Fri. Oct 17, 2025

Oral | Timing & Time Perception

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

[O1] Oral 1: Timing & Time Perception

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

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

[O1-01]

Affective modulation of temporal binding using linguistic stimuli

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

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

[O1-02]

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

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

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

[O1-03]

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

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

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

[O1-04]

Moments or Continuum? Testing the Temporal Resolution of Human Anticipation

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

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

[O1-05]

Spatial tool use modulates time perception in near and far space

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

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

[O1-06]

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

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

Oral | Development, Clinical

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

[O2] Oral 2: Decelopment, Clinical

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

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

[O2-01]

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

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

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

[O2-02]

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

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

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

[O2-03]

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

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

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

[O2-04]

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

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

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

[O2-05]

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

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

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

[O2-06]

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

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

Oral | Attention, Multisensory, Time Perception

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

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

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

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

[O3-01]

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

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

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

[O3-02]

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

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

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

[O3-03]

The priority accumulation framework – attention in time and space

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

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

[O3-04]

Multisensory Integration and Delay Adaptation in Sensorimotor Timing

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

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

[O3-05]

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

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

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

[O3-06]

Interference between time and space in advanced age

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

Sat. Oct 18, 2025

Oral | Memory, Emotion, Decision

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

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

Chair:Müge Cavdan(Justus Liebig University Giessen)

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

[20301-06-01]

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

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

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

[20301-06-02]

Alpha power indexes working memory load for durations

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

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

[20301-06-03]

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

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

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

[20301-06-04]

Mental Time Travel Impairments in Neurodegenerative Diseases

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

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

[20301-06-05]

Level of Detail in Near and Far Future Imagined Events

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

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

[20301-06-06]

Perceptual decision making of nonequilibrium fluctuations

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

Oral | Prediction, Temporal perception, Computational Modeling

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

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

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

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

[O6-01]

Temporal Prediction through Integration of Multiple Probability Distributions of Event Timings

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

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

[O6-02]

The anticipation of imminent events is time-scale invariant

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

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

[O6-03]

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

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

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

[O6-04]

What does the Fröhlich effect tell us about sensation time?

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

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

[O6-05]

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

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

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

[O6-06]

An investigation of auditory rhythms with a spiking neural network autoencoder

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

Oral | Computational Modeling, Neural Mechanisms

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

[O5] Oral 5: Computational Modeling, Neural Mechanisms

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

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

[O5-01]

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

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

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

[O5-02]

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

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

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

[O5-03]

Rationalizing temporal decision making and the neural representation of time

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

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

[O5-04]

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

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

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

[O5-05]

Sensory Reliability Shapes Sequential Effects in Human Duration Perception

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

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

[O5-06]

Bach and Bayes: Prediction in Noisy Musical Sequences

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

Sun. Oct 19, 2025

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))

Oral | Timing & Time Perception

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

[O1] Oral 1: Timing & Time Perception

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

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

[O1-01]

Affective modulation of temporal binding using linguistic stimuli

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

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

[O1-02]

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

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

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

[O1-03]

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

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

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

[O1-04]

Moments or Continuum? Testing the Temporal Resolution of Human Anticipation

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

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

[O1-05]

Spatial tool use modulates time perception in near and far space

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

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

[O1-06]

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1. Sapienza University of Rome

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

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

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

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

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

Keywords: temporal randomness, rhythmicity, time perception

Moments or Continuum? Testing the Temporal Resolution of Human Anticipation

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

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

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

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

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

References

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2. J. Gibbon, *Psychol. Rev.* **84**, 279–325 (1977).
3. E. G. Akyürek, *Neurosci. Biobehav. Rev.* **170**, 106041 (2025).
4. A.C. Nobre, F. van Ede, *Nat. Rev. Neurosci.* **19**, 34–48 (2018).

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

Spatial tool use modulates time perception in near and far space

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

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

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

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

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

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

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

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

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

Oral | Development, Clinical

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

[O2] Oral 2: Decelopment, Clinical

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

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

[O2-01]

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

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

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

[O2-02]

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

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

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

[O2-03]

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

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

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

[O2-04]

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

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

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

[O2-05]

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

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

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

[O2-06]

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

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

Hospital (India))

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

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

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

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

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

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

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

1. Federal University of ABC

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

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

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

*Sebastian L. Kübel[1,2,3]

