octave equivalence. We then trained the finches to respond discriminate between sounds with different pitches, and then tested whether a novel sounds with octave high or low might be perceived as being similar with the original sound. This behavioral experiment is ongoing and we will be able to show the results in the conference. The study will show whether or not a species of the songbirds, with similar usage of sound signals with our music, perceives octave equivalence. (Work supported by JSPS 24H05160 and 23H05428 to KO).

TRF

Fri. Oct 17, 2025 1:20 PM - 5:00 PM JST | Fri. Oct 17, 2025 4:20 AM - 8:00 AM UTC TCVB tour

[T03] Tokyo River Cruise & Hamarikyu Gardens

TRF | Other

Fri. Oct 17, 2025 10:45 AM - 11:00 AM JST | Fri. Oct 17, 2025 1:45 AM - 2:00 AM UTC Room 1(Mathematical Science Building)

[T00] Opening Remarks

Yuko Yotsumoto

Invited | Other

Sat. Oct 18, 2025 3:15 PM - 4:15 PM JST | Sat. Oct 18, 2025 6:15 AM - 7:15 AM UTC Room 2(West B1)

[K2] ECR Keynote: Devika Narain

Chair:Martin Wiener(George Mason University)

Timing and motor control are inextricably linked, giving rise to the remarkable feats of motor precision observed across the animal kingdom. Laboratory assessments of movement timing, however, often reveal significant variability and systematic biases, presenting a seemingly contradictory picture. Previous research has attempted to reconcile this discrepancy through Bayesian frameworks, which describe how prior beliefs about temporal variables guide precise actions in the face of environmental uncertainty. While these models successfully account for a wide range of behaviors across different domains, the neural mechanisms responsible for forming and utilizing such prior beliefs remain poorly understood. In this work, we propose a role for cerebellar circuits in the acquisition of prior knowledge that shapes basic predictive motor behaviors, specifically, the conditioned eyelid response observed in Pavlovian eyeblink conditioning. We present evidence suggesting that cerebellar Purkinje cells encode probability distributions of sensory stimuli and propose a mechanism by which this encoding influences motor output kinematics. At the population level, we demonstrate that cerebellar cortical activity exhibits a topological organization characterized by curved manifolds, with prior knowledge encoded along the curvature of these structures, consistent with previous work in monkeys. In the second part of the talk, we introduce methodological advances aimed at identifying and embedding neural manifolds formed by the dynamics underlying these tasks within their intrinsic dimensions, enabling the decoding of task-relevant information. Using this approach, we test the hypothesis that the curvature of neural manifolds reflects the encoding of prior knowledge in sensorimotor timing tasks. Overall, we propose a neural mechanism through which prior beliefs governing the temporal control of movement are acquired at the cellular level and subsequently represented in the topological structure of neural populations, consistent with normative theories that explain the emergence of precise timing behavior.

3:15 PM - 4:15 PM JST | 6:15 AM - 7:15 AM UTC

[K2-01]

Prior beliefs for timing movements: from neurons to manifolds

*Devika Narain[1] (1. Erasmus Medical Center (Netherlands))

Prior beliefs for timing movements: from neurons to manifolds

*Devika Narain[1]

1. Erasmus Medical Center

Timing and motor control are inextricably linked, giving rise to the remarkable feats of motor precision observed across the animal kingdom. Laboratory assessments of movement timing, however, often reveal significant variability and systematic biases, presenting a seemingly contradictory picture. Previous research has attempted to reconcile this discrepancy through Bayesian frameworks, which describe how prior beliefs about temporal variables guide precise actions in the face of environmental uncertainty. While these models successfully account for a wide range of behaviors across different domains, the neural mechanisms responsible for forming and utilizing such prior beliefs remain poorly understood. In this work, we propose a role for cerebellar circuits in the acquisition of prior knowledge that shapes basic predictive motor behaviors, specifically, the conditioned eyelid response observed in Pavlovian eyeblink conditioning. We present evidence suggesting that cerebellar Purkinje cells encode probability distributions of sensory stimuli and propose a mechanism by which this encoding influences motor output kinematics. At the population level, we demonstrate that cerebellar cortical activity exhibits a topological organization characterized by curved manifolds, with prior knowledge encoded along the curvature of these structures, consistent with previous work in monkeys. In the second part of the talk, we introduce methodological advances aimed at identifying and embedding neural manifolds formed by the dynamics underlying these tasks within their intrinsic dimensions, enabling the decoding of task-relevant information. Using this approach, we test the hypothesis that the curvature of neural manifolds reflects the encoding of prior knowledge in sensorimotor timing tasks. Overall, we propose a neural mechanism through which prior beliefs governing the temporal control of movement are acquired at the cellular level and subsequently represented in the topological structure of neural populations, consistent with normative theories that explain the emergence of precise timing behavior.

Keywords: Bayesian frameworks

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.
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.

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

Oral | Memory, Emotion, Decision

Sat. Oct 18, 2025 9:00 AM - 10:30 AM JST | Sat. Oct 18, 2025 12:00 AM - 1:30 AM UTC Room 3(East B1)

[20301-06] Oral 4: Memory, Emotion, Decision

Chair:Müge Cavdan(Justus Liebig University Giessen)

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

[20301-06-01]

Investigating the effect of emotion on the temporal resolution of visual processing in viewing flickering LED.

*Makoto Ichikawa[1], Misa Kobayashi[2] (1. Graduate School of Humanities, Chiba University (Japan), 2. Graduate School of Science and Engineering, Chiba University (Japan))

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

[20301-06-02]

Alpha power indexes working memory load for durations

*Sophie Herbst[1], Izem Mangione[1], Charbel-Raphael Segerie[2], Richard Höchenberger[2], Tadeusz Kononowicz[4,1,3], Alexandre Gramfort[2], Virginie van Wassenhove[1] (1. Cognitive Neuroimaging Unit, INSERM, CEA, Université Paris-Saclay, NeuroSpin, 91191 Gif/Yvette, France (France), 2. Inria, CEA, Université Paris-Saclay, Palaiseau, France (France), 3. Institute of Psychology, The Polish Academy of Sciences, ul. Jaracza 1, 00-378 Warsaw, Poland (Poland), 4. Institut NeuroPSI - UMR9197 CNRS Université Paris-Saclay (France))

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

[20301-06-03]

Mentally shifting in time induces a shift in the amplitude of evoked responses

*Anna Maria Augustine Wagelmans[1], Virginie van Wassenhove[1] (1. Cognitive Neuroimaging Unit, INSERM, CEA, Université Paris-Saclay, NeuroSpin (France))

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

[20301-06-04]

Mental Time Travel Impairments in Neurodegenerative Diseases

*Valentina La Corte[1,2], Pascale Piolino[1,2] (1. Memory, Brain and Cognition lab,UR 7536, University Paris Cité (France), 2. Institut Universitaire de France (France))

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

[20301-06-05]

Level of Detail in Near and Far Future Imagined Events

*Ori Levit[1], Guy Grinfeld[1], Cheryl Wakslak[2], Yaacov Trope[3], Nira Liberman[1] (1. School of Psychological Science, Tel Aviv University (Israel), 2. Department of Management and Organization, University of Southern California, Los Angeles, California (United States of America), 3. Department of Psychology, New York University, New York (United States of America))

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

[20301-06-06]

Perceptual decision making of nonequilibrium fluctuations

*Aybüke Durmaz[1], Yonathan Sarmiento[1,2], Gianfranco Fortunato[1], Debraj Das[2], Mathew Ernst Diamond[1], Domenica Bueti[1], Édgar Roldán[2] (1. Sissa (International School for Advanced Studies) (Italy), 2. ICTP (The Abdus Salam International Centre for Theoretical Physics) (Italy))

Investigating the effect of emotion on the temporal resolution of visual processing in viewing flickering LED.

*Makoto Ichikawa[1], Misa Kobayashi[2]

1. Graduate School of Humanities, Chiba University, 2. Graduate School of Science and Engineering, Chiba University

We investigated how emotional responses with different degrees of valence and arousal evoked by viewing a photograph of various facial expressions affects temporal resolution of the visual processing. In Experiment 1, we measured the critical flicker-fusion frequency (CFF) as an index of temporal resolution of visual processing. We used the method of constant stimuli to measure CFF. We presented facial photographs with different expressions (anger, sad, or neutral) in an upright or an inverted orientation. Then, we presented flickering LED with seven different temporal frequencies of LED flicker, and the stimuli in which the duration of on and off of LED was 5ms (100 Hz) as catch stimuli. In each trial, participants reported whether they found the LED flickered or consistent by pressing keys. We found that CFF was smaller for the angry face than for the neutral face only with the upright presentation. In Experiment 2, we measured the detection rate of LED flicker with different ISI (20 or 100ms) between the facial photographs with different expressions (fear, sad, or neutral) and flicker of LED. We prepared four temporal frequency conditions for the LED flashing (15, 17, 19 ms conditions of the on-off of the flashing, and no flickered-consistent condition). Participants reported whether they found the LED flickered or consistent by pressing keys. Results showed that the detection rate for fearful face was significantly higher than the detection rate of the neutral face, and that the detection rate correlated with rating for arousal positively, and with rating for valence negatively only at short ISI. These results suggest that emotion evoked by viewing pictures may elevate the temporal resolution of the visual processing which was measure as CFF only with the upright presentation, and that this effect would decay within short period.

Keywords: critical flicker-fusion frequency, arousal, valence, facial expression, method of constant stimuli

Alpha power indexes working memory load for durations

*Sophie Herbst[1], Izem Mangione[1], Charbel-Raphael Segerie[2], Richard Höchenberger[2], Tadeusz Kononowicz[4,1,3], Alexandre Gramfort[2], Virginie van Wassenhove[1]

1. Cognitive Neuroimaging Unit, INSERM, CEA, Université Paris-Saclay, NeuroSpin, 91191 Gif/Yvette, France, 2. Inria, CEA, Université Paris-Saclay, Palaiseau, France, 3. Institute of Psychology, The Polish Academy of Sciences, ul. Jaracza 1, 00-378 Warsaw, Poland, 4. Institut NeuroPSI - UMR9197 CNRS Université Paris-Saclay

Seminal models of explicit duration perception include a working memory component, serving the comparison between just encoded durations and durations stored in long-term memory. Yet, neither time perception models, nor time memory models provide clear predictions as to the representation of duration in memory. Previously, we have been able to show based on a novel n-item delayed reproduction task, that the precision of duration recall decreases with the number of items to be remembered in sequence, but not with the duration of the sequence (Herbst et al., 2025). This suggests that durations are maintained as discrete items, rather than a continuous temporal code. Here, we investigated the neural signatures of a sequence of durations (n-item sequence) held in working memory. We recorded human participants using magnetoencephalography (MEG) while they performed the n-item delayed reproduction task, which required to encode a sequence of durations, maintain it, and then reproduce it. The number of items in a sequence (one or three) and the duration of the sequence were varied orthogonally. Our results show that during working memory maintenance, the number of durations, but not the duration of the sequence, affected recall precision and could be decoded from alpha and beta oscillatory activity. Parieto-occipital alpha power showed a direct link with the precision of temporal reproduction. Our results extend the earlier behavioral findings suggesting that durations are itemized in working memory and that their number, not their duration, modulates recall precision. Crucially, we establish that alpha power reflects a universal signature of working memory load and mediates recall precision, even for abstract information such as duration.

Keywords: duration perception, working memory, alpha oscillations, beta oscillations, duration reproduction

Mentally shifting in time induces a shift in the amplitude of evoked responses

*Anna Maria Augustine Wagelmans[1], Virginie van Wassenhove[1]

1. Cognitive Neuroimaging Unit, INSERM, CEA, Université Paris-Saclay, NeuroSpin

Through mental time travel (MTT), humans can explore past events or possible futures. One hypothesis is that MTT builds on flexible temporal cognitive maps of events' position in time (Gauthier & van Wassenhove, 2016). Previous studies have shown the implication of the hippocampal-entorhinal system for MTT (Gauthier et al., 2019; 2020), where the sequential firing of neuronal assemblies on shifting phases of theta oscillations codes for spatial position and distance (Dragoi & Buzsáki, 2006). Yet, the computation of temporal distances remains to be characterized. In a novel paradigm (N = 63), participants mentally projected themselves to different dates in the past or future. They were shown historical events, and had to report whether the event would happen before or after, with respect to their temporal position. We found that the further away in time participants imagined themselves to be, the slower their reaction times. This parametric shift shows that distance computations can be captured during MTT at a behavioural level, and grounds the hypothesis of a similar shift in neural responses. Herein, we adapted this task to magnetoencephalography (N = 31). We show that the amplitude of neural responses evoked by mentally projecting in time increased compared to being in the present, but did not shift along temporal distance. This suggests that the evoked response captures the operation of mentally projecting oneself in time, but not the underlying distance computations. Source reconstruction based on anatomical scans is ongoing to identify the regions contributing to this increase in evoked activity, with a primary focus on the hippocampus.

Keywords: mental time travel, cognitive map, MEG, hippocampus

Mental Time Travel Impairments in Neurodegenerative Diseases

*Valentina La Corte[1,2], Pascale Piolino[1,2]

1. Memory, Brain and Cognition lab,UR 7536, University Paris Cité , 2. Institut Universitaire de France

In recent decades, research on memory processes has expanded to include the mechanisms involved in envisioning future events, within the broader framework of mental time travel (MTT). *Prospection* refers to a broad and complex set of cognitive processes that enable individuals to anticipate, plan for, and mentally simulate future experiences.This study focuses on a specific form of episodic prospection known as episodic future thinking (EFT)—the capacity to project oneself forward in time to pre-experience personal future events.Previous studies have documented impairments in EFT among individuals with neurodegenerative diseases such as Alzheimer’ s disease (AD) and semantic dementia (SD), often related to long-term memory deficits. However, the neurocognitive mechanisms underlying these deficits remain poorly understood—particularly regarding the role of temporal distance.The aims of the present study were:

(i) to investigate MTT capacities across different temporal distances in AD and SD patients;

(ii) to disentangle the relationship between EFT and long-term memory deficits in these neurodegenerative profiles.Our results show that AD patients exhibited significant impairments in EFT for near-future events, while their performance for distant-future scenarios was relatively preserved. Additionally, they demonstrated deficits in past event recollection regardless of temporal distance. In contrast, SD patients showed an opposite pattern: preserved EFT for near and intermediate future events, but impaired performance for distant ones. Regarding the past dimension, SD patients showed deficits specifically for remote events.These findings contribute to a more nuanced understanding of how episodic and semantic memory impairments differentially affect past and future-oriented cognition in neurodegenerative conditions. The results carry both theoretical significance and potential clinical applications.

Keywords: mental time travel, memory, neurodegenrative diseases, personal temporality, episodic future thinking

Level of Detail in Near and Far Future Imagined Events

*Ori Levit[1], Guy Grinfeld[1], Cheryl Wakslak[2], Yaacov Trope[3], Nira Liberman[1]

1. School of Psychological Science, Tel Aviv University, 2. Department of Management and Organization, University of Southern California, Los Angeles, California, 3. Department of Psychology, New York University, New York

How does psychological distance influence the level of detail in our mental representations of future imagined events? According to Construal Level Theory (CLT), there are four psychological distance dimensions: events can feel distant in time (temporal), space (spatial), social relationship (social), or probability (hypothetical). Yet we lack direct measures of how these distances affect the level of detail in mental representations. We bridged this gap by adapting Reality Monitoring Theory's Memory Characteristics Questionnaire to measure the level of detail in future imagined scenarios. Across six studies (N=1,749), we demonstrated that psychological distance, including the temporal dimension, systematically reduces the level of detail in mental imagery. Study 1 found that more psychologically distant imagined scenarios were rated as significantly less detailed ($r = -.16$, $p = .005$). Studies 2-3 manipulated hypotheticality, showing that probable future meetings were imagined with greater detail than improbable future meetings ($d = 0.47$, $p < .001$). Study 4 examined the same idea in spatial distance ($d = 0.20$, $p = .007$), and Study 5 examined social distance ($d = 0.31$, $p = .01$). Study 6 specifically examined temporal distance: older adults closer to retirement age imagined their future retirement with greater detail than younger adults ($r = .23$, $p < .001$), and this increased temporal detail mediated the relationship between temporal closeness and actual retirement savings behavior (indirect effect: $b = 0.06$, 95% CI [0.01, 0.03]). These findings demonstrate that psychological distance systematically affects the level of detail in future mental representations. For timing research, this reveals how temporal distance affects mental representation: feeling temporally closer to events increases mental detail, which influences real-world planning behavior

Keywords: Psychological Distance, Temporal Distance, Mental Imagery, Future thinking, Construal level

Perceptual decision making of nonequilibrium fluctuations

*Aybüke Durmaz[1], Yonathan Sarmiento[1,2], Gianfranco Fortunato[1], Debraj Das[2], Mathew Ernst Diamond[1], Domenica Bueti[1], Édgar Roldán[2]

1. Sissa (International School for Advanced Studies), 2. ICTP (The Abdus Salam International Centre for Theoretical Physics)

A pedestrian deciding when to cross a busy street must consider not only the average traffic flow but also the fluctuations in the movement of individual cars. Similarly, the perceptual system must handle both local fluctuations in individual elements and the global patterns that emerge from their interactions. To investigate how the brain makes efficient decisions in such nonequilibrium systems—where evidence changes over time—we conducted three experiments with sixty-seven human participants who judged the direction of a particle exhibiting drifted Brownian motion. The entropy production rate extracted from the particle's trajectory served as a measure of noise dynamics.

We found that mean decision time was inversely proportional to the entropy production rate, establishing an analytical approach to predict the amount of time required to extract the signal given stimulus parameters. Moreover, participants required more time than predicted, indicating suboptimal decision times. An evidence integration approach, equipped with a memory time constant, resulted in tighter fits, indicating that participants adjusted their integration time window to stimulus dissipation, favoring the global trajectory of the stimulus over local fluctuations when the stimuli exhibited higher entropy production.

Furthermore, comparisons between blocked and intermixed conditions revealed that environmental stability was directly linked with decision optimality as well as the flexibility in adjusting integration time window. Complementary approaches indicated that decision optimality was linked to (I) memory load, (II) the recency effect, and (III) the ability to detect meaningful statistical cues in the evidence.

Overall, our work shows that providing a detailed model of the physical properties of the stimuli allows for a better characterization of the variables influencing perceptual decision-making, and refines our understanding of the temporal dynamics of efficient evidence integration.

Keywords: perceptual decision making, nonequilibrium systems, decision optimality, evidence integration, stimulus statistics, integration time window

Oral | Prediction, Temporal perception, Computational Modeling

Sat. Oct 18, 2025 1:00 PM - 2:30 PM JST | Sat. Oct 18, 2025 4:00 AM - 5:30 AM UTC Room 3(East B1)

[O6] Oral 6: Prediction, Temporal perception, Computational Modeling

Chair:Pascal Mamassian(CNRS & Ecole Normale Supérieure Paris)

1:00 PM - 1:15 PM JST | 4:00 AM - 4:15 AM UTC

[O6-01]

Temporal Prediction through Integration of Multiple Probability Distributions of Event Timings

*Yiyuan Teresa Huang[1], Zenas C Chao[1] (1. International Research Center for Neurointelligence, The University of Tokyo (Japan))

1:15 PM - 1:30 PM JST | 4:15 AM - 4:30 AM UTC

[O6-02]

The anticipation of imminent events is time-scale invariant

*Matthias Grabenhorst[1,2], David Poeppel[3], Georgios Michalareas[4,1,2] (1. Ernst Struengmann Institute for Neuroscience (Germany), 2. Max Planck Institute for Empirical Aesthetics (Germany), 3. New York University (United States of America), 4. Goethe University (Germany))

1:30 PM - 1:45 PM JST | 4:30 AM - 4:45 AM UTC

[O6-03]

The timing of neural-cardio-respiratory network states predicts perception across the senses

*Andreas Wutz[1] (1. University of Salzburg (Austria))

1:45 PM - 2:00 PM JST | 4:45 AM - 5:00 AM UTC

[O6-04]

What does the Fröhlich effect tell us about sensation time?

*Pascal Mamassian[1] (1. CNRS & Ecole Normale Supérieure Paris (France))

2:00 PM - 2:15 PM JST | 5:00 AM - 5:15 AM UTC

[O6-05]

Oscillatory Entrainment in Non-Deterministic Continuous Environments, Independent of Bayesian Interval Learning: Computational and Behavioral Evidence

*Elmira Hosseini[1,2], Assaf Breska[1] (1. Max-Planck Institute for Biological Cybernetics (Germany), 2. Tübingen University (Germany))

2:15 PM - 2:30 PM JST | 5:15 AM - 5:30 AM UTC

[O6-06]

An investigation of auditory rhythms with a spiking neural network autoencoder

*Rodrigo Manríquez[1,2], Sonja A. Kotz[2,3], Andrea Ravignani[4,5], Bart de Boer[1] (1. Vrije Universiteit Brussel (Belgium), 2. Maastricht University (Netherlands), 3. Max Planck Institute for Human Cognitive and Brain Sciences (Germany), 4. Sapienza University of Rome (Italy), 5. Aarhus University & The Royal Academy of Music (Denmark))

Temporal Prediction through Integration of Multiple Probability Distributions of Event Timings

*Yiyuan Teresa Huang[1], Zenas C Chao[1]

1. International Research Center for Neurointelligence, The University of Tokyo

Our brain uses prior experience to anticipate the timing of upcoming events. This dynamical process can be modeled using a hazard function derived from the probability distribution of event timings. However, the contexts of an event can lead to various probability distributions for the same event, and it remains unclear how the brain integrates these distributions into a coherent temporal prediction. In this study, we create a foreperiod sequence paradigm consisting of a sequence of paired trials, where in each trial, participants respond to a target signal after a specified time interval (i.e. foreperiod) following a warning cue. The prediction of the target onset in the second trial can be based on the probability distribution of the second foreperiod and its conditional probability given the foreperiod in the first trial in the context of foreperiod sequence. These probability distributions are then transformed into hazard functions to represent the temporal predictions. The behavioral model incorporating both of the prediction and the contextual prediction significantly improves fit of reaction times to the target signal, indicating that both regularities of temporal information contribute to making predictions. We further show that electroencephalographic source signals are best reconstructed when integrating both predictions. Specifically, the prediction and the contextual predictions are separately encoded in the posterior and anterior brain regions, and to achieve synergy between both predictions, a third region—particularly the right posterior cingulate area—is needed. Our study reveals brain networks that integrate multilevel temporal information, providing a comprehensive view of hierarchical predictive coding of time.

Keywords: Temporal prediction, Multiple probability distributions, Hazard functions, Forward encoding analysis, EEG source

The anticipation of imminent events is time-scale invariant

*Matthias Grabenhorst[1,2], David Poeppel[3], Georgios Michalareas[4,1,2]

1. Ernst Struengmann Institute for Neuroscience, 2. Max Planck Institute for Empirical Aesthetics, 3. New York University, 4. Goethe University

Humans predict the timing of imminent events to generate fast and precise actions. Such temporal anticipation is critical over the range of hundreds of milliseconds to a few seconds. However, it was argued that timing mechanisms differ below and above a boundary at around 1–2 seconds in time perception and interval discrimination (Grondin, J Exp Psychol, 2012; Gibbon et al., Curr Opin Neurobiol, 1997) and duration discrimination (Rammsayer & Lima, Percept Psychophys, 1991; Rammsayer et al, Frontiers in Psychology, 2015) which may affect timing behavior in the anticipation of imminent events. Recent work showed that the brain models the probability density function of events across time, suggesting a canonical mechanism for temporal anticipation (Grabenhorst et al., Nat Commun, 2019 & 2025). Here we investigate whether this core computation remains stable across the described temporal boundaries when the distribution of events is stretched across different time spans. In a Set - Go task, the time between the two cues was randomly drawn from probability distributions which, across experimental blocks, were defined over different time spans. Participants were asked to react as fast as possible to the Go cues and generated > 52000 reaction times (RT). We found that, irrespective of the time span, anticipation, measured as RT, scales with the event distribution. This shows that the key computation –the estimation of event probability density –is invariant across temporal scales. We further found that the variance in anticipation is also scale invariant which contradicts Weber’s law. The results hold in vision and audition, suggesting that the core computations in anticipation are independent of sensory modality. These findings demonstrate that –independent of temporal scale –perceptual systems estimate probability over time to anticipate the timing of future events. We conclude that temporal anticipation, a basic function in cognition, is time-scale invariant.

Keywords: Temporal prediction, Probability estimation, Time estimation, Temporal cognition, Weber's law

The timing of neural-cardio-respiratory network states predicts perception across the senses

*Andreas Wutz[1]

1. University of Salzburg

For the past decades, neuroscience research has repeatedly highlighted the pivotal role of observer-dependent, internal network states predisposing sensory experiences in the external world. Nevertheless, many open questions remain: How are these internally generated processes implemented in the perceiver? How are they controlled and timed relative to each other and to sensory inputs? And, do they generalize across different sensory systems? In this talk, I present novel magneto-encephalography (MEG), cardiac and respiratory data that conclusively demonstrate top-down brain networks influencing perception across different sensory modalities and their relationships to ongoing dynamics in the body. On each trial, different visual, auditory or tactile stimuli were shown at individual perceptual thresholds, such that about half of the stimuli were consciously detected, while the other half were missed. The main findings show neural activity bursts occurring shortly before stimulus onset across frontal and posterior cortex in the brain’s dominant alpha-frequency band rhythm (8-13 HZ). The precise timing of these neural activity bursts is predictive of subsequent perceptual outcomes generalized across all three senses. Moreover, the neural activity bursts happen at specific phases of the participants’ cardiac cycle, suggesting a crucial role of pre-stimulus neural-cardio network timing for conscious perception. Because cardiac activity is strongly coupled to respiration, neural-cardio network interactions may be top-down controlled and timed by the participants’ breathing behavior. In line with this hypothesis, the participants strategically regulate their respiratory activity during the task both relative to stimulus onset and to neural burst onset. The participants’ breath out earlier for successfully detected vs. missed stimuli with respect to the onset of the activity bursts in the brain. Overall, our results reveal an interactive, multi-stage temporal processing cascade bridging both neural and bodily systems and preparing the perceiving organism for the optimally timed integration of conscious experiences.

Keywords: perception , oscillations, MEG, brain-body interactions

What does the Fröhlich effect tell us about sensation time?

*Pascal Mamassian[1]

1. CNRS & Ecole Normale Supérieure Paris

When an object suddenly appears and starts moving, its initial position is often mislocalized in its direction of motion. In 1923, Friedrich Fröhlich used this effect to measure the “sensation time”, i.e. the time between the impact of light on the retina and the corresponding visual sensation. He reasoned that sensation time can be directly inferred from the spatial bias, given the object speed. This reasoning has since been heavily criticised and new interpretations for the Fröhlich effect have been offered, in particular one based on a spatial prediction that extrapolates into the future to compensate for neural delays. Does this mean that the Fröhlich effect is useless to measure sensation time? We addressed this question by manipulating the duration of a moving object from 50 to 300ms. For the same observers in different experiments, we asked them to report the perceived spatial onset of a small moving disc, its perceived offset, its perceived duration, and its perceived speed. To control for possible eccentricity effects, the object rotated along a visible circle centered on the fixation point. This path was divided into two sectors of different colours, half was blue and the other half orange, and the colour boundaries defined reference marks that observed used to report their perceived onset or offset (e.g. “was stimulus onset in the blue or orange sector?”). Surprisingly, we found an “anti-Fröhlich” effect: the perceived spatial onset was before the start of the motion, at a location that the object never occupied. We also found that perceived speed was largely overestimated, and more so for shorter durations. Finally, we did not find any significant bias in perceived offset or perceived duration. Overall, these results are consistent with a global inference of perceived duration, speed, onset and offset locations, all at the same time at the end of the motion. We argue that this delay relative to the object appearance is informative about sensation time.

Keywords: sensation time, Fröhlich effect, motion perception, visual psychophysics

Affective modulation of temporal binding using linguistic stimuli

*Felipe Toro Hernández[1], Theresa Moraes Ramalho[2], André Mascioli Cravo[2], Peter M. E. Claessens[2]

1. Graduate Program in Neuroscience and Cognition, Federal University of ABC (UFABC), São Paulo, Brazil, 2. Center for Mathematics, Computing and Cognition, Federal University of ABC (UFABC), São Paulo, Brazil

Temporal binding (TB)—the perceived shortening of time between a cause (event A) and its effect (event B)—is often associated with voluntary action. This temporal compression is typically stronger when the action is self-generated, making TB a widely used implicit marker of the sense of agency (SoA). Whereas explicit measures of SoA are usually sensitive to outcome valence (positive outcomes yield higher agency ratings than negative ones), implicit measures such as TB have produced less consistent findings. We examined whether emotional valence influences TB using a two-alternative forced-choice (2AFC) interval discrimination task in three experiments, varying the predictability of outcome valence. Emotional words (e.g., "joy," "death," "chair") served as outcomes, categorized as positive, negative, or neutral. Relevant psycholinguistic variables were matched across valence groups using previous normatization studies for Brazilian Portuguese and two online surveys (N = 54). In Experiment 1 (N = 33), agency (active vs. passive) and word valence were fixed within blocks. In Experiment 2 (N = 40), valence was either fixed or varied across trials, depending on the block. Experiment 3 (N = 40) used only trial-wise variation in valence. Across all experiments, generalized linear mixed models (GLMMs) replicated the TB effect: active trials were perceived as more temporally compressed than passive ones. However, outcome valence did not interact with agency in any of the experiments, suggesting no affective modulation of TB. These findings suggest that emotional valence alone may not be sufficient to influence implicit measures of agency, such as TB. Future research should investigate additional factors and methodologies to gain a deeper understanding of how emotion, agency, and time perception interact.

Keywords: Temporal binding, Sense of Agency, temporal cognition, psychophysics, cognitive-affective neuroscience

An investigation of auditory rhythms with a spiking neural network autoencoder

*Rodrigo Manríquez[1,2], Sonja A. Kotz[2,3], Andrea Ravignani[4,5], Bart de Boer[1]

1. Vrije Universiteit Brussel, 2. Maastricht University, 3. Max Planck Institute for Human Cognitive and Brain Sciences, 4. Sapienza University of Rome, 5. Aarhus University & The Royal Academy of Music

Here, we present a biologically inspired spiking neural network, or SNN, framework that learns auditory rhythms from acoustic data by exploiting the exact spike timing of spikes. Although classic deep learning models have been applied to investigate temporal sequences, spiking NNs more accurately reflect the temporal dynamics of biological neural systems.

We first encoded acoustic waveforms containing rhythmic information into spike trains and considered a subcortical model of the peripheral auditory pathway [1.] This model reproduces cochlear transduction and auditory-nerve firing across characteristic frequencies, yielding parallel streams of precisely timed spikes that retain the temporal structure of the input. These spike trains were then used to train a purely spike-based autoencoder. In this framework, the encoder compresses input data into a latent representation, i.e. a simplified representation that captures underlying features of the data, while the decoder reconstructs the amplitude envelope of the original sound, preserving rhythmic features.

By training on isochronous sequences, where consecutive onsets were separated by identical intervals, we demonstrate that rhythmic structure is preserved in the latent space representation. Moreover, the network develops predictive behaviour, by anticipating subsequent beat onsets even in the absence of a beat. This sensitivity reflects a form of temporal expectation embedded in the SNN. To evaluate how the network internalises rhythmic structures, we tested it with sequences that missed beats and inspected the resulting latent representations. By analysing the spiking activity and internal variables within this hidden layer, we revealed how the model encodes temporal regularities and reconstructs the expected onset pattern, in a way that would not be possible in a non-spiking neural network.

1. Zuk, N., Carney, L., Lalor, E. 2018. Preferred Tempo and Low-Audio-Frequency Bias Emerge From Simulated Sub–cortical Processing of Sounds With a Musical Beat. *Front. Neurosci.*, *12*.

