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 | 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))

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*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]

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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

Klimesch, W. The frequency architecture of brain and brain body oscillations: an analysis. *European Journal of Neuroscience* 48, 2431–2453 (2018).

Criscuolo, A., Schwartze, M. & Kotz, S. A. Cognition through the lens of a body–brain dynamic system. *Trends Neurosci* (2022) doi:10.1016/J.TINS.2022.06.004.

Keywords: rhythm, body-brain interactions, smart wearable, perception, action

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, 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

*Camille L. Grasso[1], Ladislas Nalborczyk[2], Virginie van Wassenhove[1]

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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

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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

*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

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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