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

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

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

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

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

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

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

*Rafael Román-Caballero[1,2], Maya Psaris[2], Betania Y. Georlette[3], Mohammadreza Edalati[3], Barbara Tillmann[4], Sahar Moghimi[3], Gabriel (Naiqi) Xiao[2], Laurel J. Trainor[2], Juan Lupiáñez[1]

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

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

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

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

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

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

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

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

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

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

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

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

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

Oral | Attention, Multisensory, Time Perception

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

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

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

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

[O3-01]

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

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

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

[O3-02]

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

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

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

[O3-03]

The priority accumulation framework – attention in time and space

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

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

[O3-04]

Multisensory Integration and Delay Adaptation in Sensorimotor Timing

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

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

[O3-05]

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

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

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

[O3-06]

Interference between time and space in advanced age

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

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

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

1. The University of British Columbia

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

Keywords: event perception, time scarcity

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

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

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

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

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

The priority accumulation framework –attention in time and space

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

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

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

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

Multisensory Integration and Delay Adaptation in Sensorimotor Timing

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

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

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

Keywords: Multisensory Integration, Delay Adaptation, Sensorimotor Timing

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

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

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

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

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

Interference between time and space in advanced age

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

1. Technical University Berlin

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

Keywords: space-time interference, aging, virtual reality

Oral | Memory, Emotion, Decision

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

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

Chair:Müge Cavdan(Justus Liebig University Giessen)

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

[20301-06-01]

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

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

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

[20301-06-02]

Alpha power indexes working memory load for durations

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

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

[20301-06-03]

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

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

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

[20301-06-04]

Mental Time Travel Impairments in Neurodegenerative Diseases

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

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

[20301-06-05]

Level of Detail in Near and Far Future Imagined Events

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

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

[20301-06-06]

Perceptual decision making of nonequilibrium fluctuations

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

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

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

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

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

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

Alpha power indexes working memory load for durations

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

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

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

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

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

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

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

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

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

Mental Time Travel Impairments in Neurodegenerative Diseases

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

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

In recent decades, research on memory processes has expanded to include the mechanisms involved in envisioning future events, within the broader framework of mental time travel (MTT). *Prospection* refers to a broad and complex set of cognitive processes that enable individuals to anticipate, plan for, and mentally simulate future experiences.This study focuses on a specific form of episodic prospection known as episodic future thinking (EFT)—the capacity to project oneself forward in time to pre-experience personal future events.Previous studies have documented impairments in EFT among individuals with neurodegenerative diseases such as Alzheimer’s disease (AD) and semantic dementia (SD), often related to long-term memory deficits. However, the neurocognitive mechanisms underlying these deficits remain poorly understood—particularly regarding the role of temporal distance.The aims of the present study were:
(i) to investigate MTT capacities across different temporal distances in AD and SD patients;
(ii) to disentangle the relationship between EFT and long-term memory deficits in these neurodegenerative profiles.Our results show that AD patients exhibited significant impairments in EFT for near-future events, while their performance for distant-future scenarios was relatively preserved. Additionally, they demonstrated deficits in past event recollection regardless of temporal distance. In contrast, SD patients showed an opposite pattern: preserved EFT for near and intermediate future events, but impaired performance for distant ones. Regarding the past dimension, SD patients showed deficits specifically for remote events.These findings contribute to a more nuanced understanding of how episodic and semantic memory impairments differentially affect past and future-oriented cognition in neurodegenerative conditions. The results carry both theoretical significance and potential clinical applications.

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

Level of Detail in Near and Far Future Imagined Events

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

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

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

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

Perceptual decision making of nonequilibrium fluctuations

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

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

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

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

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

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

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

Oral | Prediction, Temporal perception, Computational Modeling

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

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

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

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

[O6-01]

Temporal Prediction through Integration of Multiple Probability Distributions of Event Timings

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

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

[O6-02]

The anticipation of imminent events is time-scale invariant

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

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

[O6-03]

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

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

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

[O6-04]

What does the Fröhlich effect tell us about sensation time?

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

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

[O6-05]

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

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

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

[O6-06]

An investigation of auditory rhythms with a spiking neural network autoencoder

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

Temporal Prediction through Integration of Multiple Probability Distributions of Event Timings

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

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

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

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

The anticipation of imminent events is time-scale invariant

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

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

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

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

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

*Andreas Wutz[1]

1. University of Salzburg

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

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

What does the Fröhlich effect tell us about sensation time?