Keywords: Spiking Neural Networks, Auditory Processing, Rhythm Processing

Oral | Computational Modeling, Neural Mechanisms

Sat. Oct 18, 2025 9:00 AM - 10:30 AM JST | Sat. Oct 18, 2025 12:00 AM - 1:30 AM UTC Room 2(West B1)

[O5] Oral 5: Computational Modeling, Neural Mechanisms

Chair:Assaf Breska(Max-Planck Institute for Biological Cybernetics)

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

[O5-01]

Centralized mechanisms of explicit and implicit timing in the human cerebellum: a neuropsychological approach

*Chiara Zanonato[1,2], Richard Ivry[3,4], Assaf Breska[1,3] (1. Max-Planck-Institute for Biological Cybernetics, Tübingen (Germany), 2. University of Tübingen (Germany), 3. Department of Psychology, University of California, Berkeley, CA (United States of America), 4. Helen Willis Neuroscience Institute, University of California, Berkeley, CA (United States of America))

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

[O5-02]

Unique Effect of Entrainment on Perception? Context-Specific Temporal Prediction Mechanisms in Multiple Aspects of Perception

*Christina Bruckmann[1,2], Assaf Breska[1] (1. Max Planck Institute for Biological Cybernetics (Germany), 2. University of Tübingen (Germany))

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

[O5-03]

Rationalizing temporal decision making and the neural representation of time

*Marshall G Hussain Shuler[1,2] (1. Johns Hopkins (United States of America), 2. Kavli Neuroscience Discovery Institute (United States of America))

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

[O5-04]

A Methodology to Accelerate Our Information Processing Toward Revealing the Relation between Process Speed and Time Perception

*Oki Hasegawa[1], Shohei Hidaka[1] (1. Japan Advanced Institute of Science and Technology (Japan))

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

[O5-05]

Sensory Reliability Shapes Sequential Effects in Human Duration Perception

*Taku Otsuka[1,2], Joost de Jong[1,3], Wouter Kruijne[1], Hedderik van Rijn[1] (1. University of Groningen (Netherlands), 2. The University of Tokyo (Japan), 3. Université de Paris (France))

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

[O5-06]

Bach and Bayes: Prediction in Noisy Musical Sequences

*Akanksha Gupta[1], Alejandro Tabas[2,3] (1. INS, INSERM, Aix-Marseille University, Marseille (France), 2. Perceptual Inference Group, Basque Center on Cognition, Brain and Language, San Sebastian (Spain), 3. Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig (Germany))

Centralized mechanisms of explicit and implicit timing in the human cerebellum: a neuropsychological approach

*Chiara Zanonato[1,2], Richard Ivry[3,4], Assaf Breska[1,3]

1. Max-Planck-Institute for Biological Cybernetics, Tübingen, 2. University of Tübingen, 3. Department of Psychology, University of California, Berkeley, CA, 4. Helen Willis Neuroscience Institute, University of California, Berkeley, CA

Humans keep track of temporal intervals for various purposes, ranging from explicitly reporting perceived durations to implicitly orienting attention in time. Whether shared or segregated timing mechanisms subserve these timing processes is a key neuroscientific question. While neuroimaging studies revealed task-dependent functional dissociations, mostly at the cortical level, recent behavioral work hints at potential computational overlap. Moreover, separate lines of research have implicated the cerebellum in both explicit and implicit interval timing, but whether this reflects one shared or two task-specific cerebellar circuits is unknown. Here, we investigated how the cerebellum might act as a central timing circuit in implicit and explicit interval timing. Cerebellar Ataxia (CA) patients (N=18) and age-matched neurotypical controls (N=16) performed explicit (temporal discrimination) and implicit (cued temporal orienting for speeded detection) interval timing tasks, as well as a control task to account for non-temporal factors. Two intervals (S1, S2) were sequentially presented: S1 was either short (700ms) or long (1200ms), while S2 spanned between the short and long S1. CA patients' performance was impaired compared to healthy controls in both tasks, showing lower temporal sensitivity in temporal discrimination and smaller validity effect in temporal orienting, in line with previous studies. Critically, the performance in the two tasks was more strongly associated in the patient than the control group, with only the former showing a significant correlation, as predicted by a shared process model. Moreover, this was not explained by non-temporal factors. These findings establish the cerebellum as a central sub-second interval timing hub, causally involved in timing intervals independently of the final purpose.

Keywords: explicit timing, implicit timing, interval timing, cerebellum, cerebellar ataxia

Unique Effect of Entrainment on Perception? Context-Specific Temporal Prediction Mechanisms in Multiple Aspects of Perception

*Christina Bruckmann[1,2], Assaf Breska[1]

1. Max Planck Institute for Biological Cybernetics, 2. University of Tübingen

Temporal prediction and preparation are essential for adaptive behavior, and can be generated based on various temporal regularities, including rhythms and interval memory. In rhythmic streams temporal predictions are thought to uniquely rely on phase-aligning neural oscillations to the external rhythm. However, in motor tasks, previous studies found similar behavioral benefits and neural phase alignment patterns for rhythm- and interval-based temporal predictions, questioning the unique role of entrainment in these phenomena. Yet, if rhythmic entrainment acts at low-level sensory circuits, its unique effect might only be revealed under high perceptual load. Here we address this using a challenging perceptual discrimination task, in which visual target timing is either non-predictable, is on-beat with a preceding rhythm (~1.11 Hz), or matches a previously presented interval (900 ms). Examining the differential effect of temporal expectation on multiple levels of perception, we collect both objective classification accuracy and subjective visibility reports, a fundamental distinction in consciousness research that has been overlooked in the temporal attention literature. In line with previous findings, both interval- and rhythm-based temporal expectations improve performance compared to the irregular stream, but to a similar degree, which is inconsistent with the idea that rhythmic entrainment provides a unique perceptual benefit beyond temporal prediction. In EEG, we critically found similar increases in occipital delta phase alignment in the rhythm and interval conditions. This was not found in central channels, demonstrating the independence of sensory from high-level phase alignment. Taken together, these results show that phase alignment can occur in the absence of oscillatory entrainment and call into question whether rhythmic entrainment provides perceptual benefits beyond what would be expected by temporal prediction alone.

Keywords: temporal attention, rhythmic entrainment, interval, EEG, visual discrimination

Rationalizing temporal decision making and the neural representation of time

*Marshall G Hussain Shuler[1,2]

1. Johns Hopkins, 2. Kavli Neuroscience Discovery Institute

By what neural means do we represent the passage and structuring of time and decide how to spend time? How do these representations of value and time relate to evolutionary pressure to maximize reward accumulation? To address these questions, we evaluate whether the temporal difference reinforcement learning (TDRL) algorithm can rationalize temporal decision-making. First, we derive the *optimal solution* for reward accumulation and demonstrate that TDRL's value estimates—infinite sums of exponentially discounted future rewards—systematically deviate from this optimum. Then we show how TDRL, operating over a time state-space representation using regular intervals, fails to learn values that rationalize the curious pattern of decision-making errors exhibited by humans and animals. Our insight, however, is that this failure can be best mitigated by representing time using a time-dilating state-space, wherein the amount of time spent in a subsequent state increases by a precise proportion. TDRL applied to such a time-dilating state-space then learns values that rationalize the diverse suboptimalities observed over decades of investigating how animals and humans decide to spend time. Specifically, it affords optimal forgo behavior, minimizes a suboptimal bias toward sooner-smaller rewards in mutually exclusive choices, and leads to a suboptimal unwillingness to abandon engaged pursuits (sunk cost). In proposing PARSUIT theory (Pursuit-based Atomized Reinforcement of State-value Using Increasing Timesteps), we provide 1) a general, mechanistically descriptive explanation of temporal decision making, 2) a normative rationalization for why time takes the neural form that it does, and 3) advance TDRL as the learning algorithm used in temporal decision-making.

Keywords: Temporal Difference Reinforcement Learning, reward-rate maximization, dilating time state-space, temporal decision-making

A Methodology to Accelerate Our Information Processing Toward Revealing the Relation between Process Speed and Time Perception

*Oki Hasegawa[1], Shohei Hidaka[1]

1. Japan Advanced Institute of Science and Technology

The subjective experience of time slowing down during peak performance, or 'flow', suggests a link between cognitive processing speed and time perception. However, this relationship is not well understood due to the limitations of short-duration tasks, which are typically employed in psychological and neurological laboratory studies. This is a critical limitation, as the phenomena of interest typically emerge during continuous, sustained activities in the real world. Therefore, to properly test our central hypothesis—an extension of Treisman’ s internal clock model which posits that a high-arousal state accelerates an internal pacemaker to simultaneously improve information processing speed and extend subjective time —an experimental paradigm capable of inducing and continuously sustaining such a state is first necessary. Here, we present this paradigm, which involves an adaptive Tetris game designed to induce a flow-like state and enable a continuous study of the aforementioned link. The system uses a Markov process model to estimate players' abilities and adjust the task's difficulty in real time. To validate this approach, we first measured baseline performance in an ideal, untimed version of the task, confirming that player performance fell within the range predicted by our model. We then investigated the effect of three patterns of difficulty change —linear increase, linear decrease and random —on processing speed (lines cleared per minute). Although players achieved a similar maximum performance level at the end of the game in all conditions, performance improved most quickly under the linearly increasing difficulty condition. These results demonstrate that an adaptive challenge that continuously and predictably increases in response to a player's ability is a key factor for accelerating cognitive processing. At this conference, we will report on the preliminary performance evaluation of the developed task system.

Keywords: Flow State, Infomation Processing Speed

Sensory Reliability Shapes Sequential Effects in Human Duration Perception

*Taku Otsuka[1,2], Joost de Jong[1,3], Wouter Kruijne[1], Hedderik van Rijn[1]

1. University of Groningen, 2. The University of Tokyo, 3. Université de Paris

Perceived durations are biased towards immediately preceding percepts. Although such sequential effects in time perception have long been recognized, the Bayesian framework has recently emerged as a compelling account of these phenomena. Crucially, while the Bayesian framework posits that the magnitude of the sequential effect depends on the reliability of both the previous and current stimuli, empirical support for this prediction remains lacking. In order to test this central prediction of the Bayesian framework, we systematically manipulated the perceptual noise of to-be timed stimuli by embedding them in dynamic visual noise. We found that reproduced durations were biased towards the duration of the preceding stimulus, confirming the presence of a sequential effect. Importantly, the magnitude of this effect was modulated by the reliability of both the previous and current stimuli, in a manner consistent with Bayesian predictions. Furthermore, by fitting a Bayesian computational model that updated prior expectations on a trial-by-trial basis, we demonstrated that manipulating the uncertainty of the current sensory input (likelihood variance) enabled the model to capture the observed reliability-dependent modulation of the sequential effect. These findings provide direct empirical evidence for reliability-based integration in human duration judgements and highlight the sequential effect as an adaptive mechanism that dynamically adjusts to sensory uncertainty.

Keywords: sequential effect, Bayesian modeling, duration reproduction, sensory reliability

Bach and Bayes: Prediction in Noisy Musical Sequences

*Akanksha Gupta[1], Alejandro Tabas[2,3]

1. INS, INSERM, Aix-Marseille University, Marseille, 2. Perceptual Inference Group, Basque Center on Cognition, Brain and Language, San Sebastian, 3. Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig

Information from the external environment is often uncertain and ambiguous, posing a challenge for the brain to accurately infer the state of the world. According to the predictive processing framework, prior knowledge pertinent to inference is compressed into predictions about imminent future states. These predictions are combined with sensory inputs using Bayesian belief updating. While this approach is optimal for inferring latent states in certain stochastic systems, it may not be useful when applied to more complex systems such as music or language. In this work, we examine whether neural networks trained to infer the current latent state in a musical sequence also develop a capacity to predict what comes next.

To investigate this hypothesis, we utilized tokenized Bach compositions corrupted with noise as sensory inputs and gated recurrent neural networks (GRUs) to model neural circuits. The training procedure involved two stages: first, to infer the current token, and then, to optimize a linear readout for predictions of the next token to see if the predictions are encoded in the network's internal states. Furthermore, we benchmarked the network’s performance against an optimal Markovian model, which predicts the next token using only the current token. Our findings demonstrate that neural circuits fine-tuned for perceiving the current state can learn to predict future sensory input, suggesting that predictive capabilities emerge as a consequence of such optimization. This evidence strengthens the computational foundation of the predictive coding framework and offers insights into how biological systems may utilize prior knowledge to adaptively operate within uncertain environments.

Keywords: Predictive Processing, Bayesian Brain Hypothesis, Recurrent Neural Networks (RNNs), gated recurrent neural networks (GRUs)

Poster | Other

Sat. Oct 18, 2025 12:45 PM - 2:45 PM JST | Sat. Oct 18, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P2] Poster: Day 2

[P2-01]

Disentangling the effects of movement speed and travel distance on perceived traveled time

*Cindy Jagorska[1], Christopher Hilton[1], Martin Riemer[1] (1. Technical University Berlin (Germany))

[P2-02]

withdrawn

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[P2-03]

Impaired Temporal Perception Following Sight Restoration After Congenital Cataracts

*Abel Mewleddeg Legu[2], Gianluca Mariscano[1], David Melcher[1,4], Ehud Zohary[2,3] (1. Department of Psychology, New York University Abu Dhabi (United Arab Emirates), 2. Project Eyeopener (Ethiopia), 3. The Hebrew University of Jerusalem (Israel), 4. Center for Brain and Health, New York University Abu Dhabi (United Arab Emirates))

[P2-04]

Decoding the reproduction of durations in size-varying virtual environment

*Camille L. Grasso[1], Matthew Logie[1], Virginie van Wassenhove[1] (1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris-Saclay, Gif/Yvette, 91191 France (France))

[P2-05]

Ticking Forward or Counting Down: The Impact of Clock Format on Time Perception and Task Performance

Maria Nogales[1], *Judit Castellà[1] (1. Autonomous University of Barcelona UAB (Spain))

[P2-06]

Electrophysiological signatures of post-interval activity in explicit and implicit timing

*Mariagrazia Capizzi[1], Cristina Narganes Pineda[1], Pom Charras[3], Giovanna Mioni[2], Antonino Visalli[4] (1. Mind, Brain and Behavior Research Center (CIMCYC), University of Granada; Department of Experimental Psychology, University of Granada, Granada, Spain (Spain), 2. Department of General Psychology, University of Padua, Padua (Italy), 3. Univ Paul Valéry Montpellier 3, EPSYLON EA 4556, F34000, Montpellier, France (France), 4. Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia (Italy))

[P2-07]

Time in the primate hippocampus during a metronome task

*Mildred Salgado-Menez[1], Ana Maria Malagon[1], Victor de Lafuente[1] (1. Universidad Nacional Autonoma de Mexico (Mexico))

[P2-08]

Effects of simultaneity and arm posture on tactile time perception in young and older adults

*Chika Goto[1], Naoya Tachibana[1], Shogo Sugiyama, Yuko Yotsumoto[1] (1. the University of Tokyo (Japan))

[P2-09]

Hand proximity enhances visual encoding via anticipatory processing

*Ankit Maurya[1,3], Tsukasa Kimura[2,3], Minto Hashimoto[4,3], Masamichi J. Hayashi[3,4], Tony Thomas[1] (1. Department of Humanities and Social Sciences, Indian Institute of Technology Roorkee, Roorkee (India), 2. Graduate School of Human Sciences, The University of Osaka, Suita (Japan), 3. Center for Information and Neural Networks (CiNeT), Advanced ICT Research Institute, National Institute of Information and Communications Technology, Suita (Japan), 4. Graduate School of Frontier Biosciences, The University of Osaka, Suita (Japan))

[P2-10]

Role of Supplementary Motor Areas in temporal estimation using tDCS.

*Claire TERRAN[1], Laurence CASINI[1] (1. CRPN - Centre for Research in Psychology and Neuroscience, AMU, CRNS (France))

[P2-11]

Duration Underestimation in Peripheral Visual Field

*YUHUI ZHOU[1], Sae Kaneko[1] (1. Hokkaido University (Japan))

[P2-12]

Embodying the expanded moment: the role of bodily awareness in temporal production during meditation-like attentional states

*Ludovica Ortame[1,2], Michele Pellegrino[2], Joseph Glicksohn[3,4], Patrizio Paoletti[2], Fabio Marson[5], Stafno Lasaponara[1,6], Maria Sofia Romano[1], Fabrizio Doricchi[1,6], Filippo Carducci[1], Tal Dotan Ben-Soussan[2] (1. Sapienza University of Rome (Italy), 2. Research Institute of Neuroscience, Education and Didactics (RINED) (Italy), 3. Bar-Ilan University (Israel), 4. The Leslie and Susan Gonda (Goldschmied) Multidisciplinary Brain Research Center, Bar-Ilan University, Ramat Gan (Israel), 5. University of Milano-Bicocca (Italy), 6. RCCS Fondazione Santa Lucia (Italy))

[P2-13]

Temporal unfolding contributes to interocular comparison for motion-in-depth perception in peripheral vision

*Ikuya Murakami[1] (1. The University of Tokyo (Japan))

[P2-14]

Assessing Temporal Resolution in Amblyopic and Fellow Eyes Using the Two-Flash Fusion Paradigm

*Aysha Hamkari[1], Gianluca Marsicano[1], Katja Cundric[1], David Melcher[1] (1. New York University Abu Dhabi (United Arab Emirates))

[P2-15]

Neural Bases of the Audiovisual Temporal Binding Window Using TMS

*Solène Leblond[1], Tutea Atger[1], Franck-Emmanuel Roux[1,2], Robin Baurès[1], Céline Cappe[1] (1. CerCo (Centre de Recherche Cerveau et Cognition), CNRS UMR 5549, University Toulouse (France), 2. Pôle neurochirurgie, CHU Purpan, Toulouse (France))

[P2-16]

Temporal Binding Across Timing Domains: Behavioural Evidence and a Protocol for Causal Manipulation via Transcranial Direct Current Stimulation

*Gustavo Brito de Azevedo[1], André Mascioli Cravo[2] (1. Graduate Program in Neuroscience and Cognition, Federal University of ABC (UFABC) (Brazil), 2. Center for Mathematics, Computing and Cognition, Federal University of ABC (UFABC) (Brazil))

[P2-17]

Modality-Specific Temporal Assimilation in a Bisection Task

*Gabriel Cafeu Brandão[1], Gustavo Brito de Azevedo[1], Peter Maurice Erna Claessens[1], André Mascioli Cravo[1] (1. Center for Mathematics, Computing and Cognition, Federal University of ABC (UFABC) (Brazil))

[P2-18]

Serial dependence between duration and numerosity perception

*Takuma Hashimoto[1,2], Yuko Yotsumoto[1] (1. The University of Tokyo (Japan), 2. Research Fellow of Japan Society for the Promotion of Science (Japan))

[P2-19]

Effects of attentional orienting on the production of temporal durations: an eye-tracking study

*Mariagrazia Ranzini[1], Sebastiano Cinetto[3], Sara Noacco[1], Zaira Romeo[2], Mario Bonato[4], Marco Zorzi[4], Giovanna Mioni[1] (1. Department of General Psychology (DPG), Univ. of Padova (Italy), 2. Neuroscience Institute, National Research Council, Padova (Italy), 3. Padova Neuroscience Center (PNC), Univ. of Padova (Italy), 4. Department of General Psychology (DPG) and Padova Neuroscience Center (PNC), Univ. of Padova (Italy))

[P2-20]

Retrospective Passage of Time Judgments in a Population of Parkinson’s Disease Patients: A Matter of Self-Projection in Time

*Florie MONIER[1], Michael DAMBRUN[1], Pierre-Michel LLORCA[2], Sylvie DROIT-VOLET[1] (1. Université Clermont-Auvergne (France), 2. Université Clermont-Auvergne, CHU clermont-ferrand (France))

[P2-21]

Cardiac Rhythms, Interoception and Temporal Counting: Dynamic Interactions across Time Ranges

*Mai Sakuragi[1,2], Elisa M. Gallego Hiroyasu[1,2], Satoshi Umeda[1] (1. Keio University (Japan), 2. Japan Society for the Promotion of Science (Japan))

[P2-22]

When do we perceive our heartbeats? Exploring temporal dynamics in interoception

*Yusuke Haruki[1], Keisuke Suzuki[2], Yuri Terasawa[3], Kenji Ogawa[4], Olaf Blanke[5], Yuko Yotsumoto[1] (1. Department of Life Sciences, The University of Tokyo (Japan), 2. Center for Human Intelligence, Artificial Intelligence, and Neuroscience, Hokkaido University (Japan), 3. Department of Psychology, Keio University (Japan), 4. Department of Psychology, Hokkaido University (Japan), 5. Laboratory of Cognitive Neuroscience, Ecole Polytechnique Federal de Lausanne (Switzerland))

[P2-23]

Distributional Variability Increases Uncertainty in Mean Duration Judgments

*Taku Otsuka[1,2], Hakan Karsilar[1], Hedderik van Rijn[1] (1. University of Groningen (Netherlands), 2. The University of Tokyo (Japan))

[P2-24]

Image Memorability Shapes 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))

[P2-25]

Effects of Network Topology and Goals on Interpersonal Synchronization in a Virtual ‘Rhythm Network’

*Jonathan Kirsh[1], Sharanya Badalera[1], John Rehner Iversen[1] (1. McMaster University (Canada))

[P2-26]

EEG Correlates of Movement-Induced Enhancements of Beat Timing

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

[P2-27]

The effect of repetitive transcranial magnetic stimulation (rTMS) over the supplementary motor area on the groove experience

*Takahide Etani[1,2,3], Mitsuaki Takemi[4,5], Tomohiro Samma[6], Jun Nitta[7], Saki Homma[6,8], Kenta Ueda[6], Keigo Yoshida[9,6], Kenjun Hayashida[4,5], Tatsuro Fujimaki[4], Sotaro Kondoh[6,9,10], Kazutoshi Kudo[7], Shinya Fujii[9] (1. Keio Research Institute at SFC (Japan), 2. Keio Univ. Hospital (Japan), 3. Japanese Red Cross Ashikaga Hospital (Japan), 4. Graduate School of Science and Technology, Keio Univ. (Japan), 5. Graduate School of Advanced Science and Engineering, Hiroshima Univ. (Japan), 6. Graduate School of Media and Governance, Keio Univ. (Japan), 7. Graduate School of Arts and Sciences, The Univ. of Tokyo (Japan), 8. Department of Neuropsychiatry, Keio Univ. School of Medicine (Japan), 9. Faculty of Environment and Information Studies, Keio Univ. (Japan), 10. Japan Society for the Promotion of Science (Japan))

[P2-28]

Timing Difficulties in Developmental Language Disorder and Stuttering: A planned study on the Role of Dysfunctional Synchronization of Brain Rhythms

*Christian A. Kell[1], Lars Meyer[2], Joachim Gross[2], Katrin Neumann[2] (1. Goethe University (Germany), 2. Muenster University (Germany))

[P2-29]

Contributions of cognitive abilities and attention to Motor Timing in Parkinson’s Disease

*Elisa M. Gallego Hiroyasu[1], Yuko Yotsumoto[2], Giovanna Mioni[3] (1. Keio University (Japan), 2. The University of Tokyo (Japan), 3. Universita di Padova (Italy))

[P2-30]

Exploring the role of rhythmicity for infant word learning by entrainment of brain and behaviour in social contexts: A preliminary study

*Erica Flaten[1], Cristina Conati[2], Janet Werker[1] (1. Department of Psychology, University of British Columbia (Canada), 2. Department of Computer Science, University of British Columbia (Canada))

[P2-31]

Pre-motor and auditory processing for inner and overt speech

*Lachlan James Hall[1], Thomas J Whitford[2], Mike E Le Pelley[2], Bradley N Jack[1] (1. Australian National University (Australia), 2. University of New South Wales (Australia))

[P2-32]

Neural correlates of changes of mind and confidence in the judgement of elapsed time

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

[P2-33]

Metacognition of Time Discrimination

*Valdas Noreika[1], Stefano Arlaud[1] (1. Queen Mary University of London (UK))

[P2-34]

Timing Control of Upper Body Movements in Playground Swing Pumping: The Role of External Forces

*Chiaki Hirata[1], Shun'ichi Kitahara[1] (1. Jumonji University (Japan))

[P2-35]

Social modulation of sense of responsibility and subjective time experience in semi-automated motor tasks

*Sayako Ueda[1,2] (1. Japan Women's University (Japan), 2. RIKEN CBS (Japan))

[P2-36]

When Time Stands Still: Altered spatiotemporal experiences in depersonalization

*Julia Ayache[1], Malika Auvray[2], Anna Ciaunica[3,4] (1. EuroMov Digital Health in Motion, Univ. Montpellier IMT Mines Alès, Montpellier (France), 2. Institut des Systèmes Intelligents et de Robotique, Sorbonne Université, CNRS, Paris (France), 3. GAIPS INESC-ID, Instituto Superior Tecnico, University of Lisbon, Lisbon (Portugal), 4. Institute of Cognitive Neuroscience, University College London, London (UK))

[P2-37]

Recalibrating perceptual time through motor learning

*Nicola Binetti[1], Federico Mancinelli[3], Marco Zanon[2], Domenica Bueti[2] (1. Università degli studi di Roma Tor Vergata (Italy), 2. International School for Advanced Studies (Italy), 3. University of Bonn (Germany))

[P2-38]

Beyond Pacemaker Speed: A Planned Investigation into Atemporal Perceptual Processes Underlying Differences in Auditory-Visual Duration Judgments

*Valtteri Arstila[1], Jarno Tuominen[1] (1. University of Turku (Finland))

[P2-39]

Influence of turn-taking regularity on respiratory activity in human conversation

*Mirei Kin and Hiroki Koda (Graduate School of Arts and Sciences, The University of Tokyo)

[P2-40]

Female gibbons’ great calls change tempo in the presence of their offspring

*Yoichi Inoue[1], Waidi Sinun[2], Kazuo Okanoya[1] ([1]Teikyo University, [2]Research and Development Division, Yayasan Sabah Group)

Disentangling the effects of movement speed and travel distance on perceived traveled time

*Cindy Jagorska[1], Christopher Hilton[1], Martin Riemer[1]

1. Technical University Berlin

Perceived travel time is influenced by both the distance traveled and the speed of movement. While greater distances are typically associated with longer perceived travel time, higher movement speeds have been found to be associated with compressed time perception. Because distance, speed, and time are inherently interdependent, isolating their individual effects on perceived travel time remains a challenge.To investigate these effects, we are conducting a pre-registered experiment in which participants move through a virtual environment under varying combinations of travel distance and movement speed. After each movement, participants receive feedback about the distance they have traveled, presented via a landmark placed at one of three locations: closer than the actual distance (indicating a shorter distance), at the correct location, or farther than the actual distance (indicating a longer distance). This manipulation allows us to disentangle perceived distance from actual movement speed, while keeping travel time constant. Participants are then asked to reproduce the time of the movement based on their subjective experience.We expect that, when feedback about traveled distance is held constant while movement speed is changing, increased movement speed will lead to shorter reproduced travel time, highlighting the negative association between movement speed and perceived travel time. Conversely, when speed is held constant, but the landmark suggests a longer traveled distance, participants are expected to report longer perceived travel times, highlighting the positive association between travel distance and perceived travel time. The results of the experiment will contribute to understanding how movement speed and traveled distance respectively influence the perception of travel time.

Keywords: space-time interference, travel time, virtual reality

Does Semantic Modulation Induce Time Dilation? The Role of Flicker Frequency and Visual Saliency

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Flicker-Induced Time Dilation (FITD) describes the phenomenon where the perceived duration of a stimulus is overestimated due to its flickering nature. Recent findings suggest that semantic content might also play a role in modulating perceived time. This study aimed to explore the contribution of ventral visual pathway activation to FITD. To this end, we utilized a variety of flickering stimuli whose frequencies were systematically modulated. Alongside scrutinizing the impact of semantic information, flicker frequency was parametrically manipulated to examine the interplay between stimulus saliency and the perception of time. The Semantic Wavelet-Induced Frequency Tagging (SWIFT) technique was employed to generate scrambled and semantic flicker stimuli. A critical aspect of these stimuli was the preservation of low-level visual characteristics across all frames for both flicker types. In the first experiment, standard stimuli comprised scrambled and semantic flickers presented at 2, 4, and 6 Hz. While both categories of flickers were designed to evoke minimal responses in early visual processing areas, the semantic variants were specifically intended to preferentially engage higher-level regions within the ventral visual pathway. The second experiment introduced luminance-based flickers (scramble/semantic) at identical frequencies to ensure robust activation of low-level visual regions. A consistent and strong influence of flicker frequency on perceived duration was evident across both experimental setups, a conclusion supported by inclusion Bayes factors of $BF_{incl} = 14.04$ in Experiment I and > 1000 in Experiment II, indicating strong to extreme evidence. In contrast, the type of stimulus (scramble/semantic) provided only anecdotal support for any discernible effect. These observations imply that higher rates of flicker reliably result in a greater degree of time dilation, whereas the semantic nature of the stimuli appears to have a minimal effect. The observed increase in time dilation as a function of frequency was notably amplified when early visual cortices were more intensely engaged. Future investigations will focus on elucidating the connection between subjective saliency and time dilation by behaviorally assessing the perceived salience of each type of flicker stimulus.

Keywords: time dilation, semantic flicker, SWIFT, saliency

Impaired Temporal Perception Following Sight Restoration After Congenital Cataracts

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Temporal integration is essential for understanding rapidly changing visual information, enabling us to perform visual functions such as motion perception and causal inference. While spatial aspects of visual recovery following sight restoration are well documented, far less is known about how temporal integration develops. Notably, individuals with a history of congenital cataracts often show reduced alpha activity, which has previously been linked to the resolution of temporal perception over short intervals (50- 100ms). We investigated temporal integration in 6 participants with congenital cataracts who had undergone cataract surgery, using both a two-flash fusion and a causality perception task. The first task involves judging between one or two flashes at varying inter-stimulus intervals (ISIs). Our results show that only one participant performed the task with a typical pattern, while the other 5 showed temporal integration thresholds that were over 3 times longer than what is typically reported in normally sighted individuals to see two distinct flashes. The second task involves judging whether one moving object caused the movement of another at varying temporal lags. While longer time lags typically result in reduced perception of causality, 5 out of 6 participants showed no systematic differences in causality perception at different time lags. Together, these findings suggest a potential critical window for the development of temporal integration mechanisms, with potential knock-on effects for higher-level temporal perception tasks like causality, and are consistent with previous electrophysiological studies showing reduced alpha activity for patients with bilateral congenital cataracts even following sight restoration.

Keywords: Temporal integration, Causality perception, Two-flash fusion, Congenital cataracts, Sight restoration

Decoding the reproduction of durations in size-varying virtual environment

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When and how is duration encoded in the brain? In this EEG study, we investigated the cognitive and neural correlates of environmental constraints and production of durations. Previous works revealed that participants over-produce durations when immersed in larger virtual environments, relative to smaller ones (e.g., Delong et al., 1981; Ma et al., 2024; Riemer et al., 2018). A proposed explanation for these findings, derived from the action constraint theory, which suggests that larger environments involve longer possible movements (and consequently, more time). However, this working hypothesis remains untested, and the underlying cognitive and neural mechanisms unknown. To test this , we manipulated environmental constraints in virtual reality (i.e., room size, ceiling height) and combined behavioral measures of duration production (relative production time and error) with EEG recordings and multivariate pattern analyses (decoding). Behavioral results replicate and extend previous ones: participants produced longer durations in large environments, relative to smaller ones. Decoding analyses showed that it is possible to decode both the produced duration and the size of the environment, as early as the first button press. These results suggest that the effect of environmental constraints occurs at the early stages of duration production. This study provides a deeper understanding of how environmental constraints influence temporal cognition.

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Keywords: Temporal production, Decoding, Virtual environment , Environmental constraints, EEG

Ticking Forward or Counting Down: The Impact of Clock Format on Time Perception and Task Performance

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The influence of time pressure on time perception and performance has been widely studied; however, no research to date has compared forward-counting clocks with countdown clocks. These two formats are believed to evoke different emotional connotations that may influence the intensity of perceived time pressure and its effects. This study aimed to examine how these clock formats impact performance on a mathematical task, as well as the perception of time duration and speed. A quasi-experimental within-subjects design with counterbalancing was employed with 26 university students, who were asked to solve multiplications of three-digit by two-digit numbers under both clock conditions. Results showed that performance and motivation were significantly higher in the forward-counting condition. While no significant differences in time perception were found between conditions, participants reported a greater sense of time acceleration and a shorter perceived duration with the forward-counting clock. These findings suggest that the forward-counting format may be associated with more positive emotional connotations and lower perceived time pressure, ultimately enhancing task performance.

Keywords: Time pressure, Countdown, Forward-counting, Performance, Time perception

Electrophysiological signatures of post-interval activity in explicit and implicit timing

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The distinction between explicit and implicit timing in the processing of millisecond-to-second intervals is gaining attention in timing research. Explicit timing involves the deliberate estimation of time in tasks that require overt temporal judgments, whereas implicit timing occurs incidentally in tasks where time is not the primary focus, yet temporal processing still influences behavior. Whether explicit and implicit timing rely on shared or distinct neural mechanisms remains an open question. In the present study, we addressed this issue by directly comparing explicit and implicit timing tasks, paired with electrophysiological (EEG) recording. In the explicit timing task, participants judged whether a comparison interval was shorter or longer than a standard interval. In the implicit timing task, participants judged whether a comparison color was more reddish or yellowish than a standard color. Durations and colors were fully orthogonalised across the two tasks, ensuring that the only difference lay in the task instructions, which directed attention either to duration or to color. Event-related potentials (ERPs) were time-locked to the offset of the comparison intervals, either attended or unattended depending on the task. Behaviorally, we found that the color dimension was irrelevant for the temporal discrimination task. In contrast, the implicit temporal manipulation influenced color perception, with shorter durations leading participants to perceive colors as brighter. EEG results showed that temporal processing modulated early components over central scalp electrodes in a similar manner across both explicit and implicit tasks. In contrast, a sustained activity pattern with a frontal-posterior bipolar distribution emerged, indicating differential engagement depending on task demands. Overall, our results suggest that explicit and implicit timing shape behavior via both shared and distinct neural mechanisms.

Keywords: Time discrimination, Explicit processing, Implicit processing, ERPs

Time in the primate hippocampus during a metronome task

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We addressed how interval time is encoded in the non-human primate hippocampus. Are time-encoding hippocampal signals susceptible to contextual changes? And if they are, how are these signals dynamically adapted? (visual vs. non-visual). At the single cell level, we describe mixed selectivity to different task features, followed by a population analysis using PCA, where we report the geometry of abstract information representation in the hippocampus that accurately reflected the diverse tuning properties of individual cells that differed between visual and non-visual epochs of the task. We observed oscillatory activity at individual and population levels at the non-visual epoch of the timing task. The fact that some drift of the temporal and spatial information was being represented without any relevant visual input proves that this short-term memory function operates without the regular input that provides the reference position for a spatial view. These findings are evidence for the operation of an attractor that influences the activity of hippocampal pyramidal cells.

Keywords: hippocampus, visual task, interval timing, neural dynamics

Effects of simultaneity and arm posture on tactile time perception in young and older adults

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While age-related decline in basic sensory processing is well documented, its effects on higher-order tactile functions remain unclear. In particular, how aging affects tactile frequency discrimination has received limited attention. Prior research reported that frequency discrimination becomes more difficult when tactile stimuli are presented simultaneously (Kuroki et al., 2017), but the role of stimulus simultaneity in age-related decline has not been systematically examined.To address this gap, we conducted a vibrotactile frequency discrimination task with ten young adults (age range = 19–22; Mean = 19.0; SD = 1.29) and 30 older individuals (age range = 65–83; Mean = 74.0; SD = 3.93). Stimuli were presented either simultaneously or sequentially (with a 200 ms interval). Given that arm crossing could modulate task difficulty, experiments were conducted under both crossed and uncrossed arm conditions.Results showed a significant age-related decline in frequency discrimination performance, particularly during simultaneous presentation ($BF_{inclusion}$ = 3.452; $F(1, 28) = 27.25$, $p < .01$), suggesting difficulty in suppressing competing tactile information presented in close temporal proximity. Additionally, older adults exhibited a stronger arm-crossing effect ($BF_{inclusion}$ = 2.854; $F(1, 38) = 5.455$, $p < .02$), indicating increased vulnerability to interference from task-irrelevant spatial information. These findings highlight the impact of aging on higher-order tactile and spatial processing, potentially linked to declining inhibitory function in the secondary somatosensory cortex.

Keywords: frequency discrimination, vibrotactile perception, arm-crossing, aging, simultaneity

Hand proximity enhances visual encoding via anticipatory processing

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Precise encoding of physical properties of objects is essential for efficient reaching, grasping, and manipulating. Previous psychophysical studies have reported that perceived duration expands when a visual stimulus is presented near the hand (peri-hand space), suggesting the involvement of anticipatory mechanisms associated with peri-hand space. However, the neural evidence for anticipatory processing associated with peri-hand space remains scarce. In humans, contingent negative variation (CNV), a slow negative deflection in electroencephalography (EEG), has been proposed as a neural signature of anticipatory processing. Therefore, we hypothesized that the appearance of objects in peri-hand space modulates CNV, facilitating accurate encoding of the object’s properties. To test this hypothesis, we recorded EEG while participants performed a visual temporal bisection task (n = 40). Participants judged whether stimulus durations, ranging from 50 to 170 ms, were closer to which of the two reference intervals, Short’ (50 ms) or ‘Long’ (170 ms), that they acquired prior to the EEG recording. The distance between hands and the visual stimulus was manipulated by placing participant’s hands either on the sides of a monitor (Hand condition) or on their lap (No-hand condition), allowing the stimuli to appear inside or outside the graspable space. The results showed that the CNV amplitude building up toward the appearance of the visual stimulus was significantly larger in the Hand condition than in the No-hand condition. Moreover, although there was no significant difference in behavioral performance between the two conditions, participants who exhibited greater CNV amplitude demonstrated higher sensitivity in the bisection task in the Hand condition. These findings suggest that placing the hands near an object enhances anticipatory processing, which may facilitate the precise encoding of stimuli for efficient reaching, grasping, and manipulating.

Keywords: Temporal anticipation, Time perception, Near-hand space , Contingent Negative Variation

Role of Supplementary Motor Areas in temporal estimation using tDCS.

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Time is a fundamental aspect of life, orchestrating a wide array of behaviours in our daily activities. Multiple models explaining the mechanisms of temporal estimation coexist, attributing this function to different neural structures. A key distinction is often made between sub-second and supra-second intervals: durations under one second are thought to be prosessed primarly via a cortico-thalamo-cerebellar network, while longer intervals are believed to rely on a cortico-thalamo-striatal circuit. However, evidence also suggests the possibility of shared mechanisms across these time scales. We chose to anchor this study within the internal clock model, more specifically the pacemaker-accumulator framework, to investigate: (1) whether the supplementary motor areas (SMA) could serve as a substrate for the accumulation process and, (2) whether judgments of both short and long durations rely on an accumulation process. Using transcranial Direct Current Stimulation (tDCS), we modulated the activity of the SMA and subsequently assessed its role on temporal estimation using a temporal bisection task. Participants’ performance provided insights into two key parameters of temporal estimation: precision and variability. Preliminary results reveal that SMA modulation affects temporal estimation differently depending on the duration range. Specifically, tDCS significantly impacted the variability of long-duration judgments, whereas it affected the accuracy of estimations in the short-duration range. Interpreted within the pacemaker-accumulator model, these findings support the hypothesis that the SMA may act as the neurobiological substrate for the accumulation process, one of the internal clock’s critical components. Overall, this study enhances our understanding of the neural mechanisms underlying temporal estimation and highlights the pivotal role of the SMA in the estimation of both short and long durations.

Keywords: Timing, tDCS, SMA, Duration range, Bisection task

Duration Underestimation in Peripheral Visual Field

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In recent years, there has been an increasing number of studies discussing the fundamental differences in perception between central and peripheral visual fields (form, color, and texture) (Baldwin et al., 2019; Cohen et al., 2020; Cohen et al., 2021). However, the results of prior studies on differences in time perception are contradictory (Long & Beaton, 1981; Kliegl & Huckauf, 2014; Bao et al., 2024). This study examines the differences in duration perception between the central and peripheral visual fields using static Gabors. In the experiment, two Gabor patches (10˚ of diameters, spatial frequency: 5cpd, 100 % contrast, with a randomized phase) were presented sequentially at two locations: the peripheral (10, 30, 50, 70˚) and central (0˚) visual field. Two standard stimulus durations (67/250ms) were consistently presented in the periphery, while the duration of the central Gabor was varied at nine steps. Participants were instructed to select which Gabor lasted longer. The results indicated that underestimation of duration occurred in the peripheral visual field. However, no significant differences in duration perception were observed between 10˚ and 70˚ for either standard duration. The fact that no significant differences in time perception were found in the 10 to 70˚ may suggest that time perception is relatively stable across different eccentricities, from the central to the periphery. This indicates that time perception may depend on a higher level of visual information processing stage.

Keywords: Time Perception, Central Visual Field, Peripheral Visual Field

Embodying the expanded moment: the role of bodily awareness in temporal production during meditation-like attentional states

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In a world going at an increasingly faster pace, leading to higher attentional demands, there is a growing need to understand how attentional states influence time perception and how one can achieve a more self-regulated experience of time. The literature that suggests that meditation affect subjective time shows conflicting results (Morin & Grondin, 2024). This could be due to the challenge of investigating temporal tasks during meditation without interfering with the practice itself. In the current study we therefore examined temporal productions (TP) tasks during meditation-like attentional states. This study is, to our knowledge, the first to assess time perception during attentional states associated with contemplative practices without requiring actual meditation. Drawing on the Sphere Model of Consciousness (Paoletti & Ben-Soussan, 2019) and the hierarchy of meditation types (Laukkonen & Slagter, 2021), we hypothesized a gradual slowing down of TP across three conditions: (1) a simple TP; (2) focused attention on an external visual stimulus; and (3) longest TP in the stronger bodily condition. Participants (n=43) underwent the three conditions requiring to perform a TP task while a bistable figure (BF) appeared on the screen. During the (1) simple condition participants completed the TP task while just looking at the figure; (2) focused attention condition, they were additionally asked to focus on one feature of BF; (3) focused attention and monitoring condition, participants were divided into two groups based on additional requests: namely to furtherly focus on either their own breath or on rhythmic sounds. Results revealed progressively longer produced durations from the simple to more embodied condition, with stronger effects in breath group. These results highlight the role of bodily awareness when assessing TP, and suggest that more embodied states are associated with a slowing down of subjective time.

Keywords: Time, Attention, Awareness, Meditation, Interoception

Temporal unfolding contributes to interocular comparison for motion-in-depth perception in peripheral vision

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Time has often been considered as a confounder in stereoscopic depth perception. For example, the Pulfrich effect tells us that when one eye somehow requires longer latency, the visual system is ignorant of the actual cause of lags and ascribe them to spatial lags between eyes, hence fake binocular horizontal disparities producing illusory depths. However, recent studies have suggested that dynamic depth cues may help construct motion-in-depth perception. Due to their subtle efficacy and other geometrical constraints, most studies have been conducted around the fovea, and little is known about the characteristics in the periphery, where changing disparity over time (CDOT) may help construct dynamic scenes, but effects of another dynamic depth cue, interocular velocity difference (IOVD), are unknown. We aimed to examine whether motion-in-depth perception in peripheral vision is possible solely from the IOVD when fine grating patterns move oppositely between eyes. Gratings were chosen because they were compatible with a unitary grating object moving in depth in a real scene. Importantly, the spatial frequency of the gratings was set sufficiently high to maintain the maximally attainable disparity still below depth detection threshold at the tested eccentricity, making the CDOT useless. These gratings moved either leftward or rightward at a constant speed, forming four conditions that were consistent with four different motion percepts: receding, approaching, leftward, and rightward. Observers were asked to indicate perceived motion by three alternative forced response: receding, traversing, and approaching. If the grating in one eye tended to mask the grating in the other eye, the traversing responses would be a great majority irrespective of the conditions. Contrary to this prediction, the results indicated that observers well discriminated the conditions of non-zero IOVDs from the conditions of traversing, suggesting interocular comparison. Even though none of the component frames produce depth, their animation over time does.

Keywords: Motion in depth

Assessing Temporal Resolution in Amblyopic and Fellow Eyes Using the Two-Flash Fusion Paradigm

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Amblyopia, traditionally viewed as a monocular visual disorder, is increasingly understood as a neurodevelopmental condition that affects cortical-level visual processing. While its effects on spatial vision are well-documented, less is known about how amblyopia may disrupt temporal integration - the brain’s ability to combine information over time into coherent percepts. This study investigates temporal integration in patients with amblyopia by using the two-flash fusion (2FF) task, which varies the interstimulus interval required to perceive two flashes as distinct. We hypothesize that the amblyopic eye will exhibit higher 2FF thresholds compared to the non-amblyopic eye, indicating impaired temporal resolution. As part of this ongoing study, four amblyopic participants with corrected-to-normal vision have so far completed psychophysical testing under binocular and two counterbalanced monocular conditions using eye patching. Preliminary results suggest that in some cases, the amblyopic eye exhibits higher 2FF thresholds compared to the non-amblyopic eye, indicating potential delays in temporal resolution and hence longer integration window for the amblyopic eye. However, other participants show relatively similar thresholds across both eyes, pointing to individual variability. There are also preliminary indications of asymmetries in performance across visual fields. We also implemented a staircase procedure to estimate personalized thresholds for the amblyopic eye and tailor ISI ranges for subsequent testing.These early findings suggest that temporal integration deficits in amblyopia may vary across individuals, potentially reflecting different degrees of cortical adaptation. Ongoing recruitment and psychometric modeling will help clarify underlying neural mechanisms. This work may contribute to the identification of non-invasive perceptual biomarkers to aid early detection and intervention in amblyopia.

Keywords: amblyopia, temporal integration, visual perception, psychophysics

Neural Bases of the Audiovisual Temporal Binding Window Using TMS

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The temporal law, one of the main principles of multisensory integration (Stein & Meredith, 1993) stipulates that two stimuli from two distinct modalities must occur synchronously to be perceived as part of the same event. The temporal binding window (TBW) corresponds to the time interval within which auditory and visual stimuli are perceived as synchronous. Although the brain regions involved in audiovisual TBW have been identified, such as the superior temporal gyrus (STG), prefrontal cortex, and primary sensory areas (Zhou et al., 2020), most studies relied on correlational methods (Vaidya et al., 2019). Zmigrod & Zmigrod (2015) used tDCS to establish a causal link between the right posterior parietal cortex (rPPC) and TBW plasticity.
Our study aims to confirm the involvement of the STG and the intraparietal sulcus (IPS) in TBW using transcranial magnetic stimulation (TMS) guided by anatomical MRI. By applying single-pulse TMS at different time delay after stimulus presentation, we are also able to investigate the temporal dynamics of the neural processes underlying the TBW. Participants performed a simultaneity judgment task in which they were asked to determine whether two stimuli, one visual and one auditory, were synchronous. Single-pulse TMS was applied with six delays ranging from 50 to 300 ms post visual stimulus, over the IPS, STG, or vertex (control site).
Our results showed a temporal dynamics different involvement of the IPS and STG. First, the right STG is involved as early as 100ms. This is followed by the involvement of the left IPS (150 ms) and then a later the one of right and left STG (250 ms).
Our results partially confirm those of Zmigrod and Zmigrod (2015) by showing IPS involvement, though only in the left hemisphere at 150 ms post stimuli. TMS enabled us to reveal the timing of this activation, highlighting the left IPS’ s role at this latency. We also confirm the involvement of the STG at both early and later stages of the simultaneity judgment process. Early stimulation of these regions increased the perception of simultaneity, whereas later stimulation, mainly to the STG, increased asynchrony detection. These findings suggest that the IPS and STG belong to a broader cortical network supporting the TBW, with each region contributing at different stages of multisensory processing.

Keywords: Temporal Binding Window, Multisensory Integration, Transcranial Magnetic Stimulation, AudioVisual

Temporal Binding Across Timing Domains: Behavioural Evidence and a Protocol for Causal Manipulation via Transcranial Direct Current Stimulation

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Temporal binding - the perceived shortening of time between a cause and its effect - is typically assessed using tasks that tap into different timing processes: event timing (e.g., Libet Clock, Response Mapping) and interval timing (e.g., Temporal Estimation, Reproduction). This ongoing study examines whether temporal binding is consistent across these tasks and whether it varies by interval length. To date, fifteen participants completed two sessions, each involving four timing tasks under causal and non-causal conditions, with action-effect delays of 250 ms, 625 ms, and 1000 ms. Median responses were analysed using a 2 (Condition: causal vs. non-causal) ×2 (Session) ×3 (Interval) repeated-measures ANOVA. The Libet Clock task revealed a significant Condition ×Interval interaction ($F(2,28) = 4.63$, $p < .05$), with stronger temporal binding for causal trials at 250 ms ($t(14) = -3.16$, $p < .001$, mean diff. = 30.23 ms) and 1000 ms ($t(14) = -2.83$, $p < .05$, mean diff. = 18.14 ms). The Reproduction task similarly showed a Condition ×Interval interaction ($F(2,28) = 6.49$, $p < .01$), with greater under-reproduction for causal trials at 250 ms ($t(14) = -2.78$, $p < .05$, mean diff. = 95.72 ms) and 625 ms ($t(14) = -2.29$, $p < .05$, mean diff. = 86.04 ms). Response Mapping also exhibited a significant Condition ×Interval interaction ($F(2,28) = 12.25$, $p < .001$), with stronger binding at 1000 ms ($t(14) = -4.64$, $p < .001$, mean diff. = 49.50 ms), alongside trends at 250 ms ($t(14) = -2.02$, $p = .06$) and 625 ms ($t(14) = 1.87$, $p = .08$). The Estimation task showed neither a main effect of condition ($F(1,14) = 0.07$, $p = .79$) nor a significant Condition ×Interval interaction ($F(2,28) = 2.13$, $p = .14$). These findings suggest that temporal binding occurs across both event and interval timing tasks but is shaped by the specific task and interval used. We propose a follow-up study using transcranial direct current stimulation (tDCS) over the left angular gyrus to test whether event timing can be selectively disrupted without affecting interval timing.

Keywords: temporal binding, time perception, causality, tDCS

Modality-Specific Temporal Assimilation in a Bisection Task

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Time perception is fundamental to adaptive behavior, yet its neural mechanisms remain debated. While some models propose a centralized internal clock, others argue for distributed, modality-specific processing. This study tests these models by investigating whether the temporal assimilation effect, in which target intervals are underestimated after short distractors, generalizes across sensory modalities (auditory, visual, tactile). In Experiment 1 ($n = 20$), auditory targets paired with auditory or visual distractors revealed assimilation only when the distractor and target shared the same auditory modality. A significant main effect of distractor duration was found, $F(1, 19) = 15.8473$, $p < .05$, as well as a significant interaction effect, $F(1, 19) = 19.2034$, $p < .05$. In Experiment 2 ($n = 20$), auditory targets with frequency-varied auditory distractors (500Hz vs. 4000Hz) showed no significant modulation of assimilation. The distractor effect was present, $F(1, 17) = 5.2168$, $p < .05$, but no interaction, $F(1, 17) = 1.5918$, $p > .05$, indicating that modality, but not stimulus dissimilarity, modulated the effect. To test whether the modality effect in Experiment 1 was due to participants being able to inhibit visual processing, a novel tactile-vibratory device was developed and preliminarily validated through pilot testing ($n = 2$) to extend the paradigm to tactile-auditory pairings. We are recruiting 20 participants for a bisection task with tactile distractors (50- 217ms) and auditory targets. Data collection will test if assimilation persists cross-modally. If tactile distractors modulate auditory targets, this suggests supramodal temporal integration; the absence of this effect further supports the notion of distributed processing. Taken together, our findings raise questions about centralized models of time perception and suggest the possibility of modality-specific temporal encoding. The tactile extension may help clarify whether distributed timing mechanisms operate universally or vary across different sensory hierarchies.

Keywords: Time perception, Temporal bisection, Crossmodal integration, Distributed processing, Psychophysics

Serial dependence between duration and numerosity perception

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Serial dependence refers to the phenomenon where current perception is biased toward previous perception. This effect has been observed across various features, including magnitude dimensions such as numerosity. Converging evidence suggests overlapping mechanisms among magnitude dimensions, and cross-dimensional adaptation has been reported. However, whether cross-dimensional serial dependence occurs remains unclear. Togoli et al. (2021) investigated serial dependence between duration and numerosity perception but failed to observe such an effect. One possible cause is the absence of feature-based attention to the inducing feature (i.e., duration or numerosity). Therefore, the present study examines whether cross-dimensional serial dependence occurs under condition that require feature-based attention.In line with the previous study, we will recruit 28 participants. Participants will compare sequentially presented dot arrays and indicate which stimulus had a longer duration or a greater number of dots. The two tasks –duration comparison and numerosity comparison will be conducted on separate days. Inducer stimuli will be presented prior to the comparison task to influence the reference stimuli. To ensure feature-based attention to the inducing feature, we will include catch trials at unpredictable intervals. In these trials, participants will classify the inducer stimuli according to the dimension not used in the main task. For example, when the main task involves duration comparison, participants will classify the inducer as “few” or “many” in catch trial, and vice versa. If feature-based attention to the inducing feature is critical for cross-dimensional serial dependence, we expect to observe the effect. Such a finding would suggest that serial dependence occurs more broadly than previously thought and supports the view that higher-level cognitive processes contribute to serial dependence. It would also further support the idea of shared processing mechanisms for duration and numerosity. Conversely, if feature-based attention is not critical, or cross-dimensional serial dependence is inherently absent, the effect will not be observed.

Keywords: serial dependence, duration, numerosity, ATOM

Effects of attentional orienting on the production of temporal durations: an eye-tracking study

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Many studies indicate the existence of a spatial representation for temporal durations: shorter durations are represented on the left, and longer duration are represented on the right of the temporal continuum (Bonato, Zorzi, & Umiltà, 2012). Evidence exists indicating that time-space associations are mediated by mechanisms of visuospatial attention, which orient attention along the temporal continuum (e.g., Di Bono et al., 2012). In this study, we analysed gaze shifts during a temporal production task to test the hypothesis that attentional orienting through eye movements could predict production duration. Forty-six healthy adults participated in the study. At each trial, the participant listened to an alert stimulus, pressed the spacebar, and held it for a duration of choice. During the execution of the task, eye movements were recorded. The trial-by-trial analysis of eye movements in function of the produced duration revealed evidence for time-space associations. Importantly, upwards gaze shifts in the first 100ms after the trial onset predicted the subsequent time production magnitude, with larger shifts predicting longer durations. Differently from what expected, leftwards or rightwards gaze shifts were not related to duration. Furthermore, exploratory analyses also revealed that participants producing briefer productions took longer preparation times. Overall, these findings indicate that the spatialisation of time along the horizontal axis is not systematic, while it appears reliable along the vertical axis. Also, this study highlights the usefulness of the used duration task to assess and investigate links between space and time. These results will be further discussed in light of embodied and grounded cognition theories.

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Keywords: Time Perception, Mental Time Line, Visuospatial Attention, Eye Movements, Eye-Tracking

Retrospective Passage of Time Judgments in a Population of Parkinson’ s Disease Patients: A Matter of Self-Projection in Time

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In this study, we examined retrospective judgments of the passage of time (PoT) in 56 patients with Parkinson’ s disease, compared to 53 age-matched healthy participants, to evaluate whether interoceptive perceptions or psychological representations of the self were responsible for these judgments. Participants rated their perception of the passage of time using 7-point Likert scales for distant life periods (5–10 years ago). They also compared their current feeling about the passage of time with how they remembered feeling during those past periods, and they evaluated their recent experience of time passing (over the past week, days, and months). Then, they completed short scales assessing their emotional states, perceived health, well-being, and feelings of happiness. Finally, they completed the Dambrun & Ricard (2001) scale assessing the psychological dimension of self-transcendence. Our results confirmed that the passage of time related to long past periods and the current feelings of PoT are two distinct dimensions of retrospective feelings about time. The former is related to the dimension of self-consciousness linked to self-projection across the lifespan. The latter depends on representations of bodily states and emerges from perceived health, present well-being, and emotional state. Finally, Parkinson’ s disease itself did not alter the judgment of PoT related to either the present self or the projected self. Self-transcendence strongly modulated the perception of both the present and future self, and significantly influenced PoT judgments in both patients and healthy participants.

Keywords: retrospective PoT, Parkinson’ s disease , Emotions, Self-transcendence

Cardiac Rhythms, Interoception and Temporal Counting: Dynamic Interactions across Time Ranges

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While previous research has established links between heart rate variability over fixed time periods and interoception (perception of bodily responses) with time perception, the relationship between beat-to-beat cardiac activity patterns and actual counting timing remains unexplored. This study investigated how individual heartbeat interval time-series relate to temporal counting intervals across different time ranges. Seventy healthy participants performed time estimation tasks for three durations (23, 40, and 56 seconds) while cardiac activity was monitored. Individual counting intervals were estimated from variability in task performance across trials. Trial-by-trial heart rate and Dynamic Time Warping (DTW) distances between heartbeat intervals and estimated temporal counting intervals were calculated. Additionally, interoceptive accuracy was assessed using the heartbeat counting task. Results revealed time condition-specific relationships between cardiac activity and time perception: in the 23-second condition, higher average heart rate was associated with reduced variability in temporal counting intervals. In the 56-second condition, larger DTW distances between cardiac and counting time-series predicted better timing accuracy, indicating that greater divergence between cardiac and temporal counting rhythms enhanced time perception performance. Interoceptive accuracy showed weak positive correlation trends with timing performance in shorter durations, but this trend weakened in the 56-second condition. These findings demonstrate that while bodily arousal, interoception and temporal regularity are closely linked in shorter time conditions, divergence between cardiac and temporal counting rhythms becomes advantageous for accurate time perception in longer durations. This beat-to-beat time-series analysis approach revealed that optimal relationships between cardiac activity and time perception adaptively change according to the estimated time length.

Keywords: Time Perception, Heart Rate, Interoception, Dynamic Time Warping

When do we perceive our heartbeats? Exploring temporal dynamics in interoception

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Interoception refers to the process by which our nervous system detects, conveys, integrates, interprets, and utilises the vast array of sensations arising from within the body. Such processes are now recognised as playing critical roles in cognitive functions, including perception, emotion, decision-making, and so on. Cardiac signals and conscious access to them have been widely used to assess individual differences in perceptual ability related to interoception, reflecting how well individuals can detect internal bodily processes (i.e., their own heartbeats). However, previous methodologies have serious shortcomings in evaluating interoceptive ability, as some of them cannot exclude estimation strategies to count the heartbeats, are too difficult to perform, and crucially, all of them neglect the temporal aspect of heartbeat perception.Here, we developed a novel method called the “oneshot” heartbeat detection task, which allows us to examine the temporal dynamics of heartbeat perception. This approach enables us to identify the precise moments when individuals become aware of their heartbeat sensations or not in a trial-by-trial manner. Specifically, participants are instructed to press a button when they perceive their first heartbeat following a cue, while maintaining focus on internal sensations. After a number of heartbeats later (ranging from 1 to around 20), a word color is changed, timed either with their cardiac systole or diastole. Participants then answer a forced-choice question regarding the synchronicity of the heartbeat and color change. Using this task, we reveal characteristic patterns that distinguish individuals who are good at detecting heartbeat sensations from those who are not. Our findings provide new insights into the perceptual mechanisms underlying interoception, and further elucidate how multisensory interactions occur between interoceptive and exteroceptive modalities.

Keywords: heartbeat perception, interoception, temporal dynamics, signal detection theory

Distributional Variability Increases Uncertainty in Mean Duration Judgments

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Prior studies on contextual effects in duration perception have focused on how current perception is influenced by traces of past stimuli. However, real-world performance often requires extracting and retaining summary statistics, such as the mean and variance, of temporal distributions. For example, in baseball, it is advantageous for a batter to estimate the average speed of pitched balls and the variability around this mean to prepare for the next game. In order to investigate such summary representations in time perception, we explicitly instructed participants to estimate the mean duration of stimulus distributions. Critically, these distributions had identical means but differed in their variability. We found that the variability of participants’ mean estimates increased with the variability of the distributions, even though the actual mean remained constant. We further examined how this variability-related effect was reflected in EEG signals during the task. The contingent negative variation (CNV) correlated not only with single-trial reaction times but also with the extent to which participants’ mean estimates were influenced by the distributions’ variability. Conversely, the post-interval P2 component was associated with the perceived duration of the current stimulus. These findings suggest that while humans can accurately estimate the mean of a temporal distribution, the uncertainty of this representation increases as distributional variability increases, as reflected in the preparation-related CNV during temporal judgments.

Keywords: distributional variability, contextual effect, Bayesian, EEG, contingent negative variation

Image Memorability Shapes the Temporal Structure of Memory

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Remembering past events involves the ‘what’, the ‘where’ and the ‘when’ of memory. This suggests that we retain the temporal structure of episodes in memory, including detailed information about temporal distances between events. Stimulus properties, known to affect temporal judgments, may also shape this structure. For example, image memorability—an intrinsic property of visual stimuli linked to their likelihood of being remembered—is parametrically related to subjective duration distortions: the duration of presentation of highly memorable images is judged as longer than that of forgettable images (Ma et al., 2024). Herein we report an online study (n=33) in which participants actively viewed sequences of images varying in memorability and then reported the temporal distance between image pairs from each sequence using a Visual Analog Scale. We found that memorable images were systematically perceived as temporally closer in memory than forgettable images, suggesting that memorability also influences temporal memory. Additionally, we found that a transition between low and high memorability altered temporal distance judgments: pairs spanning a change in memorability were reported as further apart in time than pairs within the same memorability group. This suggests that a shift in memorability might act as a boundary, segmenting the sequence into two distinct events. Follow-up online studies revealed that participants are able to segment images into groups based on memorability—showing above-chance performance despite being unaware of the grouping criteria. Overall, these results indicate that stimulus manipulations which elicit online temporal distortions also influence the temporal organization of memory, supporting the view that context operates as a cognitive scaffold for encoding and retrieving episodic temporal information.

Keywords: Temporal distance, Memorability, Event segmentation, Duration distortion, Temporal memory

Effects of Network Topology and Goals on Interpersonal Synchronization in a Virtual 'Rhythm Network'

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Drum circles provide a rich context for investigating interpersonal coordination and group timing dynamics. In real-world drum circles all participants can generally hear each other, enhancing group-level cooperative synchrony as group size increases (Dotov et al., 2022, eLife). But how does group synchronization behave in uncooperative, or reduced-information situations? We have developed a virtual drum circle paradigm to explore such challenging contexts, hypothesizing that individuals will display more diverse strategies when so challenged. In two pilot drum circles (N=6) we contrasted group synchronization in three conditions: all-all network topology with goals either to 1) maximize synchronization (all-sync) or 2) maximize desynchronization (all-desync), and 3) a ring topology with impoverished information flow across the group (ring-sync), which we hypothesize will force each individual to rely on an imagined collective goal and reveal different capacities to manage frustration with a seemingly uncooperative partner. In all-sync, the group successfully achieved high synchrony (Kuramoto order parameter $r \approx 1$), though, as often observed, with an acceleration of tempo. In all-desync, the order parameter remained between 0.25 and 0.5, suggesting difficulty in fully decoupling from one another. In ring-sync, each participant hears only their left neighbor, so any coordination occurs with a large delay, mediated through the entire group. This topology inverts traditional assumptions, predicting that group synchrony degrades as group size increases. For N=6 we observed dynamic behavior, with surprising periods of complete synchrony ($r \approx 1$) alternating with deep desynchronization ($r < 0.2$), suggesting that participants may rely on internal models of group intention. This flexible virtual 'Rhythm Network' paradigm offers possibilities to test models of group synchronization in extreme behavioral regimes and lays the foundation for future studies of inter-brain synchrony.

Keywords: Group Synchronization, Drum Circle, Network Topology, Simulation

EEG Correlates of Movement-Induced Enhancements of Beat Timing

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Previous work has shown that motor systems and rhythmic auditory processing are linked, such that motor system activation is coincident with auditory system activity while listening to music, suggesting an interaction between auditory and motor systems. Further, behavioral work has shown that inducing movement in a subject can lead to enhancement of auditory timing abilities. Yet, the neural correlates of this enhancement are not well understood. Here, we replicate and extend work by Manning and Schutz (2013) in which subjects tap along or passively listen to isochronous woodblock sequences, and then must detect if a final, delayed probe tone is aligned with the implied beat and explore the brain activity associated with this effect of movement using EEG. Preliminary data suggest stronger neural entrainment to the beat in the movement condition in comparison to no-movement. Further activity locked to the probe tone also demonstrated a larger amplitude P300 and N600 for the movement condition. For response-locked activity during choice, the movement condition exhibited a larger preceding negativity peaking higher and closer to the response as well as a positive potential following the response that is higher in amplitude compared to the no movement condition, suggesting greater certainty. Data collection will proceed to investigate the strength of these results and potential correlations related to these findings. Overall, these findings suggest an improvement in timing perception and processing, stronger entrainment to the beat, and faster target detection associated with movement.

Keywords: Beat Perception, Sensorimotor Integration, Rhythm, Movement

The effect of repetitive transcranial magnetic stimulation (rTMS) over the supplementary motor area on the groove experience

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The pleasurable urge to move along with the music is called "groove." This study aimed to examine whether activation of the supplementary motor area (SMA) is related to the groove experience using repetitive transcranial magnetic stimulation (rTMS). We hypothesized that excitatory stimulation would enhance, and inhibitory stimulation would decrease, the groove experience compared to the sham condition. Fifteen healthy individuals (mean age = 24.8±7.26 years; 9 females) participated in the study. Each underwent three rTMS conditions using an automated TMS robot system: SMA-iTBS (excitatory intermittent theta burst stimulation over the SMA), SMA-cTBS (inhibitory continuous theta burst stimulation over the SMA), and sham stimulation over the vertex. After each session, participants listened to ten musical excerpts (five high-groove and five low-groove) from a previous study (Janata et al., 2012) and rated their experienced groove ("urge to move" and "pleasure") using a visual analog scale (0–100). A two-way ANOVA (stimulation condition [SMA-iTBS, SMA-cTBS, and sham] x music type [high-groove and low-groove music]) revealed no significant main effect of stimulation condition on either rating. There was a significant main effect of music group on “pleasure” ratings ($F_{(1,28)} = 257.7$, $p < .001$), with high-groove music receiving higher ratings. Contrary to our hypothesis, SMA stimulation did not significantly affect the groove experience, suggesting that the SMA may not be directly involved in the groove experience.

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Keywords: groove, pleasure, repetitive transcranial magnetic stimulation (rTMS), supplementary motor area (SMA), music

Timing Difficulties in Developmental Language Disorder and Stuttering: A planned study on the Role of Dysfunctional Synchronization of Brain Rhythms

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In this planned study we will characterize the neural underpinnings of timing difficulties in developmental language disorder (DLD) and developmental stuttering. Children suffering from DLD display receptive timing difficulties and misperceive temporal modulations, in particular at high rates. In contrast, children who stutter (CWS) show timing difficulties during actions, such as speech production.
We hypothesize that timing difficulties in DLD and stuttering arise from an underlying deficit in the synchronization of rhythmic brain activity. In DLD, we hypothesize dysfunctionalsynchronization with the external speech signal during perception. In contrast, CWS are hypothesized to display dysfunctional internal auditory–motor synchronization, which is particularly important for the processing of auditory feedback.
Children with DLD, children who stutter, and control children aged 10-15 (66 each) will participate in an MEG study at Muenster and Goethe university Frankfurt. We will investigate speech-brain synchronization, rhythmic deviance detection, and synchronization/ continuation tapping with and without feedback.
We will present and discuss the details of the study design.

Keywords: Developmental Stuttering, Developmental Language Disorder, Speech-Brain Alignment, Synchronization-Continuation Tapping Paradigm, Auditory-motor interactions, Magnetoencephalography

Contributions of cognitive abilities and attention to Motor Timing in Parkinson’ s Disease

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Finger tapping tasks are often employed to measure the rhythm of the internal clock. These, however, are susceptible to influences from both motor symptoms and cognitive functions which makes interpreting results difficult. This study investigates the influence of specific cognitive functions on finger tapping in Parkinson’ s Disease (PD). In contrast to the widespread use of tools like the Mini-Mental State Examination (MMSE), our focus lies on specific cognitive domains crucial to finger tapping—Montreal Cognitive Assessment (MoCA) and Trail Making Test (TMT). PD patients engaged in spontaneous tapping and 1-second paced tapping tasks. Cognitive functions were assessed using the MoCA for general cognitive abilities and TMT-A for attention and processing speed. Bayesian model comparisons were employed to evaluate 12 different models predicting the interval between taps and variability of taps, for each task. The results confirmed previous findings of a faster tapping rate and increased variability in free tapping and 1-second tapping tasks among PD patients. Furthermore, distinct trends emerged concerning MoCA and TMT-A performance and their effect on tapping tasks, differentiating between PD patients and healthy controls.

Keywords: Parkinsons, Motor Timing

Exploring the role of rhythmicity for infant word learning by entrainment of brain and behaviour in social contexts: A preliminary study

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Infants learn words from caregivers labelling objects with their names. Such interactions involve infant-directed (ID) communication, which is inherently highly rhythmic. Infants attend more to, learn better from, and more strongly neurally track ID than adult-directed speech, however, whether this is specifically due to rhythmicity is currently unknown. We thus posit that rhythmicity in ID speech dynamically engages infants' cognitive processes in real time (such as measured via eye-tracking), which enhances word learning, and that such learning processes are anchored by underlying neural activity. We are currently testing this hypothesis while developing machine learning (ML) techniques to utilize infants' multiple signals together (e.g., eye-tracking and/or EEG, video of facial expressions) to predict learning outcomes. Specifically, 9- to 11-month-old infants (data collection is ongoing) from English-speaking homes were familiarized with two novel objects one at a time on a screen, each paired with a pseudoword (e.g., 'Bap' & 'Dit'). The word was spoken repeatedly over an intonation phrase, and these phrases were manipulated to be rhythmically regular (i.e., with regular inter-onset-intervals[IOIs] between word onsets) or irregular (e.g., jittered IOIs between words). During familiarization, infants' visual and neural signals were measured using eye-tracking and EEG, respectively. Following this, infants' associative word learning was then tested: infants heard the learned pseudowords one at a time while both objects appeared on the screen, and looking times to the correct vs. incorrect object was measured to index learning. We predict that infants' brains will more strongly track the regular compared to irregular phrases, and that this pattern will predict their word learning outcomes. Additionally, ML models will predict which infants learned best using the eye-tracking (and in the future, EEG and facial expression) data from the familiarization phase. This project is the first to directly manipulate rhythmic regularity in ID speech to investigate word learning, and additionally, to employ ML techniques to extract features from infants' multiple signals that predict learning outcomes. This work will better our understanding of the processes involved in early language acquisition.

Keywords: Word Learning, Infants, Neural Tracking, EEG, Eye-tracking

Pre-motor and auditory processing for inner and overt speech

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There is a long-standing debate as to whether the neural processes associated with inner speech –the silent production of words in one’ s mind –and overt speech –the audible production of words via movement of the articulator organs –are the same or different. Watson (1913) claimed that the only difference between them is that inner speech does not produce an audible sound, whereas Vygotsky (1934) argued that they are completely different. To distinguish between these possibilities in the context of pre-motor and auditory processing, we sought to investigate the similarities and differences in both the N1, an event-related potential (ERP) associated with auditory processing, and the slow negative wave, a negative-going deflection preceding the onset of a voluntary action. To elicit these potentials, participants were instructed to watch an animation which provided them with precise knowledge about when they should produce a sound (e.g., “cat”) in either inner or overt speech. At the same time, participants would hear an audible sound played through headphones that either matched (e.g., “cat”) or mismatched (e.g., “dog”) the sound they produced. The results and their implications for understanding the perception of inner and overt speech will be discussed.

Keywords: Inner Speech, EEG, Decoding, Overt Speech

Neural correlates of changes of mind and confidence in the judgement of elapsed time

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The ability to monitor and correct errors is essential for accurate timing. Recently, investigators have started probing confidence in temporal decisions as a means of understanding temporal metacognition (Fu, et al. 2023). However, few studies have investigated the EEG correlates of metacognitive inferences in time perception (Kononowicz, et al. 2019; Kononowicz & van Wassenhove, 2019). Separately, perceptual decision-making studies have found that, when given the option, subjects will shift their decisions from one choice to another, so-called "changes of mind" (Resulaj, et al. 2009; van Den Berg, et al. 2016). We have found that changes-of-mind also exist for temporal decisions (Wiener, et al. 2019). Here, we probed the EEG correlates of these changes-of-mind and confidence estimates in a suprasecond auditory temporal bisection task. Our initial analysis revealed that the late positive component of timing (LPCt), an EEG signal associated with post-decisional evidence in timing tasks (Wiener & Thompson, 2015; Ofir & Landau, 2022), is significantly lower on trials in which subjects changed their minds about their decision. Additional analyses will examine the link between this shift in LPCt amplitude and decision confidence, both at the neural and behavioral level, as well as if changes-of-mind can be predicted by pre-decisional evidence accumulation.

Keywords: decision-making, changes-of-mind, temporal metacognition

Metacognition of Time Discrimination

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While the conscious sense of the passage of time is often assessed in the temporal orientation studies on the individual’ s focus on the past, present and future, much less is known about metacognitive awareness of our perception of short time scales. In a series of time discrimination studies, we measured the sensitivity of time judgments (Level 1) and the metacognitive accuracy (Level 2) of the Level 1 responses. We found that different aspects of time judgment (threshold, slope) predict metacognitive awareness of time perception. In addition, participants showed systematic over- and under-estimation of sub-second vs. supra-second judgements, which was also reflected in the metacognitive processes. The results highlight the higher-level processing of time, which likely cannot be carried out without conscious awareness of time.

Keywords: Time discrimination, Metacognition, Sub-second vs. supra-second, Consciousness

Timing Control of Upper Body Movements in Playground Swing Pumping: The Role of External Forces

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Playground swing pumping represents a coupled oscillator system consisting of the swing apparatus and the human swinger. Dynamic simulations using equations of motion reveal that for seated pumping, swing amplification requires synchronization between the swing's resonant frequency and the swinger's upper body movements. Furthermore, a progressive phase shift between the swing and upper body motion is essential for effective pumping. Specifically, when swing amplitude is small, maximum backward lean of the upper body should occur when the swing moves forward and the swing is at the vertical. As swing amplitude increases, the timing of maximum backward lean must shift earlier toward the swing's back extreme.

Motion capture analysis of 10 untrained participants pumping an in-lab playground swing showed that while one swing cycle lasted approximately 2.5 seconds, the phase shift advanced about 30 milliseconds per cycle. This precise phase control was consistent across all participants, suggesting it occurs without conscious intention.

Our hypothesis proposes that external forces—including inertial, fictitious, and centrifugal forces—acting on the swinger's upper body drive this phase shift. To test this hypothesis, we constructed a virtual reality swing environment consisting of a head-mounted display connected to a personal computer and a stationary bar stool with poles mimicking swing chains. The VR swing responds to upper body movements synchronized with swing motion, but critically, no external forces act on the swinger's body since the seat remains fixed to the ground.

Ten participants successfully pumped both VR swing. Importantly, during VR swing pumping, the phase relationship between the seat and upper body remained constant throughout the pumping process, contrasting with the progressive phase shift observed in physical swing pumping.

These findings demonstrate that external forces are crucial for the automatic phase shift that enables effective swing pumping. This research advances our understanding of how environmental constraints shape motor coordination in coupled oscillatory systems.

Keywords: phase shift, external forces, coupled oscillator system, playground swing

Social modulation of sense of responsibility and subjective time experience in semi-automated motor tasks

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Automation technologies increasingly assist or augment human motor functions in contexts such as driving, surgery, and rehabilitation. As such systems become more prevalent, it is essential to understand how they influence users' subjective experience, particularly in social settings where individuals may compare themselves with others using more or less capable systems. Previous research has shown that automation can modulate the sense of agency (SoA), responsibility, and time perception, but these effects have mostly been examined in non-social contexts. In this study, we examined how automation and social context shape users' sense of responsibility and temporal experience. Participants engaged in a continuous circle-tracing task using a trackpad-controlled cursor under two automation conditions: auto-correction and delay. In Experiment 1, participants performed the task alone. In Experiment 2, two social contexts were introduced: while observing another agent using the same system (social–matched), or a different system (social–mismatched). The results showed that the automation condition consistently influenced subjective control, performance, drawing speed and accuracy in both experiments, with better outcomes in the auto-correction condition. The social context had no effect on these indices. However, temporal reproduction and responsibility judgements exhibited different patterns in Experiment 2. Specifically, subjective time compression occurred in social conditions under delay, and responsibility ratings were highest when the observer used the same system, and lowest when they used a different one. These findings suggest that automation performance has a consistent influence on core aspects of task execution and self-evaluation, while social context selectively modulates higher-order, self-related experiences, such as responsibility attribution and time perception. These findings emphasize the importance of considering technological and social factors when evaluating user experience in semi-automated environments.

Keywords: sense of responsibility, subjective time perception, human–automation interaction, social context, sense of agency

When Time Stands Still: Altered spatiotemporal experiences in depersonalization

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Introduction. Depersonalization (DP) is a common condition characterized by distressing feelings of estrangement from the self and the external world. Unlike schizophrenia, peripersonal space is preserved in DP, yet altered time perception are also observed. This asymmetry needed to be further investigated by considering DP facets in spatiotemporal experiences.

Methods. An online study was conducted ($N = 1034$) investigating the association of HIGH DP traits measured by the Cambridge Depersonalization Scale (CDS score > 50) with altered subjective experiences of body, time, and space.

Results. The results demonstrated associations between DP scores and distorted experiences of time, body and space. When shared variance between CDS facets is considered, the facet "Anomalous Body Experience", appears as main predictor of spatiotemporal alterations, associated with subjective experience of time slowing down.

Conclusion. These results echo phenomenological experiences of spatiotemporal disruption in DP and suggest that these experiences may mainly come from estrangement experiences from the bodily self. Our work calls for further investigations linking DP to disruption of internal/external clock, in relation to active movements in the world.

Keywords: Depersonalization, Time Perception, Altered Self, Bodily Self

Recalibrating perceptual time through motor learning

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Timing is central to human cognition and behaviour, underscoring people’ s ability of comprehending speech, playing instruments and competing in sports. Accumulating evidence supports a motoric basis of timing, whereby time processing is embedded in motor control neural circuits and perceptual time undergoes distortion in proximity of action. Yet, the dynamic interplay between timing and motor systems remains under-characterized, particularly in goal-directed contexts where control is refined through practice. In a first study, we investigated this interaction by asking participants to judge brief visual durations while preparing hand movements toward either specific (Cued) or unspecified (Non-cued) targets, or during equivalent intervals without movement (Sensory). Temporal judgments were biased toward expansion in the Cued condition, and both action conditions showed progressive time expansion across trials, paralleling motor learning as indexed by decreases in action latency. EEG data revealed that these perceptual distortions arise from biased temporal encoding and decoding processes, linked to action planning and broader aspects of motor system engagement respectively. We further examined within this setup how perceptual (explicit) and motoric (implicit) timing mechanisms interact. Using a nested design that assessed both processes on a trial-by-trial basis, participants judged stimulus durations while also intercepting a target presented after a predictable interval containing the judged stimulus. Results showed that while action planning distorted perceived duration, motor-based timing remained accurate for target interception, suggesting partial decoupling between perceptual and motor timers. However, the systems also interacted: trials with faster perceptual timing (shorter perceived durations) were associated with slower motor timing (delayed responses), hinting at information leak between implicit and implicit timers. Together these findings highlight a dynamic, learning-driven coupling between perceptual time and motor control processes, wherby temporal experience is recalibrated throughout goal-directed motor learning

Keywords: Motor control , Visual timing, Sensorimotor integration , Time encoding and decoding , Behavioural modelling, EEG

Beyond Pacemaker Speed: A Planned Investigation into Atemporal Perceptual Processes Underlying Differences in Auditory-Visual Duration Judgments

*Valtteri Arstila[1], Jarno Tuominen[1]

1. University of Turku

Research consistently shows that auditory stimuli are perceived as longer than visual stimuli of equivalent duration. Current explanations for this phenomenon are based on the internal clock model; no detailed explanation has been presented within alternative frameworks, such as oscillator-based models like the striatal beat frequency model. The internal clock model explanation attributes the effect to modality-specific pacemaker speeds. This could imply either that one pacemaker operates at different speeds for different sensory modalities or that each modality has its own pacemaker operating at different speeds. (Wearden and Jones 2021) However, this approach amounts to merely *explaining by naming*; within the context of the internal clock model, the explanation doesn't truly elucidate the phenomenon but rather describes it in a novel way. As long as the accumulator and the switch/gate function largely similarly for both auditory and visual stimuli—both reasonable assumptions—differences in duration estimations can only be attributed to differences in pacemaker speeds. Consequently, the phenomenon remains unaccounted for.

In this presentation, we share initial results from psychophysical experiments—which compare duration judgments between matched auditory and visual stimuli—aimed at exploring alternative explanations for the differences in judged durations. Rather than attributing the duration judgment differences to unexplained variations in pacemaker speed, we anticipate demonstrating that these effects arise from more general and partly domain-specific perceptual and neural processes. Should our results support this explanation, they will challenge the explanatory value of modality-specific pacemaker speeds and advance our understanding of time perception by aligning it more closely with other perceptual processes.

Wearden, J. H., & Jones, L. A. (2021). “Judgements of the Duration of Auditory and Visual Stimuli.” Timing & Time Perception, 9(2), 199–224.

Keywords: Time perception, Auditory stimuli, Visual stimuli

Poster | Other

Sat. Oct 18, 2025 12:45 PM - 2:45 PM JST | Sat. Oct 18, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P2] Poster: Day 2

[P2-39] Influence of turn-taking regularity on respiratory activity in human conversation

*Mirei Kin and Hiroki Koda (Graduate School of Arts and Sciences, The University of Tokyo)
Keywords：respiratory activity; conversion; speech timing; temporal regularity; turn-taking

Human conversational communication is characterized by the dynamic alternation of speaker roles, known as turn-taking. The smooth coordination of turns requires individuals to predict the timing of their partner's utterance onsets and offsets and to execute their own speech with precise motor timing. Since speech production depends on the voluntary control of respiration, it is plausible that respiratory activity plays a role not only in individual speech planning but also in the mutual regulation of conversational flow. Specifically, respiratory control may act as a physiological substrate for inter-individual coordination by enabling reciprocal influence between speakers' breathing patterns. Such coordination may extend beyond vocal turn-taking and contribute to broader socio-psychological domain, including synchronization of autonomic nervous system activity. Despite its potential relevance, respiratory coupling in naturalistic conversation remains understudied. Here, we investigated how conversational context influences respiratory synchrony between two speakers. We recorded respiratory activity during dyadic conversations conducted under two conditions: face-to-face interaction and virtual interaction via video online system including unpredictable time delay. These settings allowed us to manipulate the physical co-presence of participants while keeping the conversational task comparable. The temporal aspects of dialogue, such as turn transition timing in relation to respiratory signals, were also examined following previous studies. Our preliminary analysis showed condition-dependent differences in respiratory synchronization. Our data partially suggested that synchronized breathing during smooth turns occurred more frequently in face-to-face conditions than in virtual interactions. Notably, simultaneous laughter emerged as a particularly salient event, during which participants' respiratory rhythms temporarily aligned. These moments of affective synchronization might facilitate smoother turn transitions and more sustained conversational flow in subsequent exchanges. These findings suggest that respiration might serve not only as a substrate for speech production but also as a medium for inter-individual coordination during conversation.

Poster | Other

Sat. Oct 18, 2025 12:45 PM - 2:45 PM JST | Sat. Oct 18, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P2] Poster: Day 2

[P2-40] Female gibbons' great calls change tempo in the presence of their offspring

*Yoichi Inoue[1], Waidi Sinun[2], Kazuo Okanoya[1] ([1]Teikyo University, [2]Research and Development Division, Yayasan Sabah Group)

Gibbons are small apes distributed throughout Southeast Asia known for their loud vocalizations (songs). Female gibbons produce a loud, elaborate, and stereotyped song known as the great call (GC). From 2009 to 2025, we observed four females in three groups of Northern Gray gibbons (Hylobates funereus) in northern Borneo and recorded their songs to investigate whether female GCs change before and after giving birth. Observations suggest that infant gibbons begin producing high-pitched vocalizations synchronized with their mother's GC from birth. By approximately 26 months of age, offspring begin to sing the initial portion of the GC in synchrony with their mother, gradually lengthening their contribution. We hypothesized that females may adapt their vocalizations to match their offspring's developing song—similar to human motherese—by producing slower, shorter calls with higher pitch. To test this hypothesis, we analyzed the GC's duration, number of notes, maximum and minimum frequencies, and note speed. The GC consists of a series of notes: the first half begins slowly and accelerates, while the second half maintains a steady tempo. Therefore, note speed was measured separately for the first 20 notes and for the 21st note onward. We compared these acoustic features before and after the birth of offspring. Although our overall findings did not support the hypothesis, we found that note speed in the first half of the GC was significantly faster after birth. This change may reflect hormonal effects related to lactation or heightened maternal arousal for offspring protection, but the underlying cause remains unclear. Further studies are needed to clarify the function and mechanisms of this vocal change (Work supported by JSPS 25H21984).

TRF

Sat. Oct 18, 2025 8:00 AM - 10:00 AM JST | Fri. Oct 17, 2025 11:00 PM - 1:00 AM UTC TCVB tour

[T04] TCVB tour @ Zazen Experience

TRF

Sat. Oct 18, 2025 5:45 PM - 8:30 PM JST | Sat. Oct 18, 2025 8:45 AM - 11:30 AM UTC Shibuya

[T05] Conference Dinner

Invited | Other

Sun. Oct 19, 2025 4:15 PM - 5:15 PM JST | Sun. Oct 19, 2025 7:15 AM - 8:15 AM UTC Room 2(West B1)

[K3] Keynote : Masaki Tanaka

Chair:Hugo Merchant(Universidad Nacional Autónoma de México)

Periodic events evoke rhythm perception, which entails predicting stimulus timing, focusing attention on the moment, and preparing synchronized motor responses. Although both the cerebellum and basal ganglia are implicated in rhythm processing, their distinct roles remain poorly understood. In monkeys performing rhythmic tasks, we found periodic neuronal activity in the cerebellar dentate nucleus and striatal caudate nucleus. Cerebellar neurons encoded the spatial properties of sensory stimuli, while caudate neurons represented the direction and type of intended movements. These results suggest a functional dissociation: the cerebellum is involved in sensory prediction, whereas the striatum contributes to periodic motor preparation. Consistent with this view, optogenetic suppression of dentate activity impaired the detection of subtle changes in isochronous stimulus timing. Furthermore, Purkinje cells in the cerebellar crus lobules, which project to the dentate nucleus, showed periodic modulation in both simple and complex spikes, suggesting that synaptic plasticity in the cerebellar cortex may contribute to the formation of an internal model for rhythmic sensory input.

4:15 PM - 5:15 PM JST | 7:15 AM - 8:15 AM UTC

[K-01]

Decoding subcortical mechanisms of temporal prediction of periodic events

*Masaki Tanaka[1] (1. Hokkaido University (Japan))

Decoding subcortical mechanisms of temporal prediction of periodic events

*Masaki Tanaka[1]

1. Hokkaido University

Periodic events evoke rhythm perception, which entails predicting stimulus timing, focusing attention on the moment, and preparing synchronized motor responses. Although both the cerebellum and basal ganglia are implicated in rhythm processing, their distinct roles remain poorly understood. In monkeys performing rhythmic tasks, we found periodic neuronal activity in the cerebellar dentate nucleus and striatal caudate nucleus. Cerebellar neurons encoded the spatial properties of sensory stimuli, while caudate neurons represented the direction and type of intended movements. These results suggest a functional dissociation: the cerebellum is involved in sensory prediction, whereas the striatum contributes to periodic motor preparation. Consistent with this view, optogenetic suppression of dentate activity impaired the detection of subtle changes in isochronous stimulus timing. Furthermore, Purkinje cells in the cerebellar crus lobules, which project to the dentate nucleus, showed periodic modulation in both simple and complex spikes, suggesting that synaptic plasticity in the cerebellar cortex may contribute to the formation of an internal model for rhythmic sensory input.

Keywords: temporal prediction, cerebellum

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

Oral | Language, Animal

Sun. Oct 19, 2025 10:45 AM - 12:15 PM JST | Sun. Oct 19, 2025 1:45 AM - 3:15 AM UTC Room 3(East B1)

[O8] Oral 8: Language, Animal

Chair:Hiroki Koda(The University of Tokyo)

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

[O8-01]

Towards Differentiating Endogenously and Exogenously Driven Rhythms in the Brain: Syntax, Prosody and Delta-Band Activity

*Leonardo Zeine[1,2], Peter Donhauser[1], David Poeppel[3] (1. Ernst Strüngmann Institute for Neuroscience (Germany), 2. Max Planck School of Cognition (Germany), 3. New York University (United States of America))

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

[O8-02]

Reversible inactivation of insular and prelimbic cortices in a temporal decision-making task in rats

*Marcelo S Caetano[1], Estela B Nepomoceno[2] (1. Universidade Federal do ABC (UFABC) (Brazil), 2. Universidade São Caetano do Sul (USCS) (Brazil))

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

[O8-03]

Temporal Strategies and Cue Integration in Rats: Evidence from Operant and T-Maze Midsession Reversal Tasks

*Marcelo Bussotti Reyes[1], Marcelo Salvador Caetano[1], Armando Machado[2] (1. Universidade Federal do ABC (Brazil), 2. University of Aveiro (Portugal))

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

[O8-04]

Implicit timing in a group of freely behaving Guinea baboons

*Jennifer T Coull[1], Nicolas Claidière[1,2], Adrien Meguerditchian[1,2], Siham Bouziane[1] (1. Centre for Research in Psychology & Neurosciences, CNRS & Aix-Marseille University (France), 2. Station de Primatologie-Celphedia, UAR846, CNRS, Rousset (France))

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

[O8-05]

Spontaneous temporal predictions in Guinea Baboons: Insights from a sequential variable foreperiod paradigm

*Siham Bouziane[1], Adrien Meguerditchian[1,2], Nicolas Claidière[1,2], Jennifer T Coull[1] (1. Centre de Recherche en Psychologie et Neurosciences (France), 2. Station de Primatologie-Celphedia UAR846 CNRS - Rousset France (France))

12:00 PM - 12:15 PM JST | 3:00 AM - 3:15 AM UTC

[O8-06]

An evolutionary model of vocal accelerando in African penguins

*Yannick Jadoul[1,2,3], Taylor A. Hersh[2,4], Elias Fernández Domingos [3,5], Marco Gamba[6], Livio Favaro[6], Andrea Ravignani[1,2,7,8] (1. Department of Human Neurosciences, Sapienza University of Rome, Rome (Italy), 2. Comparative Bioacoustics Group, Max Planck Institute for Psycholinguistics, Nijmegen (Netherlands), 3. Artificial Intelligence Lab, Vrije Universiteit

Brussel, Brussels (Belgium), 4. Marine Mammal Institute, Oregon State University, Newport, Oregon (United States of America), 5. Machine Learning Group, Université Libre de Bruxelles, Brussels (Belgium), 6. Department of Life Sciences and Systems Biology, University of Turin, Turin (Italy), 7. Center for Music in the Brain, Department of Clinical Medicine, Aarhus University, Aarhus (Denmark), 8. Research Center of Neuroscience “CRiN-Daniel Bovet”, Sapienza University of Rome, Rome (Italy))

Towards Differentiating Endogenously and Exogenously Driven Rhythms in the Brain: Syntax, Prosody and Delta-Band Activity

*Leonardo Zeine[1,2], Peter Donhauser[1], David Poeppel[3]

1. Ernst Strüngmann Institute for Neuroscience, 2. Max Planck School of Cognition, 3. New York University

During speech processing, the brain tracks acoustic fluctuations across multiple timescales. In the context of neural oscillations for language perception, theta-band activity (4–8 Hz) is argued to phase-lock with the occurrences of syllables, and delta-band activity (<3 Hz), with syntactic and/or prosodic events—a claim that has sparked intense debate in the field (Kazanina & Tavano, 2024). On one hand, syntax and prosody are naturally intertwined; on the other, delta-band activity is both widespread across the brain and sensitive to low-level acoustic features such as onsets.Here, we introduce a novel data-driven method to disentangle sentence-internal from boundary (onset/offset) activity. Our approach consists of two consecutive sets of spatial filters: the first, a denoiser, that captures language-related activity, and the second, a functional filter, that isolates sentence-internal responses.By analyzing an open dataset of source-localized MEG recordings from 140 participants (Schoffelen et al., 2019) who listened to sentences in Dutch, we identified two distinct timescales of sentence-internal activity: one, predominantly delta-band, in the right superior temporal gyrus (STG); and another in both delta and theta bands in the left STG. Both components exhibited higher phase clustering in the delta-band around strong prosodic boundaries compared to weak boundaries and random timepoints.We also identified two distinct onset/offset-related components: one sustained (bilateral) and another transient (right-lateralized), neither modulated by prosodic or syntactic representations. We argue that they reflect low-level acoustic responses typically conflated with endogenously driven responses in conventional sensor-space analysis. Altogether, our findings offer a comprehensive characterization of key temporal profiles in speech processing, and point to delta-band phase-locking as a candidate mechanism for integration of prosodic information.

Keywords: Syntax, Prosody, Delta-band oscilaltions, Spatial filtering

Reversible inactivation of insular and prelimbic cortices in a temporal decision-making task in rats

*Marcelo S Caetano[1], Estela B Nepomoceno[2]

1. Universidade Federal do ABC (UFABC), 2. Universidade São Caetano do Sul (USCS)

The anterior insular cortex (AIC), an area of sensory integration, detects salient events to guide goal-directed behavior, track errors, and estimate the passage of time. Projections between the AIC and medial prefrontal cortex (mPFC) are found both in rats and humans, and suggest a possible role for these structures in the integration of autonomic responses during ongoing behavior. Few studies, however, have investigated the role of AIC and mPFC in decision-making and time estimation tasks. Here, we employed bilateral inactivations to describe the role of AIC and mPFC in a temporal decision-making task in rats. In this task (the "switch task"), rats are placed in a standard operant chamber with two levers. In some trials, presses on one of the levers will lead to reinforcement after a short interval (3 s). In other trials, a press on the other lever will lead to reinforcement after a long interval (6 s). Since short and long trials are randomly presented (i.e., unpredictable), optimal performance requires a switch from the short to the long lever after the short fixed interval elapses and no reinforcement is delivered. In a first experiment, we showed that successful switch from the short to the long lever was dependent on AIC and mPFC. During AIC inactivation, switch latencies became more variable; and during mPFC inactivation switch latencies became both more variable and less accurate. In a follow-up experiment, we manipulated the probabilities associated with the occurrence of a short or a long trial, and observed that the animals were sensitive to changes in these probabilities, adjusting switch latencies in order to maximize reinforcement. These findings point to a dissociation between AIC and mPFC in temporal decision-making, and contribute to the understanding of the neural substrates involved in the encoding of uncertainty as a function of time.

Keywords: Decision-making, Timing, Probability estimation, Switch task, Muscimol

Temporal Strategies and Cue Integration in Rats: Evidence from Operant and T-Maze Midsession Reversal Tasks

*Marcelo Bussotti Reyes[1], Marcelo Salvador Caetano[1], Armando Machado[2]

1. Universidade Federal do ABC, 2. University of Aveiro

The midsession reversal (MSR) task assesses cognitive flexibility by requiring animals to switch from one correct choice (S1) to another (S2) halfway through a session, without any explicit cue signaling the change. Although the task includes no formal timing component, species such as pigeons and starlings rely heavily on temporal cues, often committing anticipatory or perseverative errors. In contrast, monkeys and humans typically adopt the optimal win-stay/lose-shift (WSLS) strategy, shifting behavior only after the first error. In rats, the strategy depends on the experimental context: in T-mazes, they tend to rely on timing, whereas in operant chambers, behavior is often dominated by WSLS, with little evidence of timing during training. Here, we directly tested the temporal hypothesis in rats using both paradigms. In the operant task, rats learned to discriminate between steady and flickering lights, always presented on the same side, with the reinforced stimulus reversing midway through each session. During training —and consistent with prior studies— rats showed no anticipation of the reversal, relying instead on WSLS. However, when we manipulated the intertrial interval (ITI), rats adjusted their responses according to elapsed time, indicating that timing can guide behavior when the task’s temporal structure is altered. In the T-maze version, rats relied on temporal cues already during training, committing both anticipatory and perseverative errors. When the ITI was manipulated, rats adopted a mixed strategy, combining timing (primarily) and trial counting. These findings demonstrate that rats flexibly integrate multiple cues depending on task dynamics, challenging the notion that they rely solely on reinforcement history in operant chambers or exclusively on timing in spatial tasks.

Keywords: reversal learning, cognitive flexibility, decision-making, strategy use

Implicit timing in a group of freely behaving Guinea baboons

*Jennifer T Coull[1], Nicolas Claidière[1,2], Adrien Meguerditchian[1,2], Siham Bouziane[1]

1. Centre for Research in Psychology & Neurosciences, CNRS & Aix-Marseille University, 2. Station de Primatologie-Celphedia, UAR846, CNRS, Rousset

We gradually develop our sense of time through experience. It helps us predict when events will occur, allowing us to direct attention and adapt behavior accordingly. Yet even though all living beings need to make temporal predictions to survive, our understanding of the evolutionary origins of such a capacity is relatively unknown. Here we used free-access operant conditioning devices to investigate temporal predictions in 15 freely behaving captive Guinea baboons. In two separate experiments, individuals were trained to optimize their response timing by touching a target that appeared after a fixed foreperiod (FP) of either 600ms or 300ms. During the testing phase, the FP was either the trained ("standard") FP (60% of trials) or was randomly selected from one of six equiprobable shorter or longer intervals (30% of trials). In the remaining 10%, the target was absent (catch trials). Results revealed a U-shaped profile of performance with RTs being fastest for the most probable FP, getting gradually slower for increasingly shorter or longer FPs. Crucially, this pattern was observed even though all non-standard FPs were equiprobable, indicating that the metrical properties of FP duration had been implicitly integrated into baboons' performance. In addition, during the longer FP trials, baboons often responded before the target even appeared. Since most of these anticipatory responses occurred around the time of the standard FP and were produced in the absence of an external stimulus, these data suggest FP probabilities had been internalized into a temporal expectation for the standard FP. Our results demonstrate, for the first time in such a large group of non-human primates, that baboons use statistical learning of temporal probabilities to implicitly form expectations about event timing, which helps them optimize behavior. These findings contribute to the growing body of evidence suggesting that predictive timing abilities may be widespread across the primate lineage and beyond.

Keywords: temporal prediction, temporal expectation, foreperiod, statistical learning, non-human primates, ethology

Spontaneous temporal predictions in Guinea Baboons: Insights from a sequential variable foreperiod paradigm

*Siham Bouziane[1], Adrien Meguerditchian[1,2], Nicolas Claidière[1,2], Jennifer T Coull[1]

1. Centre de Recherche en Psychologie et Neurosciences, 2. Station de Primatologie-Celphedia UAR846 CNRS - Rousset France

Predicting the arrival time of an event is key to navigating our environment. Previous research on temporal predictions in non-human primates (NHPs) has primarily taken place in laboratory settings, limiting both natural engagement and sample size. Here, we adopt a naturalistic approach by studying temporal prediction in a group of 20 captive Guinea baboons, using free-access operant conditioning devices that allow for voluntary participation in cognitive tasks.In two separate studies, baboons performed a simple reaction time (RT) task in which four visual targets appeared sequentially after either regular (500 ms) or irregular (300-700ms) foreperiods (FP). In both studies, the target was more likely to appear after the "standard" 500ms FP than any of the others. Importantly, baboons were free to choose their own response speed and were not rewarded for particularly fast RTs. Nevertheless, we found significant effects of FP probability on RT. First, RTs were globally faster for temporally regular sequences than irregular sequences, indicating that the temporal predictability of the sequence speeded performance. Second, within the irregular sequences, RTs were faster for targets appearing after longer FPs, indicating an influence of the hazard function. Nevertheless, an asymmetric sequential effect revealed that RTs were also influenced by the FP of the previous target, indicating an effect of temporal trial history on performance. RTs were slower when the current FP was shorter, rather than longer, than the previous one. Most importantly, this effect varied as a function of the signed temporal difference (deltaFP) between FPs on successive trials ($FP_{current}$ - $FP_{previous}$). RTs were progressively slower as deltaFP decreased, indicating an influence of FP magnitude on performance. Finally, individual differences in performance indicated statistical learning of the most common 500ms FP, demonstrating that some baboons were sensitive to more global temporal probabilities. Our results demonstrate, for the first time in such a large group of NHPs, that baboons spontaneously use temporally predictable information to optimise performance, despite never having been trained to do so, and further informs our understanding of the evolutionary roots of time processing.

Keywords: Implicit Timing, Rhythms, Non-Human Primates, Comparative Psychology, Statistical learning

An evolutionary model of vocal accelerando in African penguins

*Yannick Jadoul[1,2,3], Taylor A. Hersh[2,4], Elias Fernández Domingos [3,5], Marco Gamba[6], Livio Favaro[6], Andrea Ravignani[1,2,7,8]

1. Department of Human Neurosciences, Sapienza University of Rome, Rome, 2. Comparative Bioacoustics Group, Max Planck Institute for Psycholinguistics, Nijmegen, 3. Artificial Intelligence Lab, Vrije Universiteit Brussel, Brussels, 4. Marine Mammal Institute, Oregon State University, Newport, Oregon, 5. Machine Learning Group, Université Libre de Bruxelles, Brussels, 6. Department of Life Sciences and Systems Biology, University of Turin, Turin, 7. Center for Music in the Brain, Department of Clinical Medicine, Aarhus University, Aarhus, 8. Research Center of Neuroscience "CRiN-Daniel Bovet", Sapienza University of Rome, Rome

In animal behavior and communication, regularly-timed movement and sounds are ubiquitous, as many underlying physiological processes generate isochronous sequences of events. When it comes to rhythm and music, however, isochrony is only the simplest building block possible. For example, accelerando is a rhythmic structure which consists of an increasing tempo throughout a temporal sequence, and has been described in a wide range of animal displays. One such display are the ecstatic display songs (EDSs) produced by African penguins. During high arousal breeding seasons, individuals produce these energetically costly, multisyllabic songs. We rhythmically analyzed recordings from 26 male African penguins and found that the vocalizations within an EDS reliably exhibit accelerando and crescendo (i.e., syllables follow each other faster and become louder as an EDS progresses). We modeled the production of these temporal sequences and their interaction and used evolutionary game theory and computer simulations to link two aspects of temporal structure, acceleration and overlap: We tested whether rhythmic accelerando could evolve under a pressure for acoustic overlap in time. Both a mathematical analysis and computational simulations of our model showed that evolutionary pressure for more overlap can indeed cause a population of initially isochronous individuals to evolve the production of sequences with a moderate level of acceleration. Our model and results demonstrate a potential evolutionary trajectory for the emergence of accelerando or other forms of tempo modulation within an initially isochronous population, and suggest new hypotheses to be tested empirically. Future studies combining empirical data and computer models in such a comparative approach can provide further insight into the function and evolutionary pressure at play, here and in other model species, and will boost our understanding of the evolution of rhythm.

Keywords: evolutionary game theory, tempo, animal communication, computer simulations

Oral | Motor, Music

Sun. Oct 19, 2025 9:00 AM - 10:30 AM JST | Sun. Oct 19, 2025 12:00 AM - 1:30 AM UTC Room 2(West B1)

[O7] Oral 7: Motor, Music

Chair:Ségolène M. R. Guérin(Université du Littoral Côte d'Opale)

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

[O7-01]

Phase-dependent encoding of motor memory

*Yuto Makino[1], Masaya Hirashima[1] (1. National Institute of Information and Communications Technology (Japan))

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

[O7-02]

Mapping Time and Space in Social Interactions with the Mirror and Rock-Paper-Scissor Games

*Julia Ayache[1,2], Marta Bieńkiewicz[2], Simon Pla[2], Pierre Jean[2], Alexander Sumich[1,3], Nadja Heym[1], Benoit G. Bardy[2] (1. NTU Psychology, Nottingham Trent University, Nottingham (UK), 2. EuroMov Digital Health in Motion, Univ. Montpellier IMT Mines Alès, Montpellier (France), 3. Department of Psychology, Auckland University of Technology, Auckland (New Zealand))

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

[O7-03]

Sharing Timing in Physical and Virtual Spaces

*Julien Laroche[1], Julia Ayache[1], Marco Coraggio[2], Angelo di Porzio[2], Francesco de Lellis[3], Anna Katharina Hebborn[4], Andreas Panayiotou[5], Lyam Pepin[6], Panayiotis Charalambous[5], Simon Pla[1], Pierre Jean[1], Mario di Bernardo[2,3], Didier Stricker[4], Benoît Bardy[1] (1. EuroMov DHM, Univ. Montpellier, IMT Alès (France), 2. Scuola Superiore Meridionale (Italy), 3. Univ. Napoli ”Federico II” (Italy), 4. German Research Center for Artificial Intelligence (Germany), 5. CYENS (Cyprus), 6. Univ. Paul Valery Montpellier, (France))

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

[O7-04]

Juggling on the Moon: Adaptation of complex motor skills to simulated low-gravity enabled changes in tempo

*John Rehner Iversen[1], Akilesh Sathyakumar[1], Hyeonseok Kim[2], Makoto Miyakoshi[2], Wanhee Cho[3], Hirokazu Tanaka[4], Takahiro Kagawa[5], Makoto Sato[3], Scott Makeig[7], Hiroyuki Kambara[6], Natsue Yoshimura[3] (1. McMaster University (Canada), 2. Cincinnati Children's Hospital Medical Center (United States of America), 3. Institute of Science Tokyo (Japan), 4. Tokyo City University (Japan), 5. Aichi Institute of Technology (Japan), 6. Tokyo Polytechnic University (Japan), 7. University of California San Diego (United States of America))

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

[O7-05]

Culture-Driven Plasticity and Imprints of Body-Movement Pace on Musical Rhythm Processing

*Ségolène M. R. Guérin[1,2], Emmanuel Coulon[2], Tomas Lenc[2,3], Rainer Polak[4], Peter Keller[5], Laurie Gallant[2], Antoine Boveroux[2], Sylvie Nozaradan[2] (1. URePSSS, Université du Littoral Côte d'Opale (France), 2. Institute of Neuroscience (IoNS), Université Catholique de Louvain (UCLouvain) (Belgium), 3. Basque Center on Cognition, Brain, and Language (BCBL) (Spain), 4.

RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo (Norway), 5. Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg (Denmark))

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

[O7-06]

Evidence for neural categorization of rhythm in human newborns

*Francesca M. Barbero[1], Tomas Lenc[1,2], Alban Gallard[3], Nori Jacoby[4,5], Rainer Polak[6,7], Arthur Foulon[3], Sahar Moghimi[3], Sylvie Nozaradan[1,8] (1. Institute of Neuroscience (IoNS), University of Louvain (UCLouvain), 1348 Louvain-la-Neuve (Belgium), 2. Basque Center on Cognition, Brain and Language (BCBL), Donostia-San Sebastian (Spain), 3. Groupe de Recherches sur l'Analyse Multimodale de la Fonction Cérébrale (GRAMFC, Inserm UMR1105), Université de Picardie, 80054 Amiens (France), 4. Computational Auditory Perception Group, Max Planck Institute for Empirical Aesthetics, Grüneburgweg 14, 60322 Frankfurt am Main (Germany), 5. Department of Psychology, Cornell University, Ithaca, NY 14853 (United States of America), 6. RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo (Norway), 7. Department of Musicology, University of Oslo (Norway), 8. International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal (Canada))

Phase-dependent encoding of motor memory

*Yuto Makino[1], Masaya Hirashima[1]

1. National Institute of Information and Communications Technology

Motor behaviors are highly flexible across temporal and spatial scales. For example, when writing a letter, its geometric pattern is preserved despite variations in scale and speed (Viviani & Terzuolo, 1980). Such flexibility cannot be fully explained by internal representations based on movement states (Sing et al., 2009) or absolute time. Instead, the brain may rely on a more abstract representation that captures the temporal progression relative to its overall structure. Here, we propose the existence of phase-dependent motor primitives, where phase defines the normalized temporal position within a movement. In Experiment 1, participants adapted to an S-shaped force during an 8 cm (or 16 cm) reach, where the force reversed midway. They then produced similar force patterns in untrained 16 cm (or 8 cm) reaches. This generalization cannot be explained by movement states alone, suggesting the involvement of an abstract feature such as phase, which, in a single reach, is difficult to separate from acceleration. In Experiment 2, we dissociated phase from acceleration using a double-reach task. Opposing force fields were applied to either the first or second half of the overall movement. If the same motor primitives had been engaged in both halves, interference would be expected. However, participants successfully learned both fields, suggesting a separation of motor primitives between the first and second halves of the movement. In Experiment 3, we used a button–reach–button task to dissociate the reach phase within the overall movement sequence from the ordinal position of the reach itself. Participants learned opposing force fields depending on phase (at one-quarter vs. three-quarters in the overall movement). Since the reach was always the second action, the observed separation of motor primitives must be attributed to its phase within the overall sequence. These results suggest that internal models are organized according to phase within a unified motor sequence.

Keywords: Motor learning, Phase , Motor primitives

Mapping Time and Space in Social Interactions with the Mirror and Rock-Paper-Scissor Games

*Julia Ayache[1,2], Marta Bieńkiewicz[2], Simon Pla[2], Pierre Jean[2], Alexander Sumich[1,3], Nadja Heym[1], Benoit G. Bardy[2]

1. NTU Psychology, Nottingham Trent University, Nottingham, 2. EuroMov Digital Health in Motion, Univ. Montpellier IMT Mines Alès, Montpellier, 3. Department of Psychology, Auckland University of Technology, Auckland

Introduction. During social interactions, individuals tend to fall into synchrony (i.e., temporal matching) and imitate each other (i.e., spatial matching). While synchrony and imitation have attracted considerable attention due to their association with affiliative tendencies, they are seldom investigated simultaneously. Furthermore, although often regarded as markers of “successful” interactions, being temporally and spatially matched is not always optimal for “efficient” interactions. Consequently, this study investigated the association between synchrony and imitation using two social interaction games known to elicit these behaviors: the Mirror and Rock-Paper-Scissors (RPS) games.

Methods. Twenty-six dyads completed the Mirror and the RPS games under three visual coupling conditions: (i) OPEN, where both participants could see each other; (ii) MIXED, where only one participant could see the other; and (iii) CLOSED, where neither could see the other. The OPEN and CLOSED conditions were counterbalanced across dyads to control for order effects. Movements were recorded using infrared cameras, and participants completed self-report measures of affective state and self-other overlap before and after each interaction

Results. Visual coupling influenced emotional arousal, perceived self-other overlap, and behavioral matching. When participants could see each other, they reported feeling more connected and aroused, and demonstrated increased spatiotemporal alignment in both the Mirror and RPS games. Notably, behavioral synchrony during the Mirror Game predicted imitation tendencies in the subsequent RPS game.

Conclusion. These findings suggest a robust link between temporal and spatial alignment, even in competitive contexts. Participants who exhibited stronger behavioral synchrony in the Mirror Game were more likely to adopt similar RPS strategies, indicating that coordinated movement may foster shared cognitive patterns. Ongoing analyses of EEG synchrony and inter-individual differences may further elucidate the neural and dispositional underpinnings of this association between acting and thinking together.

Keywords: Behavioral Matching, Synchrony, Imitation, Mirror Game, Rock-Paper Scissor Game

Sharing Timing in Physical and Virtual Spaces

*Julien Laroche[1], Julia Ayache[1], Marco Coraggio[2], Angelo di Porzio[2], Francesco de Lellis[3], Anna Katharina Hebborn[4], Andreas Panayiotou[5], Lyam Pepin[6], Panayiotis Charalambous[5], Simon Pla[1], Pierre Jean[1], Mario di Bernardo[2,3], Didier Stricker[4], Benoît Bardy[1]

1. EuroMov DHM, Univ. Montpellier, IMT Alès, 2. Scuola Superiore Meridionale, 3. Univ. Napoli "Federico II", 4. German Research Center for Artificial Intelligence, 5. CYENS, 6. Univ. Paul Valery Montpellier,

Communicating and connecting with others relies on fine-tuned embodied coordination. Yet, as our social lives increasingly shift online where movement cues become impoverished, our ability to connect meaningfully is getting challenged. While Virtual Reality (VR) offers promising opportunities for embodied interaction in digital spaces, little is known about how to best capture, render and foster embodied coordination in this medium. Hence the ShareSpace project aims to better understand the constraints of virtual spaces on multi-agent embodied coordination, with the goal to optimize both motion capture and rendering.We report a series of studies on group movement coordination performed in both physical and virtual reality. In the first two studies, triads and quartets synchronized arm movements and reported their experiences of social connection. Results show that the kinematic and social benefits of group synchrony observed in physical reality transfer to VR. However, while people accelerated their pace when synchronizing in physical settings, this tendency was reversed in VR, showing how digital constraints can alter coordination strategies. In a subsequent VR study, we restricted participants' field of view to examine their interaction strategies, and in some cases, replaced one human partner with an adaptive artificial agent. This agent shared a similar appearance but was driven by a cognitive architecture optimized for group coordination. The presence of the adaptive agent led to an increase in movement pacing, suggesting that it could counteract the decelerating effects of digital interaction on collective kinematics. Most participants did not detect the agent swap yet reported feeling less socially connected to partners who had been replaced. These findings show the critical role of subtle kinematic cues in social coordination and offer new guidelines to design hybrid digital spaces that support authentic group interaction.

Keywords: Group synchronization, Virtual Reality, Social connection, Artificial Agent

Juggling on the Moon: Adaptation of complex motor skills to simulated low-gravity enabled changes in tempo

*John Rehner Iversen[1], Akilesh Sathyakumar[1], Hyeonseok Kim[2], Makoto Miyakoshi[2], Wanhee Cho [3], Hirokazu Tanaka[4], Takahiro Kagawa[5], Makoto Sato[3], Scott Makeig[7], Hiroyuki Kambara[6], Natsue Yoshimura[3]

1. McMaster University, 2. Cincinnati Children's Hospital Medical Center, 3. Institute of Science Tokyo, 4. Tokyo City University, 5. Aichi Institute of Technology, 6. Tokyo Polytechnic University, 7. University of California San Diego

Many commonly used rhythmic timing tasks can be easily varied in tempo, revealing important scaling laws of timing behavior and aiding learning. In contrast, it is more challenging to vary the tempo of real-world physical tasks like three-ball juggling. To address this, our collaborators have developed a realistic VR visuo-haptic simulation of juggling under reduced gravity using a novel force-generating input device to realistically simulate the physics and proprioception of ball throwing and catching (Kambara et al, *Proc IDW*, 2022). The setup enables the experimental modification of juggling tempo in a way that is not possible in physical settings. Our prior work has shown that juggling training in reduced gravity can enhance skill acquisition in novices, potentially by facilitating the learning of bimanual motor sequencing. (Cho et al., *IEEE VRW*, 2025). Here we shift focus to expert jugglers adapting to slow tempo juggling to test hypotheses about temporal scaling in motor control: proportional scaling vs. constant hold time (which relate to the continuous vs. discrete timing duality in the rhythmic timing literature). We measured motor kinematics (hand trajectories and timing of ball catches and throws) in relation to ball trajectory to describe how these scale with juggling tempo manipulated by changing simulated gravity. Our initial results (though n=2) are that a third alternative is suggested: jugglers attempt to increase tempo in low gravity by using shorter throws. This behavior may reflect VR-specific constraints, such as narrower field of view and less realistic proprioceptive feedback, prompting design improvements including pacing stimuli and visual apex targets to encourage slower juggling. This behavioral foundation supports planned neural studies of temporal scaling of neural dynamics using new methods for movement artifact rejection (Kim et al., *Sensors*, 2023; *J Neur Meth*, 2025).

Keywords: motor learning, adaptation, timing, rhythm, tempo, juggling

Culture-Driven Plasticity and Imprints of Body-Movement Pace on Musical Rhythm Processing

*Ségolène M. R. Guérin[1,2], Emmanuel Coulon[2], Tomas Lenc[2,3], Rainer Polak[4], Peter Keller[5], Laurie Gallant[2], Antoine Boveroux[2], Sylvie Nozaradan[2]

1. URePSSS, Université du Littoral Côte d'Opale, 2. Institute of Neuroscience (IoNS), Université Catholique de Louvain (UCLouvain), 3. Basque Center on Cognition, Brain, and Language (BCBL), 4. RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, 5. Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg

Music naturally induces human movement through its rhythmic structure. Conversely, synchronised body movement can shape rhythm perception –a short-term effect that is likely influenced itself by lifelong cultural exposure. Yet, direct experimental evidence for both short- and long-term modulation of rhythm processing through movement remains limited.

To address this, we present a registered report using electroencephalography (EEG) and hand-clapping responses to a highly syncopated, metrically ambiguous rhythm derived from West/Central African musical traditions (N = 80). These neural and behavioural responses were recorded separately in participants from West/Central Africa and Western Europe before and after a body-movement session involving stepping and clapping to a cued beat (either three- or four-beats meter, the latter concurring with original music-cultural conventions).

African participants exhibited a significant short-term effect, clapping more consistently and in closer alignment with the beat as cued in the body-movement session. They also more reliably interpreted the rhythm in line with cultural conventions, both before and after movement. In contrast, European participants showed no significant short-term movement effect. A sibling study was then conducted on an additional Western cohort (N = 40), where the body movement session was replaced by watching audiovisual clips of individuals performing the same body movement as in the first study, while remaining still. In contrast with Study 1, behavioural responses to the cued beat were found to be significantly more consistent after the training session, suggesting that multisensory inputs, possibly activating motor representation without actual movement production, can elicit a short-term effect even when production of actual movement does not.

Finally, inconsistencies between neural and behavioural data in both studies suggest that a brief training session alone may not robustly stabilise a beat interpretation that can be automatically reactivated in neural activity after the movement cessation, particularly in response to a complex, syncopated rhythm. Nonetheless, when participants are compelled to move to such a rhythm, they can draw on learnt beat–rhythm association to guide movement timing.

Keywords: cross-cultural, EEG, frequency tagging, rhythmic entrainment, body movements

Evidence for neural categorization of rhythm in human newborns

*Francesca M. Barbero[1], Tomas Lenc[1,2], Alban Gallard[3], Nori Jacoby[4,5], Rainer Polak[6,7], Arthur Foulon[3], Sahar Moghimi[3], Sylvie Nozaradan[1,8]

1. Institute of Neuroscience (IoNS), University of Louvain (UCLouvain), 1348 Louvain-la-Neuve, 2. Basque Center on Cognition, Brain and Language (BCBL), Donostia-San Sebastian, 3. Groupe de Recherches sur l' Analyse Multimodale de la Fonction Cérébrale (GRAMFC, Inserm UMR1105), Université de Picardie, 80054 Amiens, 4. Computational Auditory Perception Group, Max Planck Institute for Empirical Aesthetics, Grüneburgweg 14, 60322 Frankfurt am Main, 5. Department of Psychology, Cornell University, Ithaca, NY 14853, 6. RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, 7. Department of Musicology, University of Oslo, 8. International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal

Humans show an outstanding capacity to perceive, learn, and produce musical rhythms. These skills rely on mapping the infinite space of possible rhythmic sensory inputs onto a finite set of internal rhythm categories. What are the brain processes underlying rhythm categorization? One view is that rhythm categories stem from neurobiological predispositions constraining internal representations of rhythmic inputs. However, a growing body of work suggests that rhythm categorization is plastic, open to be shaped by experience over the course of life. To tease apart the relative contributions of neurobiological predispositions and experience in rhythm categorization, we measured neural responses to rhythm in healthy full-term human neonates, capitalizing on their minimal post-natal experience.
Scalp electroencephalography (EEG) was recorded from newborns while they were exposed to acoustic sequences consisting of repeating patterns of two inter-onset intervals ranging from isochrony (1:1 interval ratio) to long-short patterns (2:1 ratio). In a second experiment, we separately recorded neural (EEG) and behavioral (sensorimotor synchronization) responses to the same rhythms in adult participants. The data were analyzed using a novel approach combining frequency-domain and representational similarity analyses.
Preliminary results indicate significant rhythm categorization in neonates, with categories encompassing the 1:1 and 2:1 integer ratio rhythms, and with a categorical structure similar to the neural and behavioral responses of adults. These findings suggest that internal representations of rhythm may be biased towards categorical structure by neurobiological properties already in place at birth. This study thus paves the way to further investigate the neural processes by which these internal categories would be further shaped by individual and cultural experience, leading to the diversity in music perception and behaviors observed worldwide.

Keywords: musical behavior, development, rhythm perception, electroencephalography

Oral | Timing & Time Perception

Sun. Oct 19, 2025 10:45 AM - 12:15 PM JST | Sun. Oct 19, 2025 1:45 AM - 3:15 AM UTC Room 2(West B1)

[O9] Oral 9: Timing & Time Perception

Chair:Sae Kaneko(Hokkaido University)

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

[O9-01]

How each heartbeat shapes neural processing of duration?

*Irena Arslanova[1], Magda Jaglinska[2], Manos Tsakiris[1] (1. Royal Holloway University of London (UK), 2. University College London (UK))

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

[O9-02]

Mechanisms of Time Perception: Roles of Time-Frequency Power and Cross-Frequency Coupling

*Tereza Nekovarova[1,2], Veronika Rudolfova[1,2], Kristyna Maleninska[1], Ondrej Skrla[1], Jakub Svoboda[1], Jana Koprivova[1,3], Martin Brunovsky[1,3], Vlastimil Koudelka[1] (1. National Institute of Mental Health (Czech Republic), 2. Faculty of Natural Science, Charles University (Czech Republic), 3. 3rd Faculty of Medicine (Czech Republic))

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

[O9-03]

Intra- and inter-individual variability in body-brain-behavioral rhythms: a multimodal study with smart wearables

*Antonio Criscuolo[1], Michael Schwartze[1], Sonja Kotz[1,2] (1. Maastricht University (Netherlands), 2. Max Planck Institute for Human Cognitive and Brain Sciences (Germany))

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

[O9-04]

Ontogeny of rhythmic performances and contribution of motor and perceptual rhythmic preferences

*Pier-Alexandre Rioux[1], Nicola Thibault[1,2], Daniel Fortin-Guichard[3], Émilie Cloutier-Debaque[4], Simon Grondin[1] (1. Laval University (Canada), 2. CERVO, Brain Research Center (Canada), 3. McGill University (Canada), 4. University of Montreal Hospital Center (Canada))

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

[O9-05]

Representational dynamics of subjective duration in the human brain

*Camille L. Grasso[1], Ladislas Nalborczyk[2], Virginie van Wassenhove[1] (1. CEA/DRF/Inst. Joliot, NeuroSpin; INSERM, Cognitive Neuroimaging Unit; Université Paris-Saclay, Gif/Yvette, 91191 France (France), 2. Aix Marseille University, CNRS, LPL (France))

12:00 PM - 12:15 PM JST | 3:00 AM - 3:15 AM UTC

[O9-06]

Mouse Strain Differences in Time Estimation are Related to Impulsive Behavior

*MARIELENA EUDAVE-PATIÑO[1], JONATHAN BURITICÁ[2], JAIME EMMANUEL ALCALÁ TEMORES [2] (1. UNIVERSIDAD AUTÓNOMA DE AGUASCALIENTES (Mexico), 2. UNIVERSIDAD DE GUADALAJARA (Mexico))

How each heartbeat shapes neural processing of duration?

*Irena Arslanova[1], Magda Jaglinska[2], Manos Tsakiris[1]

1. Royal Holloway University of London, 2. University College London

We previously showed that perceived stimulus duration was distorted by autonomic signals arising from the heart, and that this temporal distortion was modulated by experienced arousal (Arslanova et al., 2023; Current Biology). Here, we present two studies that reveal the neural mechanisms underlying these effects using electroencephalography (EEG), testing if and how the subjective experience of duration arises from an intricate brain-heart interplay.

The first EEG study examined the neural correlates of temporal distortions when cardiac signals impacted emotionally neutral stimuli (i.e., participants judged the duration of visual Gabor patches), whereas the second EEG study focused on cardiac effects on duration perception under different levels of experienced arousal (i.e., participants judge the duration of faces showing neutral of fearful expression). The first EEG study (N = 40) showed that cardiac signalling supressed later stages of visual processing, which was correlated with contraction of perceived durations. The second EEG study (N = 41) revealed distinct mechanisms by which arousal and cardiac signals shape subjective duration perception –an early modulation by arousal, followed by a later modulation by cardiac signal.

Overall, these results reveal how cardiac signals shape subjective time experience by exerting top-down attenuation of sensory processing, how temporal information may be intrinsic to sensory response, and how affective context drives the effect of the heart on our sense of duration.

Keywords: duration perception, heart, cardiac phase, interoception, EEG

Mechanisms of Time Perception: Roles of Time-Frequency Power and Cross-Frequency Coupling

*Tereza Nekovarova[1,2], Veronika Rudolfova[1,2], Kristyna Maleninska[1], Ondrej Skrla[1], Jakub Svoboda[1], Jana Koprivova[1,3], Martin Brunovsky[1,3], Vlastimil Koudelka[1]

1. National Institute of Mental Health, 2. Faculty of Natural Science, Charles University, 3. 3rd Faculty of Medicine

Time perception in milliseconds to seconds range depends on complex neural dynamics, but its electrophysiological correlates remain poorly understood. This study examines how EEG mechanisms (cross-frequency coupling and EEG band power) relate to the precision and accuracy of temporal estimation.To investigate time perception, we used a pair-comparison task, where two sequential visual stimuli representing time intervals (3.2–6.4 s each, with a total duration of 9.6 s) were presented, and participants indicated which of these two intervals was longer. EEG data were recorded from 36 electrodes (10/20 system) at 1000 Hz, and preprocessed with bandpass filtering between 0.15–70 Hz.Linear regression models with regularization were applied to predict key metrics of temporal accuracy/precision: Point of Subjective Equality (PSE) and Just Noticeable Difference (JND), using PACz (phase-amplitude coupling) and frequency powers as predictors. The model was trained on data from the first session and tested on data from the second session to validate accuracy/precision predictions.A characteristic pattern of alpha and beta band activity –including reduced beta power –was observed in both power and coupling during the early part of the interval, and was associated with improved temporal discrimination. These findings highlight the role of oscillatory dynamics and frequency coupling in time perception.
Acknowledgment:This work was supported by the Johannes Amos Comenius Programme (OP JAK), project reg. no. CZ.02.01.01/00/23_025/0008715 and by the grant from the Ministry of Health Czech Republic (no. NU 22-04-00526).

Keywords: interval timing, pair-comparison task, EEG, phase-amplitude coupling

Intra- and inter-individual variability in body-brain-behavioral rhythms: a multimodal study with smart wearables

*Antonio Criscuolo[1], Michael Schwartze[1], Sonja Kotz[1,2]

1. Maastricht University, 2. Max Planck Institute for Human Cognitive and Brain Sciences

Our sensory environment features a multitude of temporal regularities: there are temporally regular patterns in speech and music, as well as in bodily physiological activity.Is there a precise relationship between individual bodily (e.g., cardiac) and behavioral (e.g., walking) rhythms? Some authors suggested the existence of a cross-frequency architecture characterized by harmonic relations [1]: if your heart beats at 1.25Hz, your breathing rate may be a subharmonic (˜.25Hz), while the speaking rate an harmonic (syllable rate: ˜2.5Hz). The same may hold for perception and synchronization: sensory processing may prefer input at harmonic relations with your heartbeat, and you may synchronize more easily to music in close proximity to your preferred tempo.In an ongoing study, we are using a combination of smart wearable technology (fitness tracker, mobile EEG, smart glasses), to assess individual breathing, cardiac and brain signals, along with eye movements, pupil dilation and motion tracking. Participants engage in a series of tasks ranging from resting state and listening tasks, to spontaneous tapping, speaking and walking. Within a dynamic system framework [2], our goals are to: (i) characterize intra- and inter-individual variability in body-brain-behavioral rhythms; (ii) test the hypothesis of individual cross-frequency architectures in body-behavioral rhythms; (iii) describing if and how dynamic body-brain interactions shape perception and action.Findings promise to advance our understanding of how complex body-brain interactions shape information processing, behavior and adaptation. Promoting individualized and integrative research approaches, our results may further support translational research in clinical populations characterized by altered rhythms (e.g., Parkinson’s).

References

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Keywords: rhythm, body-brain interactions, smart wearable, perception, action

Ontogeny of rhythmic performances and contribution of motor and perceptual rhythmic preferences

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1. Laval University, 2. CERVO, Brain Research Center, 3. McGill University, 4. University of Montreal Hospital Center

According to the entrainment region hypothesis, the range of tempi with which individuals can synchronize broadens during childhood. This developmental change is accompanied by a slowing of rhythmic preferences, as covered by the preferred period hypothesis. The later hypothesis posits that both motor and perceptual rhythmic preferences slow down throughout childhood, reflecting an increase in the common period of endogenous oscillations. This study aimed to provide a developmental profile of rhythmic performances (counting and tempo discrimination), while investigating the related contributions of a preferred period (spontaneous motor tempo and perceptual preferred tempo). The study (N = 70) included three groups of children (5-6, 8-9, and 11-12 years) and one group of young adults (21-30 years), all tested at the same time of day. The results show a change in rhythmic performances between the ages of 8-9 and 11-12, as well as a variable contribution of rhythmic preferences, depending on the task employed. Moreover, results indicate a significant effect of rhythmic context in tempo discrimination, suggesting that young children can discriminate tempi slower than their rhythmic preferences. This study nuances the bias of rhythmic performance towards rhythmic preferences, notably because the tasks employed to measure rhythmic performance indicate different developmental trajectories, in addition to varying in their relationships to rhythmic preferences. It is suggested that the cognitive demands relative to the task employed to measure rhythmic performances could underlie developmental differences and mask biases towards rhythmic preferences, particularly in younger children.

Keywords: Rhythm, Preferred Tempo, Entrainment, Development

Representational dynamics of subjective duration in the human brain

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How is time represented in the mind and brain? While durations are often thought to be mapped along a mental timeline (*i.e., a unidimensional spatialized representation of durations*), such a view may oversimplify the complexity of temporal representations. In this talk, I will present a project that investigates the geometry of duration representations by combining behavioral similarity judgments and representational similarity analysis of EEG data. We asked participants to rate the similarity of pairs of auditory durations and, in a separate session, recorded EEG while they performed an oddball detection task with the same stimuli. These data were used to construct representational dissimilarity matrices, which we projected into lower-dimensional spaces to visualize and compare the conceptual and neural structure of duration representations. Crucially, we explored whether the structure of neural responses could predict participants' behavioral similarity judgments, and whether these shared structures reflected non-linear or multi-dimensional embeddings—such as helical structures—rather than simple linear mappings. We further examined how classic EEG markers of timing, such as the contingent negative variation, relate to these geometrical structures. This work contributes to a growing line of research aiming to uncover the geometry of mental representations and offers a new perspective on how durations may be encoded in the brain.

Keywords: temporal cognition, subjective duration, neural dynamics , representational dynamics

Mouse Strain Differences in Time Estimation are Related to Impulsive Behavior

*MARIELENA EUDAVE-PATIÑO[1], JONATHAN BURITICÁ[2], JAIME EMMANUEL ALCALÁ TEMORES [2]

1. UNIVERSIDAD AUTÓNOMA DE AGUASCALIENTES , 2. UNIVERSIDAD DE GUADALAJARA

Differences between mouse strains have significantly impacted the results of various studies; however, the underlying sources of these differences remain unclear. Differences among mouse strains have been observed in locomotor activity, lever and nosepoke responses, impulsivity, and temporal estimation. Some studies suggest that these differences may be linked to genetics of the strains, although further research is needed to clarify these findings. The objective of this experiment was to test CD1 and C57BL/6 strains using a peak procedure, a progressive ratio schedule, a modified peak procedure, and a differential reinforcement of low rate (DRL) schedule. These procedures were used to determine whether there were differences in time estimation and the factors influencing performance on such schedules. The analysis of the curvature index in fixed interval (FI), peak, and modified peak procedures revealed that CD1 mice exhibited a higher curvature index compared to C57BL/6 mice. Additionally, differences in performance were observed in the analysis of peak trials within the peak and modified peak procedures, with CD1 mice showing a higher response rate at the start of the trial compared to C57BL/6 mice. In the progressive ratio, the post-reinforcement pause was longer in the C57BL/6 strain than in CD1 mice, but no significant differences were found in breakpoint levels between the two strains. In DRL procedure, C57BL/6 mice displayed higher inter-response times (IRTs) compared to CD1 mice, and the distribution of IRTs differed according to strain. These results indicate that there are strain-related differences in postprandial behavior that may be associated with impulsivity. Specifically, CD1 mice appear to exhibit greater impulsivity compared to C57BL/6 mice, as evidenced by their behavioral patterns in the tasks analyzed

Keywords: temporal estimation, strain differences, impulsive behavior, mice

Oral | EEG, MRI, TMS

Sun. Oct 19, 2025 1:00 PM - 2:30 PM JST | Sun. Oct 19, 2025 4:00 AM - 5:30 AM UTC Room 3(East B1)

[O10] Oral 10: EEG, MRI, TMS

Chair:Masamichi J Hayashi(Center for Information and Neural Networks (CiNet))

1:00 PM - 1:15 PM JST | 4:00 AM - 4:15 AM UTC

[O10-01]

Common EEG connectivity patterns between time reproduction and working memory

*Sergio Rivera-Tello[1], Julieta Ramos-Loyo[1] (1. University of Guadalajara (Mexico))

1:15 PM - 1:30 PM JST | 4:15 AM - 4:30 AM UTC

[O10-02]

Perception of short, but not long, time intervals is modality-specific: Converging electroencephalography evidence from vibrotactile and auditory modalities

*Nicola Thibault[1,2], Pier-Alexandre Rioux[1], Andréanne Sharp[1,2], Philippe Albouy[1,2,3], Simon Grondin[1] (1. Université Laval (Canada), 2. CERVO Brain Research Centre (Canada), 3. International Laboratory for Brain (Canada))

1:30 PM - 1:45 PM JST | 4:30 AM - 4:45 AM UTC

[O10-03]

Orthogonal Codes for Time and Decision in Human Temporal Perception

*Andre Mascioli Cravo[1], Mateus Silvestrin[3], Peter Maurice Erna Claessens[1], Nicholas Myers[2] (1. Universidade Federal do ABC (UFABC) (Brazil), 2. School of Psychology, University of Nottingham, UK (UK), 3. Federal University of the São Francisco Valley (Brazil))

1:45 PM - 2:00 PM JST | 4:45 AM - 5:00 AM UTC

[O10-04]

Shared spectral fingerprints of temporal memory precision and representation of the temporal structure of complex narratives

*Matteo Frisoni[1], Pierpaolo Croce[2], Annalisa Tosoni[2], Filippo Zappasodi[2], Carlo Sestieri[2] (1. University of Bologna (Italy), 2. University D'Annunzio Chieti Pescara (Italy))

2:00 PM - 2:15 PM JST | 5:00 AM - 5:15 AM UTC

[O10-05]

Defining a functional hierarchy of millisecond time: from visual stimulus processing to duration perception

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

2:15 PM - 2:30 PM JST | 5:15 AM - 5:30 AM UTC

[O10-06]

The chronometry of time processing in visual and premotor areas

*Domenica Bueti[1] (1. International School for Advanced Studies (SISSA) (Italy))

Common EEG connectivity patterns between time reproduction and working memory

*Sergio Rivera-Tello[1], Julieta Ramos-Loyo[1]

1. University of Guadalajara

Time perception is a fundamental cognitive ability crucial for survival, relying on the integration of multiple processes, including working memory (WM)—the brain's capacity to temporarily encode, maintain, and manipulate information. Both functions depend on the synchronization and coupling of brain rhythms. Previous literature has suggested a strong relationship between both processes, where higher WM-capacity correlates with higher timing accuracy. Here we examined EEG correlation patterns during intervallic time reproduction, 2.5 s, and a letter n-back task (2-level). Fifty-two participants (28 women) performed both tasks. EEG correlation matrices were computed for each frequency band (theta, alpha1, alpha2 and beta1), then we compute a similarity test to compare connectivity patterns between 2-back and time reproduction. Results indicate similar connectivity patterns mainly in theta (*rho=77*) and alpha2 (*rho=63*) bands. We also found a behavioral relationship between WM-capacity and temporal precision (*r=0.49*). These findings contribute to understanding the shared oscillating mechanisms between time perception and working memory, offering insights into brain connectivity dynamics.

Keywords: EEG, Connectivity, Working Memory, Time Reproduction

Perception of short, but not long, time intervals is modality-specific: Converging electroencephalography evidence from vibrotactile and auditory modalities

*Nicola Thibault[1,2], Pier-Alexandre Rioux[1], Andréanne Sharp[1,2], Philippe Albouy[1,2,3], Simon Grondin[1]

1. Université Laval, 2. CERVO Brain Research Centre, 3. International Laboratory for Brain

A longstanding debate in cognitive neuroscience questions whether temporal processing is modality-specific or governed by a "central clock" mechanism. We propose that this debate stems from neglecting the duration of the intervals processed, as studies supporting modality-specific models of time perception often focus on below 1.2-s intervals. To address this, we studied the neuronal dynamics underlying the vibro-tactile perception of time intervals shorter and longer than 1.2-s. Twenty participants underwent electroencephalography recordings during a passive vibrotactile oddball paradigm. We compared brain responses to standard and deviant intervals, with deviants occurring either earlier or later than the standard in both below and above 1.2-s conditions. Event-related potentials revealed distinct deviance-related components: a P250 for deviance detection of below 1.2s and an N400 deviants for above 1.2s. Generators lied in a modality-specific network for below 1.2s intervals, while above 1.2s intervals activated a broader, higher-level network. We found no evidence of the contingent negative variation in the tactile modality, questioning its role as a universal marker of temporal accumulation. Our findings suggest that short intervals involve modality-specific circuits, while longer intervals engage distributed networks, shedding light on whether temporal processing is centralized or distributed. These findings are also in line with our previous results (Thibault al., 2023, 2024) using the auditory modality, where short auditory intervals recruited sensory regions while longer intervals elicited a more distributed network.

Keywords: EEG, Intervals, Oddball, Time perception, Vibrotactile

Orthogonal Codes for Time and Decision in Human Temporal Perception

*Andre Mascioli Cravo[1], Mateus Silvestrin[3], Peter Maurice Erna Claessens[1], Nicholas Myers[2]

1. Universidade Federal do ABC (UFABC), 2. School of Psychology, University of Nottingham, UK, 3. Federal University of the São Francisco Valley

Time perception involves estimating physical durations and making categorical judgments relative to reference intervals. However, most studies conflate these processes, limiting insight into how they are encoded in brain activity. Here, we used EEG and multivariate pattern analysis (MVPA) to dissociate neural representations of time and decision during a temporal discrimination task. Thirty participants compared variable intervals to block-specific references, with duration and categorical status (shorter, equal, or longer) manipulated orthogonally. Behaviorally, responses were shaped by target duration, categorical judgment, and recent trial history. An Internal Reference Model (IRM) indicated that participants dynamically updated their internal reference over trials. MVPA showed that both physical duration and categorical decision information were encoded throughout the trial, though with distinct temporal profiles. These signals were represented along orthogonal neural dimensions, enabling their separation in brain activity. These findings suggest that time perception relies on parallel, functionally distinct processes for tracking duration and making temporal decisions, supporting models that treat them as independent components of temporal evaluation.

Keywords: Temporal decision, EEG, MVPA

Shared spectral fingerprints of temporal memory precision and representation of the temporal structure of complex narratives

*Matteo Frisoni[1], Pierpaolo Croce[2], Annalisa Tosoni[2], Filippo Zappasodi[2], Carlo Sestieri[2]

1. University of Bologna, 2. University D'Annunzio Chieti Pescara

The ability to organize events in time is a hallmark of episodic memory. fMRI studies have implicated the entorhinal-hippocampal system in temporal precision and event structure representation. However, little is known about the temporal dynamics and broader neural substrates of these processes. This EEG study explored (a) whether temporal precision and structural representation are related, (b) when they occur, and (c) whether they involve areas beyond the medial temporal lobe. Twenty participants viewed a movie and later placed short video clips on a horizontal timeline, estimating their time of occurrence. This task provided behavioral indices of temporal precision and subjective distances between clips. We applied multivariate pattern analysis (MVPA) on time-frequency EEG data to decode temporal precision, and representational similarity analysis (RSA) to compare neural and behavioral distances. MVPA revealed a signature of temporal precision in the high beta/low gamma range (28–40 Hz) during timeline presentation. Crucially, RSA showed that the same time-frequency window reflected the structure of temporal representations: brain activity patterns across all electrodes scaled with participants' perceived temporal distances. The two measures—precision and structure—were also correlated: greater accuracy aligned with more structured representations. We found that oscillatory activity in the high beta/low gamma frequency codes for temporal memory precision. And the same widespread distribution of activity also codes for the mnemonic representation of the temporal structure of the event. These results bridge the gap between separate recent findings in the literature on temporal memory for complex events, and shed new light on how complex events of our life become “infused with time”.

Keywords: temporal memory, episodic memory, EEG, temporal event representation, movies

Defining a functional hierarchy of millisecond time: from visual stimulus processing to duration perception

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

1. International School for Advanced Studies (SISSA)

In humans, the neural processing of millisecond time recruits a wide network of brain areas and involves different types of neural responses. Unimodal tuning to stimulus duration, for example, has been observed in some of these regions, though its presence is either inconsistently reported or appears redundant along the cortical hierarchy. Moreover, how duration tuning supports perception or contributes to different functional outcomes remains largely unexplored. To address these gaps, we measured brain activity using ultra-high-field (7T) functional MRI while participants performed a visual duration discrimination task. Using neuronal-based modeling, we estimated unimodal responses to durations across numerous cortical areas, defined with high anatomical precision. In the parietal and premotor cortices, as well as the caudal supplementary motor area (SMA), we observed neuronal populations tuned to the entire range of presented durations, with a clear topographic organization. In contrast, in the rostral SMA, inferior frontal cortex, and anterior insula, neuronal units showed duration preferences centered around the mean of the presented range. These preferences also correlated with the perceptual boundary that participants used to perform the task. The observed differences in tuning preferences, their spatial clustering, and their behavioral correlations suggest specialized functional roles across cortical regions in temporal processing—from an abstract duration representation for readout and motor-related goals in the parietal and premotor cortices, to a categorical and subjective duration representation in the insula and inferior frontal cortex. In line with these hypothesized roles, we also observed distinct patterns of correlation in duration preferences across these areas. Collectively, our findings provide a comprehensive framework of duration processing and perception in vision, highlighting its distributed and hierarchical nature.

Keywords: duration tuning, duration perception, 7T-fMRI, temporal hierarchy

The chronometry of time processing in visual and premotor areas

*Domenica Bueti[1]

1. International School for Advanced Studies (SISSA)

In humans, processing the duration of a visual event involves a network of brain areas, including the primary visual cortex (V1) and supplementary motor area (SMA). However, their functional roles in temporal computation remain unclear. A simple hypothesis is that V1, conveying sensory input, encodes duration, while SMA, at the top of a processing hierarchy, decodes it for task-related purposes. We tested this in two transcranial magnetic stimulation (TMS) studies, one of which combined twin-coil TMS with EEG, to investigate the direction and timing of V1–SMA communication. In both studies, TMS was applied while healthy volunteers (n = 15 per study) performed a visual duration discrimination task. In Study 1, paired-pulse TMS (ppTMS) was applied over right V1, SMA, or Vertex (control site) at four time points (0%, 60%, 90%, 100%) relative to the first stimulus onset. Compared to Vertex, ppTMS over V1 at 60% and SMA at 90% and 100% significantly impaired discrimination thresholds. We modeled the data using four variants of a leaky integrator model differing in the locus (input vs. perceptual) and nature (mean vs. variance) of TMS-induced noise. The best-fitting models suggested that TMS increased noise variance, with V1 and SMA effects best explained by interference at the input and perceptual levels, respectively.In Study 2, TMS was delivered within-trial over both regions in two orders (V1–SMA vs. SMA–V1) and at varying inter-pulse intervals (IPIs). Performance was most impaired when TMS was applied to SMA at stimulus offset, followed 0.1 s later by V1 stimulation. This impairment correlated with reduced EEG-based duration representation. Moreover, alpha power predicted decision criteria at long IPIs, with stronger alpha linked to a more conservative bias. These findings reveal distinct roles of V1 and SMA in duration processing and provide causal evidence for feedback communication and the role of alpha oscillations in temporal decision-making.

Keywords: Neural mechanisms, TMS EEG , Computational modelling

Poster | Other

Sun. Oct 19, 2025 12:45 PM - 2:45 PM JST | Sun. Oct 19, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P3] Poster: Day 3

[P3-01]

Perceiving Time in Sleep: Links between Misperception, REM Sleep, and Depressivity in Insomnia

*Jana Koprivova[1,2], Julie Siskova[1], Karolina Janku[1] (1. National Institute of Mental Health, Klecany (Czech Republic), 2. Third Faculty of Medicine, Charles University, Prague (Czech Republic))

[P3-02]

Implicit, but not explicit, timing is perturbed in schizophrenia

*Jennifer T Coull[1], Laurie Ladame[1], Mounira Taghdouini Kaddour[1], Tiffanie Zemour[1], Hélène Wilquin[1] (1. Centre for Research in Psychology & Neuroscience, CNRS & Aix-Marseille University (France))

[P3-03]

A Deep Reinforcement Learning Approach to Modeling Rat Behavior in Peak Interval Procedure

*S. Ruiz de Aguirre[1], Gloria Ochoa-Zendejas[2], Jonathan Buriticá[2] (1. Independent (Mexico), 2. Lab. of Cognition and Comparative Learning, Univ. of Guadalajara-CEIC, Guadalajara (Mexico))

[P3-04]

Complex impact of stimulus envelope on motor synchronization to sound

*Yue Sun[1,2], Georgios Michalareas[1,2,3], Oded Ghitza[4], David Poeppel[3,5,6] (1. Cooperative Brain Imaging Center (CoBIC), Goethe University Frankfurt (Germany), 2. Ernst Strüngmann Institute for Neuroscience (Germany), 3. Max Planck Institute for Empirical Aesthetics (Germany), 4. Department of Biomedical Engineering & Hearing Research Center, Boston University (United States of America), 5. Department of Psychology, New York University (United States of America), 6. Center for Language, Music, and Emotion (CLaME) (United States of America))

[P3-05]

Entrainment in Low- and High-Level Ventral Visual Regions Does Not Affect Temporal Overestimations

*Amirmahmoud Houshmand Chatroudi1,2, Yuko Yotsumoto1 (1. The University of Tokyo (Japan), 2. Sony Computer Sciences Laboratories (Japan))

[P3-06]

Does Semantic Modulation Induce Time Dilation? The Role of Flicker Frequency and Visual Saliency

*Takeya Oda1, Amirmahmoud Houshmand Chatroudi2, Yuko Yotsumoto1 (1. The University of Tokyo (Japan), 2. Sony Computer Science Laboratories (Japan))

[P3-07]

Top-Down Control of Alpha-Band Phase as a Mechanism of Interval Temporal Prediction: Direct Test and Preliminary Evidence

*Christina Bruckmann[1,2], Assaf Breska[1] (1. Max Planck Institute for Biological Cybernetics (Germany), 2. University of Tübingen (Germany))

[P3-08]

Aging effect on temporal processing: an ongoing study on retrospective timing and spontaneous oscillatory bursts.

*Florentine Fricker[1], Giulia Buzi[1], Maëlys Morantin[1], Franck Doidy[1], Patrice Clochon[1], Raphaël Bordas[2], Virginie van Wassenhove[2], Thomas Hinault[1] (1. Université de Caen Normandie, INSERM, EPHE-PSL, PSL University, CHU de Caen, GIP Cyceron, U1077, NIMH, 14000 Caen, France. (France), 2. Cognitive Neuroimaging Unit, INSERM, CEA, Université Paris-Saclay, NeuroSpin, 91191 Gif/Yvette, France. (France))

[P3-09]

Neural Oscillatory Entrainment in Non-Deterministic Continuous Environments, decoupled from Bayesian Interval Learning

*Elmira Hosseini[1,2], Assaf Breska[1] (1. Max-Planck Institute for Biological Cybernetics (Germany), 2. Tübingen University (Germany))

[P3-10]

Perceived time shapes the course of physical fatigue

*Pierre-Marie Matta[1,2,3], Robin Baurès[1,2], Julien Duclay[1,3], Andrea Alamia[1,2] (1. University of Toulouse (France), 2. Centre de Recherche Cerveau et Cognition, CNRS (France), 3. Toulouse NeuroImaging Center, INSERM (France))

[P3-11]

Sequential Brain Activity for subsecond-lagged Sensory and Motor events: Investigation using Temporal High-Resolution fMRI at 9.4 Tesla

*Nikolas Philipp Klein[1,2], Sebastian Mueller[2], Klaus Scheffler[2,3], Assaf Breska[1] (1. Research Group Cognitive Neuroscience of Dynamic Cognition, Max Planck Institute for Biological Cybernetics (Germany), 2. Department High-field Magnetic Resonance , Max Planck Institute for Biological Cybernetics (Germany), 3. Deparment of Biomedical Magnetic Resonance, Eberhard Karls University Tuebingen (Germany))

[P3-12]

The effect of temporal regularity on neural activity during perceptual and motor timing

*Mitsuki Niida[1], Kenji Ogawa[1] (1. Hokkaido University (Japan))

[P3-13]

Time on my hands: Examination of overlapping rhythmic synchronization mechanisms across sensory modalities

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

[P3-14]

Impact of Retrosplenial Cortex Resection on Temporal Estimation in CD1 Mice

*Tania Campos-Ordoñez[1], Marielena Eudave-Patiño[2,3], Emmanuel Alcalá[2], Jonathan Buriticá[2] (1. Departamento de Biología Celular y Molecular, Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara (Mexico), 2. Centro de Estudios e Investigaciones en Comportamiento, Universidad de Guadalajara (Mexico), 3. Universidad Autónoma de Aguascalientes (Mexico))

[P3-15]

Statistical analysis of small-integer ratios in bioacoustics and music

*Yannick Jadoul[1], Tommaso Tufarelli, Chloé Coissac[1], Marco Gamba[2], Andrea Ravignani[1,3,4] (1. Department of Human Neurosciences, Sapienza University of Rome, Rome (Italy), 2. Department of Life Sciences and Systems Biology, University of Turin, Turin (Italy), 3. Center for Music in the Brain, Department of Clinical Medicine, Aarhus University, Aarhus (Denmark), 4.

Research Center of Neuroscience “CRiN-Daniel Bovet”, Sapienza University of Rome, Rome (Italy))

[P3-16]

Rat Model of Schizophrenia: A Comparative Study of NMDA Antagonists Using the Peak Interval Task

*Veronika Rudolfová[1,2], Kristýna Malenínská[1,3], Štěpán Wenke[1,4], Anastasia Popova[1], Tereza Nekovářová[1,2] (1. National Institute of Mental Health, Topolová 748, 250 67, Klecany (Czech Republic), 2. Faculty of Science, Charles University, Department of Zoology, Viničná 7, 128 44, Prague (Czech Republic), 3. Czech Academy of Sciences, Institute of Physiology, Vídeňská 1083, 142 20, Prague (Czech Republic), 4. Aging Research Center, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Stockholm (Sweden))

[P3-17]

Strategic use of temporal cues (timing) in reversal learning: A comparative study in CD1 and C57BL/6 mice

*Jonathan Buritica[1], Ana Patricia Orozco Coles[1], Tania Campos Ordoñez[2] (1. Universidad de Guadalajara (Mexico), 2. 2.Departamento de Biología Celular y Molecular, Centro Universitario de Ciencias Biológicas y Agropecuarias. Universidad de Guadalajara, México (Mexico))

[P3-18]

Rock with Me: How Social Interaction Shapes Spontaneous Motor Tempo in Baboons’ stone rubbing

*Siham Bouziane[1], Anne Bobin-Bègue[3], Jennifer T Coull[1], Adrien Meguerditchian[1,2] (1. Centre de Recherche en Psychologie et Neurosciences (France), 2. Station de Primatologie-Celphedia UAR846 CNRS - Rousset France (France), 3. Laboratoire Éthologie Cognition Développement, Paris-Nanterre, France (France))

[P3-19]

The effect of visual perceptual load on EEG and behavioural measures of sensory time perception in vision and audition

*Keying Wang[1], Nilli Lavie[1] (1. University College London (UK))

[P3-20]

Temporal Jitter in Music Reveals Robust Early Stream Formation and Enhanced Attentional Selection via Attention Recruitment

*Shu Sakamoto[1,2], Emily Wood[1,2], Harris Miller[1], Ellia Baines[1], Kevin Yang[1], Lily Eshraghi[1], Laurel J. Trainor[1,2] (1. Department of Psychology, Neuroscience, and Behavior, McMaster University (Canada), 2. McMaster Institute of Music and the Mind (Canada))

[P3-21]

Valence and arousal lengthen time for subsequent neutral events

*Nedim Goktepe[1], Müge Cavdan[2], Knut Drewing[2] (1. INM- Leibniz Institute for New Materials (Germany), 2. Department of Psychology Justus-Liebig-University Giessen (Germany))

[P3-22]

What do the eyes tell us about emotional temporal distortion? An exploratory study

*Luigi Micillo[1], Mariagrazia Capizzi[2,3], Andrea Zangrossi[1], Giovanna Mioni[1] (1. Department of General Psychology - University of Padova (Italy), 2. Department of Experimental Psychology - University of Granada (Spain), 3. Mind, Brain and Behavior Research Center (CIMCYC) - University of Granada (Spain))

[P3-23]

Auditory Object Formation in Temporally Complex Acoustic Scenes

*Berfin Bastug[1,2,3], Yue Sun[1,5], Erich Schröger[2,3], David Poeppel[2,4] (1. Ernst Strüngmann Institute for Neuroscience, Frankfurt am Main (Germany), 2. Max Planck School of Cognition (Germany), 3. Wilhelm-Wundt-Institute of Psychology, Leipzig University, Leipzig (Germany), 4. New York University, New York (United States of America), 5. Cooperative Brain Imaging Center (CoBIC), Goethe University Frankfurt (Germany))

[P3-24]

Effect of Image Compressibility and Internal Model on Time Perception (Data Collection Forthcoming)

*Maxim Zewe[1], Domenica Bueti[1], Eugenio Piasini[1] (1. International School for Advanced Studies (SISSA) (Italy))

[P3-25]

Reference Frame Effects on Non-Spatial Tactile Decisions: Evaluation with a Drift Diffusion Model

*Naoya Tachibana[1], Yuko Yotsumoto[1] (1. University of Tokyo (Japan))

[P3-26]

Postdictive suppression of visible stimuli in backward masking: Dissociation between initial and postdictive perception

*Shosuke Nishimoto[1] (1. The University of Tokyo (Japan))

[P3-27]

Indifference Interval and Central Tendency in Temporal Reproduction: A Comparative Study of Auditory and Visual Modalities

*Kristýna Maleninská[1], Veronika Rudolfová[1,2], Kateřina Dorflová[1,3], Tereza Nekovářová[1,2] (1. National Institute of Mental Health, Topolová 748, 250 67, Klecany (Czech Republic), 2. Faculty of Science, Charles University, Department of Zoology, Viničná 7, Prague (Czech Republic), 3. Third Faculty of Medicine, Charles University, Ruská 87, Prague (Czech Republic))

[P3-28]

Simulated Gravitational Physics Shapes Time Perception in Virtual Reality

*Amir Jahanian-Najafabadi[1], Carolyn Kroger[2], Ningyuan Sun[3], Jean Botev[3], Christoph Kayser[1] (1. Department of Cognitive Neuroscience, Bielefeld University (Germany), 2. Kresge Hearing Research Institute, Department of Otolaryngology - Head and Neck Surgery, University of Michigan (United States of America), 3. VR/AR Lab, Department of Computer Science, University of Luxembourg, Esch-sur-Alzette (Luxembourg))

[P3-29]

Warped videos, twisted time: The cognitive impact of altered playback speeds

*Judit Castellà[1], Elsa Ferrer[1], Estefanía Rajó[1], Diana Ruano[1], Laura Serra[1] (1. Autonomous University of Barcelona UAB (Spain))

[P3-30]

Effects of non-temporal auditory features on timing judgments in healthy adults and cochlear-implant users

*Carolyn Kroger[1], Deborah R. Fu[1], Renee Banakis Hartl[1], Ruth Y. Litovsky[2], Anahita H. Mehta[1] (1. University of Michigan (United States of America), 2. University of Wisconsin - Madison (United States of America))

[P3-31]

L-Dopa and STN-DBS modulate the neural encoding of rhythmic auditory stimulation in Parkinson's

*Antonio Criscuolo[1], Michael Schwartze[1], Sonja Kotz[1,2] (1. Maastricht University (Netherlands), 2. Max Planck Institute for Human Cognitive and Brain Sciences (Germany))

[P3-32]

Two topological axes for temporo-spatial processing in visuomotor control

*Christian A. Kell1, Christina Nissen1 (1. Goethe University (Germany))

[P3-33]

EEG reveals how space acts as a late heuristic of timekeeping

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[P3-34]

Lag adaptation and Bayesian calibration in tactile simultaneity perception

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The modulating role of saccadic and oculomotor behavior during a temporal reproduction task

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[P3-36]

Perceptual timing precision in complex sound sequences is shaped by context-target similarity

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[P3-37]

Timing in peripersonal space beyond internal clock model

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[P3-38]

Sensory–motor mirror neurons in the basal ganglia support temporally precise song imitation in Bengalese finches.

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Vocal timing and social affiliation: A comparative study in rats of same and different strains.

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[P3-40]

Tracking vocal turn-taking and inter-brains synchrony in human interactions

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Perceiving Time in Sleep: Links between Misperception, REM Sleep, and Depressivity in Insomnia

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Subjective time perception is a crucial aspect of conscious experience, including during sleep. In individuals with insomnia, distortions in temporal estimation often manifest as sleep misperception—a mismatch between perceived and objectively measured sleep duration. This exploratory correlational study investigated two potential contributors to time misperception in insomnia: (1) the amount of rapid eye movement (REM) sleep, a stage associated with emotional regulation, and (2) subjective levels of depressivity, which have been linked to both insomnia and altered temporal experience. A total of 202 patients diagnosed with insomnia underwent overnight polysomnography at the National Institute of Mental Health (Czech Republic) between 2017 and 2024. Subjective sleep estimates and depressive symptoms (BDI-II) were assessed alongside objective sleep parameters. Sleep misperception was calculated as the difference between self-reported and measured total sleep time. The results showed no significant association between REM sleep and sleep misperception ($r = 0.091$, $p = 0.103$). However, a weak but significant positive correlation was found between sleep misperception and depressive symptom severity ($r = 0.154$, $p = 0.029$). These findings suggest that distorted time perception during sleep may be more strongly influenced by affective and cognitive factors than by REM-related physiology. To further investigate the neurophysiological basis of this phenomenon, we are conducting follow-up analyses of sleep microstructure. Preliminary results focusing on potential electrophysiological markers of time misperception in insomnia, will also be presented. Supported by ERDF-Project Brain dynamics, No. CZ.02.01.01/00/ 22_008/00046 43 and by the Charles University fund Cooperatio 38 - Neurosciences.

Keywords: time perception, sleep misperception, REM sleep, depressivity, insomnia

Implicit, but not explicit, timing is perturbed in schizophrenia

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Individuals with schizophrenia (SZ) have difficulty estimating periods of time in the peri-second range. However, it remains unclear whether these difficulties index a specific problem in representing time or are a secondary consequence of their more general cognitive disturbance. To address this question, we compared explicit (temporal generalisation) and implicit (temporal expectation) measures of timing in 13 individuals with SZ to that of 29 age-matched controls. In both tasks, the reference interval was 600ms and test intervals varied from 240 to 960ms. In the explicit task, the reference interval was presented on every trial and participants judged whether the variable test interval was the same or different to the reference. In the implicit timing task, participants had to simply respond as quickly as possible to the second of the two stimuli delineating the variable interval. Importantly, the 600ms test interval was four times more probable than the six shorter or longer intervals, which were themselves equally probable. Task order was counterbalanced across participants. Results showed that in the explicit timing task, as expected, the proportion of "same" responses was maximal for the 600ms interval and gradually decreased for increasingly shorter or longer test intervals in an inverted U-shape profile. Correspondingly, in the implicit timing task, mean RT was fastest for the 600ms interval and became gradually slower for shorter or longer intervals in a U-shaped profile. Moreover, analyses revealed that individuals with SZ were as accurate and precise as healthy controls on our explicit timing task in which the reference interval was presented on every trial. By contrast, in the implicit task individuals with SZ significantly overestimated the reference interval compared with healthy controls. This task dissociation suggests that explicit timing in SZ could, in fact, be intact. However, the temporal priors that are formed from temporally predictable information, and used to guide performance in the implicit task, appear to be distorted in individuals with SZ.

Keywords: temporal prediction, interval duration, duration estimation, foreperiod, statistical learning

A Deep Reinforcement Learning Approach to Modeling Rat Behavior in Peak Interval Procedure

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Time estimation is an important concept of adaptive behavior. Most studies focus on utilizing Peak Interval Procedures or Time Bisection Tasks, commonly done utilizing animal models. While animal models may accurately represent biological features, they come with ethical and economical caveats, also being time-consuming. In this study, we intend to generate a computational model to simulate the behavior of rats in Peak Interval Procedures with the objective of providing a replicable and low-cost alternative to running the same experiment on actual animals.
The proposed process utilizes deep reinforcement learning to generate agents that replicate previous empirical data from real rats in Peak Interval Procedures, aiming to achieve a similar Gaussian-like distribution with a peak centered around a 30-second target interval. Agents will be trained using reinforced fixed intervals, and evaluated after each training epoch in fifteen non-reinforced Peak Interval Procedure trials, until achieving results similar to the empirical data; at that point, model weights will be stored. The training process will take into account the configuration of the operant box and penalizations for energy expense upon any action not providing reinforcement.
We expect the model to replicate the characteristic peak in responding around the target interval and to generalize across different durations with adequate training. Beyond its theoretical relevance, this solution may offer an ethical and economic advantage: reducing the number of animals used in experimental settings. This work represents a step toward integrating computational intelligence with animal models in behavioral analysis for timing.

Keywords: Timing, Neural Networks, Peak Interval Procedure, Computational Modeling, Animal Behavior Simulation

Complex impact of stimulus envelope on motor synchronization to sound

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The human brain tracks temporal regularities in acoustic signals faithfully. Recent neuroimaging studies have shown complex modulations of synchronized neural activities to the shape of stimulus envelopes. How to connect neural responses to different envelope shapes with listeners’ perceptual ability to synchronize to acoustic rhythms requires further characterization. Here, we examine motor and sensory synchronization to noise stimuli with periodic amplitude modulations (AM) in human participants. We used three envelope shapes that varied in the sharpness of amplitude onset. In a synchronous motor finger-tapping task, we show that participants more consistently align their taps to the same phase of stimulus envelope when listening to stimuli with sharp onsets than to those with gradual onsets. This effect is replicated in a sensory synchronization task, suggesting a sensory basis for the facilitated phase alignment to sharp-onset stimuli. Surprisingly, despite less consistent tap alignments to the envelope of gradual-onset stimuli, participants are equally effective in extracting the rate of amplitude modulation from both sharp and gradual-onset stimuli, and they tapped consistently at that rate alongside the acoustic input. This result demonstrates that robust tracking of the rate of acoustic periodicity is achievable without the presence of sharp acoustic edges or consistent phase alignment to stimulus envelope. Our findings are consistent with assuming distinct processes for phase and rate tracking during sensorimotor synchronization. These processes are most likely underpinned by different neural mechanisms whose relative strengths are modulated by specific temporal dynamics of stimulus envelope characteristics.

Keywords: sensorimotor synchronization, audition, envelope tracking, acoustic landmarks, onset

Two topological axes for temporo-spatial processing in visuomotor control

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In visuomotor control, the right hemisphere has been associated with visuospatial, and the left hemisphere with visuotemporal processing. In right-handed people, asymmetric bimanual tasks result in a preferred use of the left hand for spatial processing and of the right hand for temporal processing. It is unclear, how the two specialized cerebral hemispheres interact with each other when task to hand arrangements respect or do not respect hemispheric processing preferences.
We thus investigated interhemispheric interactions in the cortical visuomotor network in right-handed participants during asymmetric bimanual isometric movements, using magnetoencephalography. The task involved spatially and temporally challenging visuomotor tracking with one hand and a precisely timed ballistic grip without spatial control demands with the other creating a dual task scenario with either an optimal or a non-optimal task to hand assignment.
When the right hand performed the ballistic grip while the left hand performed visuomotor tracking (optimal condition), preparatory interhemispheric broadband partial directed coherence from left premotor areas to right visuomotor regions were stronger compared to the non-optimal condition. In contrast, the non-optimal condition showed stronger preparatory interhemispheric connectivity from right inferior parietal cortex to the left hemispheric visuomotor network.
Our results indicate that the dual task problem is solved by cooperative interactions between specialized cerebral hemispheres with, both, a left-right and a rostro-caudal gradient for temporo-spatial processing.

Keywords: visuomotor timing, visuospatial processing, interhemispheric interactions, hemispheric specialization

Entrainment in Low- and High-Level Ventral Visual Regions Does Not Affect Temporal Overestimations

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Temporal illusions are intriguing yet informative glitches in our otherwise precisely functioning perception of time. One instance of such temporal illusions is our consistent tendency to overestimate flickering intervals (Kanai et al., 2006), a phenomenon known as flicker-induced time dilation (FITD). A decade of research has boiled down to two major hypotheses explaining this temporal distortion: subjective salience (Herbst et al., 2013) and neural entrainment (Hashimoto & Yotsumoto, 2018). Focusing on steady-state evoked potentials (SSVEPs)—neural responses to the regularity of flickers—evidence supporting the neural entrainment hypothesis has been inconsistent (Li et al., 2020). In this study, we employed a combination of luminance-based and semantic flickers (Koenig-Robert & VanRullen, 2013) to explore whether the cortical location of SSVEPs across the visual hierarchy could help explain the inconsistency between FITD and the entrainment hypothesis. While EEG results indicated a distinct pattern of activation in the parieto-occipital regions, the size of the temporal illusion did not vary across conditions. More importantly, the FITD magnitude in flickering conditions (luminance, semantic, and combined flickers) was comparable to the control scramble condition. This latter finding presents a fundamental challenge for time perception theories explaining temporal illusions and suggests a need to revisit the quiddity of FITD.

Keywords: Neural Entrainment, vision, time dilation, flicker

Top-Down Control of Alpha-Band Phase as a Mechanism of Interval Temporal Prediction: Direct Test and Preliminary Evidence

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The brain is able to use cue-interval associations to increase perceptual sensitivity at a specific moment in time, yet the underlying neural mechanisms are still being unraveled. Previous studies on visual perception in non-timing contexts have reported perceptual benefits at specific phases of occipital alpha-band activity. Moreover, exposure to 10 Hz sensory rhythms entrains alpha oscillations to phase-align to on-beat times. However, whether the alpha phase can be adjusted to align with the interval-based predicted target moment, without preceding entrainment, is highly debated. Here, we investigate this by presenting challenging visual discrimination targets at fully predictable intervals that differ in length by half an alpha cycle (800 or 850ms). Top-down control over the alpha-band phase should manifest in phase opposition between the two conditions in a pre-target time window. To examine whether phase inversion depends on temporal sensitivity, we assessed participants' Just-Noticable-Difference (JND) in a temporal discrimination task.In our preliminary data (N=14), alpha phase appears to be correlated with visual discrimination performance, replicating previous results from non-timing paradigms. This suggests a perceptual benefit could be gained by consistent alignment of phase. However, the preliminary data provides only partial evidence of phase inversion. We observe a substantial shift in the distribution of phase differences across participants relative to a uniform chance model towards a phase opposition model, but only a trend for increase in group-averaged mean phase difference relative to chance level. Surprisingly, we found no correlation between the degree of phase opposition and the JND or alpha amplitude. Additionally, in contrast to previous studies, pre-target intertrial phase concentration is low, calling into question the robustness of this mechanism. Future work should study the modulating factors within and across participants

Keywords: temporal attention, alpha phase, interval timing, EEG, visual perception

Aging effect on temporal processing: an ongoing study on retrospective timing and spontaneous oscillatory bursts.

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In most daily-life activities, our attention is not explicitly oriented toward the temporal dimension of the environment, and we mainly rely on retrospective estimates of time passage. As our sense of time undergoes profound changes with advancing age, we investigated age-related cognitive and neural changes in retrospective duration estimates. To this end, participants estimated the duration after the task, without prior knowledge that time would be relevant, thus relying on a memory-based reconstruction of past events. We compared the EEG oscillatory activity of 40 young (aged 20–35) and 40 older (aged 60–80) healthy adults during a 4-minute rest, followed by a retrospective time estimate (rTE) and cognitive assessment. Building on prior findings that alpha (α: 8–12 Hz) burst activity correlates with rTE in young adults (Azizi et al., 2023), we used a cycle-by-cycle analysis (Cole & Voytek, 2019) to replicate and extend these results to theta (θ: 4–8 Hz) to account for the age-related slowing of neural activity (Courtney & Hinault, 2021). Preliminary results (N = 48, including 22 older adults) revealed that while both groups showed similar behavioral estimates, α-burst activity was significantly lower in young adults relative to older adults ($F(1,46) = 4.67$, $p = .036$), but not for theta ($p = .29$). Interestingly, rTE was positively correlated with working memory (N-Back: $r = .33$, $p = .030$) and associative memory (Fast Mapping recall: $r = .36$, $p = .015$) performance. However, no significant correlation was observed between rTE and alpha or theta bursts. Ongoing data collection and analysis of intracranial EEG will help refine these trends at a finer scale. These findings offer a new approach to investigating temporal processing changes with advancing age. Timing, often overlooked, is deeply intertwined with cognition. Understanding its neural underpinnings may thus provide a unique window into age-related changes.

Keywords: Timing, Retrospective, EEG, Aging, Burst

Neural Oscillatory Entrainment in Non-Deterministic Continuous Environments, decoupled from Bayesian Interval Learning

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Predicting the timing of events in continuous, dynamic environments is essential for efficient interaction. In deterministic contexts this is putatively mediated by Oscillatory Entrainment (OE) to the rhythm, and reflected neurally in low-frequency phase alignment, buildup of ramping activity before target, and modulation of target-evoked responses. However, real-world contexts often lack deterministic regularities (e.g., speech). It remains unclear whether and when OE mechanisms engage in non-deterministic continuous streams, and if they can operate separately from distributional learning (DL) processes previously found in uncertain isolated interval conditions. Here, we combined computational modeling of OE (using a simple harmonic coupled oscillator) and DL (using an ideal Bayesian observer) with human EEG recording. We created continuous streams with low (25%) or high (50%) variability, which led to distinct predicted timepoints from the two models. Participants completed a speeded response task with targets at predicted timepoints for each model, as well as intermediate and late timepoints to control for hazard effects. Behaviorally, reaction times were reduced in the 25% relative to 50% condition, selectively for the OE-aligned targets, despite pronounced hazard effect on response times. Neurally, OE-aligned targets elicited lower P3 amplitudes in the 25% relative to 50% condition or to DL-aligned targets, indicating less need for updating for OE predictions. Additionally, delta-band inter-trial phase coherence (ITPC) was higher in the 25% condition before OE target time, mirroring observations in isochronous streams. Interestingly, no contingent negative variation (CNV) was observed. These results highlight the role of oscillatory phase alignment as a predictive mechanism even in the absence of explicit preparatory signals and support the selective engagement of OE in non-deterministic contexts with lower variability, while decoupled from Bayesian DL.

Keywords: Temporal Prediciton, Neural Mechanisms, Non-Deterministic Environments, Computational Modelling, EEG

Perceived time shapes the course of physical fatigue

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While numerous studies have documented the influence of bodily states on time perception, the reverse relationship has received less attention. Recent findings suggest that some psychophysiological processes, such as physical fatigue, may follow a subjective rather than an objective temporal evolution. However, the underlying neural mechanisms and the role of motivational confounds remain unclear. To investigate whether physical fatigue can be influenced by perceived time, we asked 24 participants to perform 100 isometric knee extensions in four separate sessions. While the rest time between contractions was constant (5s), the real (R) and perceived (P) durations of each contraction were independently manipulated, unbeknownst to the participants. In each session, contraction duration was either short (10s) or long (12s), and the displayed time was either Normal (N) or Biased (B), yielding four counterbalanced conditions: N10 (10s P, 10s R), N12 (12s P, 12s R), B10 (10s P, 12s R), and B12 (12s P, 10s R). Using force and EMG recordings, we showed that the increase in physical fatigue over contractions was larger in N12 compared to N10 and B12, but also B10, in which the real workload was the same as in N12. This finding demonstrates that, irrespective of motivational factors, physical fatigue follows the perceived time when the clock is slowed down, but not when it is accelerated. EEG analyses further revealed significant power differences in theta and beta bands over frontal (but not motor) areas between N10 and N12, with no difference between conditions sharing the same perceived time, hence highlighting a frontal oscillatory dynamic that thoroughly follows the perceived rather than the real time. All in all, our findings suggest a bidirectional relationship between time perception and bodily states: while prior models mostly emphasize how bodily states can affect time perception, our findings show that perceived time can, in turn, shape physiological processes.

Keywords: Time deception, False-clock paradigm, Fatigue, Electroencephalography, Electromyography

Sequential Brain Activity for subsecond-lagged Sensory and Motor events: Investigation using Temporal High-Resolution fMRI at 9.4 Tesla

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Temporal encoding and modulation in the subsecond is essential for visual perception and movement initiation, and relies on coordinated activity of the cerebellum, basal ganglia, and cortical regions. However, current research methods have significant limitations regarding generalizability, spatial- or temporal resolution, especially given the potential role of rapid neural dynamics in deep circuits. Here, we leveraged increased field strengths of 9.4 T to achieve both high temporal resolution (70 ms vol TR) and spatial resolution (1.5 mm isotropic voxel size), using a segmented 2D GRE EPI sequence based on [1], and tested the ability to detect sequential sub-second activations during a visual perception task with 500 ms delayed flickering checkerboard stimuli presented to the left and right lateral visual hemispheres. In the visual perception task the signal in the left and right lateral visual cortices showed periodic temporal behavior, tracking the temporal dynamics of the stimulus. A delay in the onset of the hemodynamic response function (HRF) matching the onset order of the visual stimuli is present at the majority (68 %) of all single trials in most participants, with the best participant having an accuracy of 100 % and the worst of 30 %. The feasibility of high temporal resolution fMRI in humans at 9.4 T to show temporal sequential activation in the visual cortex was shown. This method is currently being used in an ongoing study to investigate the sequential neuronal activation, ramping slope differences, and other neuronal correlates in the primary motor cortex and the supplementary motor area during movement initiation timing across different sub- and suprasecond intervals.
References[1] Stirnberg et al (2021). Magn. Reson. Med.

Keywords: Fast fMRI, Delay encoding, Sequential brain activity

The effect of temporal regularity on neural activity during perceptual and motor timing

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Perceptual and motor timing in the sub-second range are crucial for daily life, and temporal regularity is a key feature, especially in musical contexts. Previous research has shown that, in perceptual timing, regular stimuli are associated with the basal ganglia, whereas irregular stimuli rely on the cerebellum. Although perceptual and motor timing share some common neural bases, including the basal ganglia and cerebellum, distinct brain activations for regular and irregular stimuli in motor timing have not been demonstrated.

We conducted a functional magnetic resonance imaging (fMRI) experiment to compare the effects of temporal regularity on perceptual and motor timing within the same experimental paradigm. Participants performed two tasks with two types of auditory stimuli: regular and irregular sequences consisting of multiple clicks. In the perceptual task, participants judged the duration of the last interval in the sequence by comparing it to the second-to-last interval and pressed one of two buttons to respond. In the motor task, participants pressed a button after the last click to align their button press with the last two clicks in an isochronous manner.

Regarding the task effect, broad areas, including the premotor cortex, supplementary motor area, and cerebellum, were more activated during the perceptual task than the motor task, likely due to the different button-pressing requirements. Regarding the regularity effect, the putamen, a part of the basal ganglia, showed greater activation for regular than irregular stimuli. However, no significant activation was observed for irregular stimuli compared to regular. No interaction was found between task and stimulus regularity.

Although regular stimuli elicited greater activation in the basal ganglia, we found no difference in the regularity effect between perceptual and motor timing on timing-related brain activity.

Keywords: sub-second timing, temporal regularity, auditory, basal ganglia, cerebellum

Time on my hands: Examination of overlapping rhythmic synchronization mechanisms across sensory modalities

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Proper synchronization mechanisms are necessary for maintaining an understanding of our ever-changing environments. The supplementary motor area (SMA) plays a key role in dynamically processing this information to ensure accuracies in time perception when adapting to these changes. Previous literature has reported differences in synchronization optimization across sensory modalities, namely discrepancies in optimal oscillatory processing dependent on modality type and context. Preferred tapping rates, in which tapping synchronization error is minimal, are commonly used to investigate neural synchronization mechanisms across contexts. Numerous studies have demonstrated that preferred tapping rates have higher frequencies for auditory than visual stimuli, though these frequencies range across the literature. Here, we replicate and extend work by Kaya and Henry (2022) by investigating preferred tapping rates across both auditory and visual rhythms ranging from .5 to 3 Hz. The experiment follows a synchronization-continuation design wherein participants are instructed to tap along to either woodblock tones (auditory metronome) or to a circle moving across the vertical plane (visual metronome) on a computer monitor for five beats followed by maintaining that tapping rate in the absence of stimuli for seven beats. Preliminary data (n = 19) suggest no difference in preferred tapping rates between auditory and visual modalities, contrary to previous findings. Data collection will continue in a subsequent experiment (n = 20) in which participants are instructed to tap in between metronome beats, rather than on-time, in order to explore whether syncopation elicits differences in synchronization mechanisms as shown through shifts in preferred tapping rates.

Keywords: oscillations, SMA, synchronization-continuation, Hz, tapping

Impact of Retrosplenial Cortex Resection on Temporal Estimation in CD1 Mice

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The retrosplenial cortex (RSC), located in the posterior region of the brain, exhibits intricate connections to sensory and cognitive areas and is correlated with memory impairments. The RSC plays a crucial role in forming associative memory, long-term object recognition, navigation, and contextual memory. Recent evidence highlights its involvement in temporal coding, suggesting its participation in episodic memory and tracking temporal intervals during cognitive tasks. Similar to hippocampal time cells, several RSC neurons exhibit activity at specific intervals during delay periods, yet their role in temporal estimation remains unclear. This study employed an experimental model involving anterior RSC resection in adult CD1 mice, utilizing sham-operated animals as controls. Mobility was assessed in an open field, while temporal estimation was measured using a peak procedure. Results indicated that RSC resection did not impair mobility in male or female mice. However, male mice exhibited reduced response rates during the temporal estimation task compared to females, without significant differences in accuracy, precision, or attention across peak, gap, and distractor trials. The diminished response rate in males potentially reflects reduced motivation. Traditionally, the RSC is associated with spatial cognition, memory, and contextual processing. However, its connections to limbic structures might also play a role in motivation, especially in tasks that demand sustained engagement or associative learning.

Keywords: Retrosplenial cortex, Temporal Estimation, Peak procedure, CD1 mouse

Statistical analysis of small-integer ratios in bioacoustics and music

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Rhythmic structure is ubiquitous in human culture as well as in nature, but is hard to capture in all its complexity. One common pattern in human music are temporal intervals whose relative durations can be expressed as small-integer ratios. For example, the durations of a quarter note and an eight note are related in a 2:1 ratio (Roeske et al., 2020). Recent work has found that the small-integer ratio categories do not just occur in most human musical cultures, but also in a broad range of animal species' vocalizations or behavioral displays. However, biological systems are noisy, and empirically measured intervals rarely form an exact small-integer ratio, and so, statistical methods are necessary to objectively assess whether an observed behavioral intervals approximately conform to a specific integer ratio. We explain a commonly-used approach for assessing the presence of inter ratio categories in temporal sequences, and then mathematically assess whether this leading integer ratio analysis method in behavioral research makes valid statistical and biological assumptions. In particular, we (1) make the temporal properties of empirical ratios explicit, both in general and for the typical use in the literature; (2) show how the choice of ratio formula affects the probability distribution of rhythm ratios and ensuing statistical results; (3) provide guidance on how to carefully consider the assumptions and null hypotheses of the statistical analysis; (4) present a comprehensive methodology to statistically test integer ratios for any null hypothesis of choice. Our observations have implications for both past and future research in music cognition and animal behavior: They suggest how to interpret past findings and provide tools to choose the correct null hypotheses in future empirical work.

Keywords: categorical rhythm, vocalization, timing, meter, statistical assumptions

Rat Model of Schizophrenia: A Comparative Study of NMDA Antagonists Using the Peak Interval Task

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Schizophrenia is often accompanied by disruptions in temporal cognition, which may be linked with impairments in executive functioning and sensory integration. These deficits can be pharmacologically modeled in rodents using NMDA receptor antagonists. In this study, we focused on interval timing using the peak interval (PI) procedure with a 15-second target duration. We trained 24 adult male Long-Evans rats in this task and after completing an extensive learning phase, animals received acute intraperitoneal injections of saline, MK-801 (0.12 mg/kg), PCP (5 mg/kg), or ketamine (10 mg/kg) in a balanced square design over four weeks. While all three antagonists target NMDA receptors, their effect on the behaviour of the tested animals significantly diverged. Linear mixed-effect models revealed that (1) MK-801 significantly increased the peak time ($p = 0.004$) - the mean peak time increased from 15.9 s (saline) to 22.0 s after the administration of MK-801, (2) both MK-801 ($p < 0.001$) and PCP ($p = 0.012$) led to reduced overall response rates in the task. In contrast, ketamine did not produce measurable differences from saline. Interestingly, the shape of the response curve revealed subtle differences between the substances (Kruskal-Wallis test of the kurtosis of the distribution of the lever presses: $H(3) = 7.89$, $p = 0.048$), which calls for further investigation. Our results suggest the PI procedure is a promising tool for assessing schizophrenia-related timing alterations and highlight distinct effects of different NMDA antagonists on temporal processing. The results of our study also suggest that other phenomena, such as impulsivity and addiction may play a role in operant conditioning tasks.
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Keywords: NMDA antagonists, peak interval, schizophrenia, animal model, rat

Strategic use of temporal cues (timing) in reversal learning: A comparative study in CD1 and C57BL/6 mice

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Behavioral flexibility is the ability of humans and non-human animals to adapt to environmental changes by modifying their responses. Outbred CD1 and inbred C57BL/6 mouse strains showed differences in their performance in novelty, spatial learning, and memory tasks. The Midsession Reversal Task (MSR) assesses cognitive flexibility by requiring subjects to adapt to changes in reinforcement contingencies during the middle of a session. However, the performance of mice in MSR is currently unknown. This study analyzes the behavioral flexibility of C57BL/6 and CD1 mice in tasks with fixed (midsession) and variable reversals at 100% or 50% reinforcement probabilities. A fixed reversal with 100% reinforcement (F100) was used in phase one. Phase two involved a variable change with 100% reinforcement (V100). Phase three used a variable reversal with 50% reinforcement. In half of the subjects, phases 1 and 2 were switched to analyze the impact of past outcomes on cognitive flexibility. Our data indicate that CD1 and C57BL/6 mice complete the MSR task and develop a distinct response pattern depending on the phase. Despite past outcomes, CD1 shows an increased proportion of correct responses in phases 1 and 2 compared to C57BL/6 mice. Both mouse strains had similar correct responses in phase 3, in which the predictor of reinforcement was weak (50%). The problem-solving strategy employed by mice in the MSR task and under variable conditions was identified as a combination of win-stay/lose-shift (WSLS) and timing.

Keywords: Behavioral flexibility, midsession reversal task, variable changes, C57BL/6, CD1

Rock with Me: How Social Interaction Shapes Spontaneous Motor Tempo in Baboons' stone rubbing

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Humans have developed particularly advanced rhythmic abilities compared to other animal species, including non-human primates (NHPs), our closest relatives. More specifically, a finding that has sparked growing interest in the scientific community is that NHPs often struggle to temporally synchronize with an external (usually artificial) stimulus. However, the ability to synchronize is essential in social interactions. Several studies suggest synchronization ability may depend on an individual endogenous variable: the spontaneous motor tempo (SMT), which is the spontaneous production of a rhythm in the absence of an external stimulus. SMT in either the lab or the wild remains largely undocumented in NHPs. Out of the 19 Guinea baboons (*Papio papio*) living in their social group in an outdoor park, 17 displayed a naturally rhythmic behavior not yet described in this species: stone rubbing. We manually coded videos of individuals that exhibited stone-rubbing behavior by annotating each action cycle (endpoints of forward and return strokes). Then we extracted inter-movement intervals and calculated movement frequency, to derive an estimate of the SMT specific to each individual. We then investigated the influence of the presence of conspecifics engaged in the same rhythmic stone-rubbing behavior on individual SMT, by comparing solitary *versus* group contexts. Our results reveal that individuals exhibit distinct SMTs, and that these tempos are influenced by the presence of conspecifics. More interestingly, some individuals seem to adjust their rhythmic tempo to their partner's one. Our findings represent the first description of SMT in this primate species and show that baboons' individual natural tempo is flexible and is modulated by social context. Altogether, our results indicate that studying natural behavior in animals could help broaden our understanding of the evolutionary origins of human rhythmic abilities.

Keywords: Rhythms, Non-Human Primates, Ethology, Spontaneous motor tempo, Social interactions

The effect of visual perceptual load on EEG and behavioural measures of sensory time perception in vision and audition

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Despite much evidence that sensory processing of unattended stimuli depends on the level of perceptual load in the attended task, sensory timing (typically concerning sub-second durations) is often considered automatic and independent of attention (e.g. Paton & Buonomano, 2018). We therefore investigated the role of perceptual load in the perception of sub-second time periods. Participants performed a rapid serial visual presentation task under low or high perceptual load (feature vs. conjunction search) and reproduced the duration of either visual targets (250, 450, or 650 ms, Experiment 1) or concurrent auditory tones with post-cued reproduction (500, 700, or 900 ms, Experiments 2–3). The post-cue ensured participants had to track the duration of every tone while performing the primary task (in contrast to only attending to durations of targets in Experiment 1). Results showed that high perceptual load led to shorter reproduced durations, indicating that increased attentional demands in the attended task compressed the perceived durations. EEG revealed that contingent negative variation (CNV) peak amplitudes at central clusters, measured during the perceptual stage (for non-cued intervals), were significantly increased as a function of duration length, but only under low perceptual load. High perceptual load reduced both the overall CNV amplitude and, importantly, also its duration-related gradient. In contrast, auditory N1 amplitudes (peaking at temporal clusters) were unaffected by load (as expected for suprathreshold stimuli, see Molloy et al., 2019). These findings demonstrate a selective effect of perceptual load on the neural correlates of sensory time perception that is not driven by reduced sensory processing of the timing (auditory) stimulus. We discuss these results in relation to current views of the role of attention in sensory timing.

Keywords: Time Perception, Attention, EEG, Neural Sensory Timing, Perceptual Load

Temporal Jitter in Music Reveals Robust Early Stream Formation and Enhanced Attentional Selection via Attention Recruitment

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Auditory scene analysis involves organizing sounds into perceptual streams. Our prior work indicates early, automatic stream formation for music is more robust than for speech. The present study investigated if temporal regularity of stimuli, a key bottom-up feature that differentiates music from speech, affects this early automatic musical stream formation. Participants (N=15) listened to two simultaneous custom-composed polyphonic piano pieces, spatialized via head-related transfer functions. The degree of note onset jitter within pieces was varied. Tasks were to either detected targets in one stream (segregation task) or both streams (integration). We recorded 128-channel electroencephalography (EEG) and used multivariate temporal response functions (mTRFs) to reconstruct the spectral flux of stimuli, comparing two representational models: a Separated model representing independent neural processing of streams and a Combined model representing unified stream processing. Results replicated our previous findings of early stream segregation where the Separated model outperformed the Combined model at an EEG-to-stimulus lag of 62.5–85.9 ms in both tasks. Crucially, no significant interaction occurred between the Separated versus Combined representational models and jitter level in either task, suggesting note onset regularity did not modulate early, automatic stream formation. However, a significant main effect of jitter was observed, suggesting general neural encoding was enhanced for stimuli with higher jitter in both tasks. Furthermore, for the segregation task, higher jitter also enhanced attentional selection of the attended stream, evident even at early processing latencies (39.1-117.2 ms). This suggests greater temporal irregularity, which is cognitively demanding, recruits greater top-down attention when segregating streams. In conclusion, while early, automatic musical stream formation was robust to note onset regularity, increased temporal irregularity (higher jitter) recruited greater processing resources, enhancing general neural encoding and aiding attentional selection in a complex auditory scene.

Keywords: Auditory Scene Analysis, Temporal Response Functions, Jitter, EEG, Attention Decoding

Valence and arousal lengthen time for subsequent neutral events

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Emotional stimuli are typically overestimated compared to neutral stimuli of equal duration. Recent evidence suggests that the emotional states induced by emotional stimuli could also influence the timing of simultaneous neutral events. Since emotional states can outlast their sources and linger, they could also influence the timing of subsequent events. Here, we tested if and how different levels of valence and arousal modulate the timing of subsequent neutral events. To this end, participants performed a temporal bisection task where they learned a short (400 ms) and a long (700 ms) tone duration. Then, they sorted a range of durations by being more similar to the learned short or long duration. Using our custom vibration patterns, we induced different levels of valence and arousal in a task-irrelevant manner just before the onset of tones in the temporal bisection task. We fitted individual psychometric functions to estimate the bisection points (i.e. equal probability of responding short or long) and Weber fractions. We found that the duration of neutral tones was overestimated when they followed a Low Arousal-Pleasant, High Arousal-Pleasant, or High Arousal-Unpleasant vibration compared to a neutral vibration. Moreover, comparing emotional vibrations revealed an interaction between arousal and valence for subsequent timing. Specifically, we found that for low arousal, pleasant vibrations expanded timing more than unpleasant vibrations. However, independent from valence, high arousal vibrations expanded subsequent timing comparably. We observed comparable Weber fractions in emotional and neutral conditions, suggesting that participants maintain an overestimation bias when judging future events. In conclusion, our results draw a nuanced picture of how emotional states can influence the sub-second timing of future independent neutral events.

Keywords: Time perception, Arousal, Valence, Tactile, Auditory

What do the eyes tell us about emotional temporal distortion? An exploratory study

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Emotional states can significantly influence our perception of time. While this effect is often attributed to increased arousal, few studies have directly assessed arousal through physiological measures. The present study explores the intricate relationship between emotion-induced physiological arousal and temporal processing. Specifically, we examined whether arousal variations elicited by negative stimuli were reflected in pupil dynamics, and whether these changes could predict the degree of temporal distortion experienced during emotionally charged events. Forty participants (20 females; age range: 18–25) completed a time reproduction task while viewing images selected from the International Affective Picture System (IAPS), categorized into three conditions based on perceived arousal: neutral, negative-high arousal, and negative-low arousal. Pupil diameter was continuously recorded using the EyeLink 1000 Plus eye-tracking system. Data were analyzed using generalized linear mixed models to evaluate the effects of emotional content on both pupil responses and time perception. Results indicated that more negative images were associated with greater pupil constriction, suggesting a physiological response to emotional intensity. In terms of temporal processing, participants overestimated the duration of negative-high arousal stimuli compared to neutral and negative-low arousal stimuli. In conclusion, these findings highlight the role of emotion-induced physiological arousal—indexed by pupil constriction—in shaping our subjective experience of time. High-arousal negative stimuli, in particular, appear to significantly distort temporal perception.

Keywords: Time Perception, Emotion, Pupillometry, Physiological Arousal

Auditory Object Formation in Temporally Complex Acoustic Scenes

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The auditory system decomposes boundary-less sensory input into meaningful units through Auditory Scene Analysis (Bregman, 1990). Repetition helps listeners segregate overlapping sounds, and identify distinct auditory objects (McDermott et al., 2011). Studies suggest that repeated units in noisy contexts can eventually be perceived as stable auditory objects (Barczak et al., 2018; McDermott et al., 2011), but the behavioral signature of this dynamic process remains largely unexplored.
We investigated this using "tone clouds"—randomly generated clusters of 50-ms tones lacking explicit boundary cues. Repetition strength was manipulated by adjusting the ratio of repeated to regenerated tones, creating a continuum from random to repeated sequences. This formed an auditory analog to motion coherence tasks. To perceive repetition, listeners had to group repeated tones into auditory objects, allowing us to probe the minimal sensory evidence required.
There were two tasks: repetition detection and sensorimotor synchronization (SMS). In detection, participants judged if sequences repeated. We varied unit duration to examine how temporal structure affects this process. In SMS, participants tapped in sync with the repeating pattern, providing a real-time behavioral measure of perceptual organization.
We show sigmoidal performance across repetition levels in both experiments. Auditory object formation depends on repetition strength and longer durations need more evidence. But once repetition is detectable, ~4 cycles are needed to make a judgment, regardless of unit duration. This suggests the evidence is integrated over cycles. In the SMS, sigmoidal curves converge across unit durations, eliminating the interaction effect. Trial progression analysis reveals two stages during object formation: when repetition is detectable, performance gradually builds up before reaching a saturation point, suggesting a categorical perceptual shift in strong repetition conditions, in which the additional evidence no longer enhances performance.

Keywords: auditory perception, repetition detection, auditory objects, sensorimotor synchronization

Effect of Image Compressibility and Internal Model on Time Perception (Data Collection Forthcoming)

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Natural images differ dramatically in their visual complexity (VC), raising the question of how VC affects cognitive processes that depend on visual input. Specifically, low-level sensory features strongly affect perceived duration (Ma et al., 2024), suggesting that VC influences time perception. However, VC remains poorly defined, encompassing both semantic and structural components. To isolate the latter, studies have argued that complex images contain more information, making them harder to compress (Donderi, 2006). Indeed, extracting information is a potential driving force of time perception (Matthews & Meck, 2016), but the role of compressibility in time perception is underexplored, with few exceptions (e.g., Palumbo et al., 2014). Two main problems are: (1) the compressibility of typical stimuli, such as natural scenes (Ma et al., 2024), is hard to control, and (2) compressibility depends on an observer’s expectation or internal model of the images, which has thus far been neglected. To overcome these issues, we use synthetic visual textures (SVTs) - binary images with tunable multipoint correlations and compressibility (Victor & Conte, 2012) - and manipulate participants’ internal models via a yet-to-start two-alternatives forced choice task. We generate noisy SVTs of one type (e.g., horizontal stripy patterns), which participants must discriminate from noise. Subsequently, using the same (horizontally striped) stimuli, participants must judge if the images are noise or an SVT of a different type (e.g., block-like texture). This reveals how compressible the images are when the observer’s internal model is misspecified (square-like) relative to the ground truth (horizontal stripes). We employ this to measure how compressibility affects perceived duration in a reproduction task and hypothesise that more compressible images represent a greater information source, leading to over-reproduction (Matthews & Meck, 2016). This study reveals how structural visual complexity depends on an observer’s internal model and how this shapes time perception.

Keywords: time perception, compression, visual complexity, internal state

Reference Frame Effects on Non-Spatial Tactile Decisions: Evaluation with a Drift Diffusion Model

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The present study explores the interaction between egocentric and external reference frames in the context of non-spatial processing, specifically focusing on vibrotactile frequency perception. While previous studies primarily investigated the impact of reference frames on spatial judgments, such as in temporal order judgment with arm crossing (Yamamoto & Kitazawa, 2001), the effects of reference frames on non-spatial processing, including texture and frequency perception, have been largely unexplored.

Tactile frequency perception is known to exhibit an assimilation effect, wherein perceived frequency or roughness shifts towards that of a distracting stimulus, even when individuals attempt to ignore it (Kahrimanovic et al., 2009; Kuroki et al., 2017). This effect is particularly pronounced when the presentation of two stimuli is synchronized. Here, we investigated the combined influence of stimulus simultaneity and arm-crossing on tactile frequency perception.

In the experiment, vibrotactile stimuli were presented to the left and right index fingers, and participants identified which finger received the higher frequency. Stimuli were delivered either sequentially or simultaneously, with arms either uncrossed or crossed.Behavioral results revealed that non-spatial vibrotactile frequency perception was impaired not only by the absence of simultaneity but also by arm-crossing. To further examine the underlying decision-making process, we applied the Drift Diffusion Model (DDM) to participants' response time and accuracy data. The modeling revealed that the drift rate—a parameter reflecting the quality of sensory evidence—was significantly reduced in the arm-crossed condition compared to the uncrossed condition.

These results suggest that non-spatial tactile perception is influenced by spatial information, and that reference frames affect not only spatial localization but also early sensory evidence accumulation in non-spatial perceptual decisions.

Keywords: tactile perception, frequency discrimination, arm-crossing, drift diffusion model

Postdictive suppression of visible stimuli in backward masking: Dissociation between initial and postdictive perception

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Timeline theory of perception (Hogendoorn, 2022) proposes that perceptual mechanisms represent not a single timepoint, but a dynamic timeline updated by prediction and postdiction. Inspired by this view, we investigate whether a masked primer in backward masking—a phenomenon where a briefly presented stimulus becomes invisible due to a subsequent mask—might be initially available to conscious perception and later suppressed postdictively.
We conducted two experiments using a modified apparent motion interference paradigm (n=7, 560 trials). Apparent motion was induced by presenting two briefly flashed squares in succession, the second of which was sometimes followed by a mask that prevented the perception of apparent motion. A target character ('C' or mirror-reversed 'C') was then presented either in the same or opposite direction relative to the apparent motion.
In Experiment 1, participants performed a speeded two-alternative forced choice (2AFC) task to identify the character, regardless of its location. In the no-mask condition, reaction time (RT) was significantly shorter when the target appeared in the same direction as the apparent motion than in the opposite direction ($p = 0.016$, signed-rank test), with an average RT difference of 22 ms. However, in the mask condition, where the mask disrupted perception of the second square and hence the motion, this RT difference was abolished ($p = 0.93$).
In Experiment 2, participants performed a simpler 2AFC task judging only the location (left or right) of the target, irrespective of its identity. The motion-congruent RT advantage was observed in both no-mask and mask conditions (no-mask: $p = 0.016$; mask: $p = 0.016$). In the no-mask condition, RTs were on average 35 ms faster for targets in the same direction as the apparent motion compared to the opposite direction; in the mask condition, an advantage of 26 ms was observed. Overall, character discrimination required longer RTs than location discrimination.
These results suggest that the masked primer was initially perceived and influenced early responses, but was postdictively erased and no longer influenced slower perceptual reports. Our findings provide behavioral evidence for the postdictive revision of perceptual experience and support the concept of a continuously updated perceptual timeline.

Keywords: Backward masking, Postdiction, Perceptual timeline

Indifference Interval and Central Tendency in Temporal Reproduction: A Comparative Study of Auditory and Visual Modalities

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Temporal processing is influenced not only by objective stimuli duration but also by factors such as stimulus modality and contextual parameters. Auditory stimuli are often perceived as longer and reproduced more accurately than visual ones, possibly due to differences in pacemaker rate or attentional mechanisms. Combined with the tendency to overestimate short durations and underestimate long ones, these modality-driven distortions have prompted researchers to investigate where subjective timing is most accurate within the tested range. This gives rise to the theory of *indifference interval*—the duration that is reproduced most accurately. Some theories suggest this point is constant (2–3 s), while others link it to the geometric mean of the tested range (central tendency), as per Vierordt’ s law.We examined the effects of stimulus modality and presentation order on time reproduction using intervals from 1.6 to 15 seconds. Participants were assigned to two versions of the task, with one group starting with auditory stimuli and the other with visual stimuli. This design allowed us to compare performance across modalities and assess the role of block order.Our results align more closely with the idea of a constant indifference interval around 2–3 seconds than with predictions based on the geometric mean. Across all conditions, longer intervals (5–15 s) were systematically underestimated. In the auditory modality, shorter durations (1.6–3.2 s) were moderately overestimated, while in the visual modality, short intervals were more accurately reproduced or slightly underestimated. The highest accuracy occurred near 3.2 s, favoring the idea of a fixed indifference interval rather than one based on the geometric mean (˜4.9 s).These findings support the view that internal timing relies on a stable temporal reference and that modality-specific timing characteristics are robust, even when the order of presentation is reversed.This work was supported by the Johannes Amos Comenius Programme (OP JAK), project reg. no. CZ.02.01.01/00/23_025/0008715 and by the grant from the Ministry of Health Czech Republic (no. NU 22-04-00526).

Keywords: indifference interval, auditory stimuli, visual stimuli, reproduction

Simulated Gravitational Physics Shapes Time Perception in Virtual Reality

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In this study, we investigate how simulated gravitational conditions affect time perception within a virtual reality environment. Using a within-subjects design, we developed a virtual reality task in which participants actively and passively experienced Earth’s gravity, microgravity, and hypergravity. Thirty-seven healthy young adults participated in the experiment, which involved performing a motor action and place a virtual sphere into a chamber while judging whether auditory tones were shorter or longer than a baseline duration under each gravity condition. The results reveal that microgravity significantly distorted time perception, leading to increased perceptual bias and decreased temporal sensitivity. In contrast, hypergravity produced minimal distortion and, in some cases, improved temporal discrimination. These findings support the hypothesis that gravity-related bodily cues influence the perception of time and underscore the utility of VR as a potential tool for cognitive and perceptual research. Though future studies using possibly more realistic virtual environments are also required to substantiate these effects. The implications of this work extend to understanding human perception in altered gravity environments, optimizing performance in space missions, and expanding the role of virtual reality in gravity-based experimentation.

Keywords: Time Perception, Gravitational Physics, Virtual Reality, Tempo Discrimination, Perceptual Bias

Warped videos, twisted time: The cognitive impact of altered playback speeds

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As sped-up content becomes increasingly common in digital media consumption, understanding its cognitive and perceptual implications is essential. This study investigated whether video playback speed affects time and speed perception. Participants watched videos at two speeds (0.5x and 1.5x), followed by tasks assessing temporal reproduction, verbal estimation, reaction time, and subjective speed perception. Results showed that playback speed influences temporal perception and attentional processes: slowed playback was associated with subjective time dilation and better performance in the attentional task, while sped-up playback led to temporal underestimation and increased perceived speed. Both conditions may impair cognitive functioning, with accelerated playback potentially posing greater risks for tasks requiring precise timing and sustained attention.

Keywords: playback speed, time perception, attention, perceived speed

Effects of non-temporal auditory features on timing judgments in healthy adults and cochlear-implant users

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The kappa effect manifests as a perceptual bias in relative onset timing between subsequent events as a function of non-temporal (e.g. spatial) proximity. In the auditory domain, kappa effects have previously been shown for tone sequences, where tones closer in pitch were judged as occurring closer in time than tones farther in pitch. Recently, our lab established an auditory spatial kappa (ASK) effect, where two sounds presented closer in space were judged as relatively closer in time than a third, more distant sound. The present study examined temporal biasing effects of non-temporal cues in healthy aging and individuals with cochlear implants. In one experiment, we tested younger and older adults with normal hearing on ASK tasks with congruent or conflicting pitch and spatial cues. In a second experiment, we tested individuals with single-sided deafness and a cochlear implant in their deaf ear on ASK tasks to evaluate this task as an implicit measure of auditory spatial cue restoration with cochlear implantation. Results will be discussed in terms of effects of healthy aging on temporal and non-temporal auditory feature interactions as well as clinical applications of auditory spatial kappa tasks for individuals with hearing loss and cochlear implants.

Keywords: Time perception, Kappa effect, Auditory timing, Perceptual interactions, Aging

L-Dopa and STN-DBS modulate the neural encoding of rhythmic auditory stimulation in Parkinson’s

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In rhythmic auditory stimulation (RAS), temporally regular auditory stimuli (e.g., metronome or music), are utilized to support the precise temporal coordination of motion[1] in people with Parkinson’s disease (pwPD). RAS efficacy is typically associated with the switching from an altered internal pacing system to the intact external cueing system. In doing so, RAS is thought to promote the recruitment of the cerebellar-prefrontal network and recalibrate aberrant β-band synchronization in the striato-thalamo-cortical pathway [1], ultimately mirroring effects observed for dopaminergic replacement therapy (levodopa) and deep-brain stimulation (DBS; [2]) protocols targeting the subthalamic nucleus (STN). Here we asked: Do levodopa/DBS treatments modulate the neural encoding of RAS? Does everyone respond to levodopa/DBS interventions the same way?Our analyses revealed changes in (i-ii) event-locked neural responses (pre- and post-stimulus β-band, as well as event-related potentials), (iii) excitation / inhibition balance (E/I; aperiodic exponent) and (iv) neural tracking of rhythm (δ-band inter-trial phase coherence) in function of the treatment. Furthermore, we characterize the link between changes in E/I balance and motor symptom severity (UPDRS-III) with levodopa administration. Overall, we demonstrate inter-individual variability and differential effects of levodopa, 8-week and 1-year DBS treatments on the neural encoding of basic sounds and rhythm, raising doubts on whether every individual benefits from combinations of levodopa/DBS and RAS. In doing so, we encourage future multimodal imaging and translational studies to better characterize individual responses to treatments. This is a fundamental step if we aim at tailoring rehabilitation protocols and optimize intervention efficacy.

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Keywords: Parkinson, rhythm, basal ganglia, DBS, dopamine

EEG reveals how space acts as a late heuristic of timekeeping

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Humans rely on spatial metaphors, gestures, and visual tools to represent the passage of time. Nonetheless, it is unclear to what extent space is an inherent component of the brain’s representation of time. Here, we combined EEG-behavioural measures in human participants and neural network models of optimal decision-making to show that space is a late compensatory mechanism of time representation recruited when faster non-spatial timekeeping mechanisms are sub-optimally engaged. We leveraged on the STEARC effect, which shows faster recognition of “short” time intervals with responses in the left side of space and faster recognition of “long” intervals with responses in the right side, and on the recent finding that the STEARC is absent when RTs/decisions are fast (Scozia et al., 2023). EEG studies (Vallesi et al., 2011) have identified the correlates of the STEARC in the inter-hemispheric competition for the selection between left vs right manual responses to short/long time intervals, that is reflected in the amplitude of the Lateralized Readiness Potential (LRP). We investigated whether variations in the strength of the STEARC, as a function of RTs speed, are reflected in variations in LRP amplitude. Most important, we examined whether the emergence of the STEARC at slower RTs is preceded by changes in EEG components associated with temporal encoding during, around or immediately after the offset of time intervals. Although these components cannot be retrospectively modulated by the STEARC, changes in their amplitude and latency may reveal early neural precursors of the STEARC. We found that spatial engagement in timekeeping follows the insufficient non-spatial encoding of time intervals, leading to delayed decisions on their length. These findings provide the first clear evidence of when, why, and how the brain recruits spatial mechanisms in the service of temporal processing and demonstrate that non-spatial and spatial timekeeping systems can be dissociated at both behavioural and electrophysiological levels.Scozia et al. (2023) Cortex *164*, 21–32. https://doi.org/10.1016/j.cortex.2023.03.009Vallesi et al. (2011) *Cortex*, *47*(2), 148–156. https://doi.org/10.1016/j.cortex.2009.09.005

Keywords: Time intervals, Space, Stearc Effect, EEG

Lag adaptation and Bayesian calibration in tactile simultaneity perception

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Accurate perception of temporal relations between sensory events is essential for interacting with the environment. Lag adaptation—where repeated exposure to two signals in a fixed order shifts the point of subjective simultaneity (PSS) toward that order—has been robustly observed in vision, audition, and multisensory domains (e.g., Fujisaki et al., 2004). In contrast, tactile studies have reported an opposite effect—Bayesian calibration—where perceived intervals increase following exposure (Miyazaki et al., 2006). Notably, tactile studies have never adopted the canonical lag-adaptation protocol, where participants received stimulus pairs with a constant lag and then judged the simultaneity (SJ) or temporal order (TOJ) of test pairs with SOAs from an unbiased distribution. We introduced this protocol to the tactile modality to test whether the inconsistent results reflect a somatosensory peculiarity or different protocols. Results showed that the PSS shifted toward the adaptation lag in both tasks, revealing "tactile lag adaptation" for the first time. In separate experiments, we reproduced the protocol typical of earlier tactile studies by eliminating the separation between adaptation and test: participants performed SJ or TOJ of tactile pairs with SOAs from biased distributions. This protocol replicated Bayesian calibration, driving the PSS away from the prevalent lag. These findings resolve a long-standing controversy in temporal perception by demonstrating that the direction of aftereffects depends not on sensory modality but on the protocol. Our findings suggest that Bayesian calibration and lag adaptation reflect distinct yet complementary mechanisms; the former implements statistical inference, biasing perception away from frequently encountered delays, while the latter performs a recalibration, aligning perceptual simultaneity with consistent temporal patterns. Both processes appear essential in enabling flexible and context-sensitive temporal perception.

Keywords: Lag adaptation, Bayesian calibration, Simultaneity perception, Timing perception, Tactile

The modulating role of saccadic and oculomotor behavior during a temporal reproduction task

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Visual signals play a crucial role in shaping our subjective experience of time. Brief visual interruptions, such as spontaneous eye blinks, can disrupt perceptual continuity and potentially alter our judgment of time intervals. In this study, we examined the relationship between oculomotor behavior and time judgments in a temporal reproduction task, both with and without visual feedback during the reproduction phase. Our primary focus was on how different aspects of eye movements during the presentation of the temporal reference stimulus influence the reproduced duration of this. A total of 34 participants completed the task while seated 120 cm away from a monitor, with their head position stabilized using a chin rest. Participants were asked to reproduce half the duration of presented time intervals (1600, 1800, 2000, 2200, and 2400 ms) by pressing and holding the spacebar. Eye movements and blinks were recorded using the EyeLink 1000 eye-tracking system. The results show a positive predictive effect of the blink duration percentage of the interval (Adj. Marginal-R^2: 0.362, ΔAdj. Marginal-R^2: 0.0222, p=0.0008, β : 2.651), in the stimulus and response phases, in pre-test, on the error percentage of the reproduced durations. These findings support the hypothesis that oculomotor behavior contributes to subjective time perception. Blinks may lengthen perceived duration by disrupting temporal integration. Overall, our results highlight the dynamic role of visuomotor behavior in internal timing and underscore the value of eye-tracking measures in the study of time perception.

Keywords: Time perception, eye-tracking, oculomotor behaviour, blinking, fixation, feedback, duration reproduction

Perceptual timing precision in complex sound sequences is shaped by context-target similarity

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Temporal regularities play a crucial role in auditory processing. In complex sounds, such as music and speech, perceptual sensitivity for on-beat events is enhanced, while deviations from expected timing carry important information. To use such temporal information effectively, listeners must evaluate sound onset timing relative to preceding temporal structures –with high perceptual timing precision (PTP). Previous research has shown higher PTP for simple (short risetime) target sounds compared to complex (long risetime) targets. However, the contribution of preceding context acoustics to PTP is unknown. Here, we examined how context acoustics affect PTP. Participants iteratively adjusted the timing of a target sound relative to an isochronous cueing sequence until reaching perceptual isochrony. Experiment 1 (n=21) manipulated cue and target complexity to test whether cue complexity also impairs PTP. Surprisingly, cue–target similarity, rather than cue complexity per se, predicted PTP: when cue and target were identical, PTP was highest –regardless of the sounds' complexity. Mismatching cues and targets reduced precision. Notably, PTP was lower when complex cues preceded a simple target than vice versa. To further evaluate the role of acoustic similarity, Experiment 2 (n=24) independently manipulated similarity in spectral content and risetime. PTP was reduced when cue and target differed in risetimes, but not when they differed in spectral content. Together, our findings show that perceptual timing precision is sensitive not only to the acoustic properties of the target, but also to preceding contexts. We propose that listeners form temporal templates based on preceding cues, against which target sound timing is evaluated. This reveals a hitherto unknown constraint on perceptual sensitivity to rhythmic sound sequences: effective temporal prediction depends not just on rhythmic structure, but on acoustic continuity between context and target.

Keywords: perceptual timing precision, auditory perception, acoustic context, onset timing, predictive processing

Timing in peripersonal space beyond internal clock model

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Abstract: Peripersonal space refers to the implicit representation of space surrounding body parts, reflecting the physiological specificity of the body and the pragmatic relevance of nearby object perception for action. Studies on peripersonal space often employ the duration bisection task to investigate spatiotemporal interactions. However, the findings of these studies are inconsistent, and their interpretations remain incoherent. To address this issue, I philosophically examine theoretical frameworks underlying both the experimental designs and the interpretation of results. Particularly, I argue that the internal clock model fails to capture the action-guiding role of peripersonal space, and I outline an alternative approach. First, by conceptualising timing as a pure cognitive process, the internal clock model overlooks the temporality of motor processing, which influences both the structure of peripersonal space and the design of duration reproduction task. Second, the plasticity of peripersonal space through tool integration cannot be explained by the two core concepts of the model, namely, attention and the the accumulation of paces. In light of this diagnosis, I sketch an alternative framework in which estimated duration is conceived as time for action execution, rather than as the amounts of accumulated paces.

References:

Anelli, F., Candini, M., Cappelletti, M., Oliveri, M., & Frassinetti, F. (2015). The Remapping of Time by Active Tool-Use. *PLOS ONE*, *10*(12), e0146175.Hunley, S. B., & Lourenco, S. F. (2018). What is peripersonal space? An examination of unresolved empirical issues and emerging findings. WIREs Cognitive Science, 9(6), e1472.Maurya, A., & Thomas, T. (2023). Temporal Factors Associated with Visual Processing Bias in Peripersonal Space. Collabra: Psychology, 9(1), 77862.

Keywords: peripersonal space, interval timing, action guiding, internal clock, tool integration

Poster | Other

Sun. Oct 19, 2025 12:45 PM - 2:45 PM JST | Sun. Oct 19, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P3] Poster: Day 3

[P3-37] Timing in peripersonal space beyond internal clock model

*Haeran Jeong1,2 (1. University of Turku (Finland), 2. Heinrich Heine University Düsseldorf (Germany))

Keywords：peripersonal space、interval timing、action guiding、internal clock、tool integration

Peripersonal space refers to the implicit representation of space surrounding body parts, reflecting the physiological specificity of the body and the pragmatic relevance of nearby object perception for action. Studies on peripersonal space often employ the duration bisection task to investigate spatiotemporal interactions. However, the findings of these studies are inconsistent, and their interpretations remain incoherent. To address this issue, I philosophically examine theoretical frameworks underlying both the experimental designs and the interpretation of results. Particularly, I argue that the internal clock model fails to capture the action-guiding role of peripersonal space, and I outline an alternative approach. First, by conceptualising timing as a pure cognitive process, the internal clock model overlooks the temporality of motor processing, which influences both the structure of peripersonal space and the design of duration reproduction task. Second, the plasticity of peripersonal space through tool integration cannot be explained by the two core concepts of the model, namely, attention and the the accumulation of paces. In light of this diagnosis, I sketch an alternative framework in which estimated duration is conceived as time for action execution, rather than as the amounts of accumulated paces.

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Poster | Other

Sun. Oct 19, 2025 12:45 PM - 2:45 PM JST | Sun. Oct 19, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P3] Poster: Day 3

[P3-38] Sensory–motor mirror neurons in the basal ganglia support temporally precise song imitation in Bengalese finches.

*Yuka Suzuki1,2, Hiroki, Koda1, Kazuo Okanoya2, & Shin Yanagihara2 (1: The University of Tokyo, Japan, 2: Teikyo University, Japan)

Keywords：songbird、basal ganglia、mirror neuron、imitation

Songbirds learn complex vocalizations, known as songs, by imitating those of adult tutors. These songs consist of syllables arranged in specific sequences with millisecond-level temporal precision. Successful song imitation requires the integration of auditory input from tutors with vocal-motor output to produce self-generated songs. Understanding the neural mechanisms supporting this temporally precise process may provide broader insights into the neural basis of imitation learning. Previous studies have shown that the cortico-basal ganglia circuit is essential for song learning. In the premotor cortical nucleus, some neurons that project to the basal ganglia fire at specific syllable timings not only during singing but also when the bird is listening to its own song. These “sensory–motor mirror neurons” are believed to contribute to song imitation by linking sensory input with motor output: they fire at precisely timed instants within each syllable, thereby supporting temporally precise vocal control. In this study, we examined whether such sensory–motor mirror neurons exist in the basal ganglia and how their properties change throughout song development. Using single-unit recordings in adult Bengalese finches, we identified basal ganglia neurons that exhibited syllable-specific firing both during singing and during passive playback of the bird’s own song. In juveniles, we found sensory–motor mirror neurons that responded to tutor songs as well as self-generated songs. Importantly, the pattern of neural responses shifted as learning progressed: early in development, neurons responded primarily to the tutor’s song, whereas at later stages they responded more strongly to the bird’s own song. These findings suggest that sensory–motor mirror neurons support vocal imitation by dynamically updating their sensory representations from external auditory targets to self-generated vocal behavior as learning progresses.

Poster | Other

Sun. Oct 19, 2025 12:45 PM - 2:45 PM JST | Sun. Oct 19, 2025 3:45 AM - 5:45 AM UTC MM Hall (KOMCEE-B1)

[P3] Poster: Day 3

[P3-39] Vocal timing and social affiliation: A comparative study in rats of same and different strains.

*Miki Kamatani[1,2,3], Shiomi Hakataya[3,4], Genta Toya[5], Shinya Yamamoto[1], Kazuo Okanoya[2,6] ([1]Kyoto University, [2]Teikyo University, [3]Research Fellow, Japan Society for the Promotion of Science, [4]University of the Ryukyus, [5]Institute of Science Tokyo, [6]The University of Tokyo)
Keywords：rats、emotional vocalizations、ultrasonic、turn-taking

Social animals form close and enduring relationships with others, and such affiliative bonds confer adaptive advantages, including increased reproductive success and reduced stress. However, given the demands of resting and foraging essential for survival, the time available for social interaction is limited. It is therefore assumed that social animals may adopt strategies to minimize the time cost of establishing affiliative relationships—such as preferentially engaging with similar individuals upon first encounter. This study focused on rats, a highly social species that can form colonies exceeding 150 individuals and are known to maintain social networks that favor specific partners. Prior research suggests that rats may prefer individuals of the same strain in their social networks. However, little is known about how social interactions differ within versus between strains. The goal of this study is to elucidate the mechanisms underlying affiliative relationship formation by comparing social interactions between unfamiliar rats of the same and different strains. We used Sprague-Dawley and Long-Evans rats and recorded their behavior and vocalizations under free-ranging conditions. Specifically, we analyzed the number and timing of ultrasonic vocalizations (USVs): 50 kHz USVs, which are typically associated with positive affect, and 22 kHz USVs, which occur in negative or aversive contexts. Our primary hypothesis is that rats will emit more 50 kHz USVs—and show more immediate vocal responses to their partner's calls—during interactions within the same strain compared to interactions between strains, reflecting a preference for socially similar individuals (Work supported by JSPS 23H05428 to KO and JSPS 24KJ0124 to MK).

From slow motion to time lapse –Exploring biases elicited by altered video speed

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While decades of research have significantly advanced our understanding of time perception, the perception of (manipulated) video speed remains a relatively new and underexplored topic. With technological progress, the use of slow motion and time lapse has become ubiquitous in everyday life, offering new opportunities for detailed video analysis. Yet, recent research highlights potential biases in perception and low sensitivity to altered video speed. To examine the extent to which humans can perceive altered video speeds and how these manipulations influence duration perception, we conducted a series of experiments in which participants viewed short video clips at varying speeds. The results demonstrate systematic biases: overestimation of video speed during slow motion and underestimation of video speed when watching time lapse versions, intensifying with greater deviations from the original speed. Additionally, duration estimations varied systematically depending on video speed, insofar that slow motion videos were perceived as shorter in duration than videos at normal or faster speeds, suggesting a recalibration mechanism occurring during or after viewing. Both effects (misperceived video speed and video duration) seem to result in an erroneous “mental backwards calculation” in the attempt to infer the true duration of an event. This results in a distorted sense of elapsed time, which, in turn, typically can influence, for example, how intentional an action is perceived to be. The observed biases have broad implications for both time perception research and for applied contexts, such as legal or sports settings, where judgments are often based on modern video analysis and hence require careful consideration.

Keywords: video speed, slow motion, time lapse, duration, intentionality

TRF

Sun. Oct 19, 2025 3:30 PM - 4:15 PM JST | Sun. Oct 19, 2025 6:30 AM - 7:15 AM UTC Room 2(West B1)

[T] Community Meeting

All are welcome to join.

TRF

Sun. Oct 19, 2025 1:30 PM - 5:00 PM JST | Sun. Oct 19, 2025 4:30 AM - 8:00 AM UTC TCVB tour

[T06] TCVB tour: Meiji Shrine & harajuku Walking Tour