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1. CNRS & Ecole Normale Supérieure Paris

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

Keywords: sensation time, Fröhlich effect, motion perception, visual psychophysics

Affective modulation of temporal binding using linguistic stimuli

*Felipe Toro Hernández[1], Theresa Moraes Ramalho[2], André Mascioli Cravo[2], Peter M. E. Claessens[2]

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Temporal binding (TB)—the perceived shortening of time between a cause (event A) and its effect (event B)—is often associated with voluntary action. This temporal compression is typically stronger when the action is self-generated, making TB a widely used implicit marker of the sense of agency (SoA). Whereas explicit measures of SoA are usually sensitive to outcome valence (positive outcomes yield higher agency ratings than negative ones), implicit measures such as TB have produced less consistent findings. We examined whether emotional valence influences TB using a two-alternative forced-choice (2AFC) interval discrimination task in three experiments, varying the predictability of outcome valence. Emotional words (e.g., "joy," "death," "chair") served as outcomes, categorized as positive, negative, or neutral. Relevant psycholinguistic variables were matched across valence groups using previous normatization studies for Brazilian Portuguese and two online surveys (N = 54). In Experiment 1 (N = 33), agency (active vs. passive) and word valence were fixed within blocks. In Experiment 2 (N = 40), valence was either fixed or varied across trials, depending on the block. Experiment 3 (N = 40) used only trial-wise variation in valence. Across all experiments, generalized linear mixed models (GLMMs) replicated the TB effect: active trials were perceived as more temporally compressed than passive ones. However, outcome valence did not interact with agency in any of the experiments, suggesting no affective modulation of TB. These findings suggest that emotional valence alone may not be sufficient to influence implicit measures of agency, such as TB. Future research should investigate additional factors and methodologies to gain a deeper understanding of how emotion, agency, and time perception interact.

Keywords: Temporal binding, Sense of Agency, temporal cognition, psychophysics, cognitive-affective neuroscience

An investigation of auditory rhythms with a spiking neural network autoencoder

*Rodrigo Manríquez[1,2], Sonja A. Kotz[2,3], Andrea Ravignani[4,5], Bart de Boer[1]

1. Vrije Universiteit Brussel, 2. Maastricht University, 3. Max Planck Institute for Human Cognitive and Brain Sciences, 4. Sapienza University of Rome, 5. Aarhus University & The Royal Academy of Music

Here, we present a biologically inspired spiking neural network, or SNN, framework that learns auditory rhythms from acoustic data by exploiting the exact spike timing of spikes. Although classic deep learning models have been applied to investigate temporal sequences, spiking NNs more accurately reflect the temporal dynamics of biological neural systems.

We first encoded acoustic waveforms containing rhythmic information into spike trains and considered a subcortical model of the peripheral auditory pathway [1.] This model reproduces cochlear transduction and auditory-nerve firing across characteristic frequencies, yielding parallel streams of precisely timed spikes that retain the temporal structure of the input. These spike trains were then used to train a purely spike-based autoencoder. In this framework, the encoder compresses input data into a latent representation, i.e. a simplified representation that captures underlying features of the data, while the decoder reconstructs the amplitude envelope of the original sound, preserving rhythmic features.

By training on isochronous sequences, where consecutive onsets were separated by identical intervals, we demonstrate that rhythmic structure is preserved in the latent space representation. Moreover, the network develops predictive behaviour, by anticipating subsequent beat onsets even in the absence of a beat. This sensitivity reflects a form of temporal expectation embedded in the SNN. To evaluate how the network internalises rhythmic structures, we tested it with sequences that missed beats and inspected the resulting latent representations. By analysing the spiking activity and internal variables within this hidden layer, we revealed how the model encodes temporal regularities and reconstructs the expected onset pattern, in a way that would not be possible in a non-spiking neural network.

1. Zuk, N., Carney, L., Lalor, E. 2018. Preferred Tempo and Low-Audio-Frequency Bias Emerge From Simulated Sub–cortical Processing of Sounds With a Musical Beat. *Front. Neurosci.*, *12*.

Keywords: Spiking Neural Networks, Auditory Processing, Rhythm Processing

Oral | Computational Modeling, Neural Mechanisms

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

[O5] Oral 5: Computational Modeling, Neural Mechanisms

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

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

[O5-01]

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

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

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

[O5-02]

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

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

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

[O5-03]

Rationalizing temporal decision making and the neural representation of time

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

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

[O5-04]

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

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

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

[O5-05]

Sensory Reliability Shapes Sequential Effects in Human Duration Perception

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

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

[O5-06]

Bach and Bayes: Prediction in Noisy Musical Sequences

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

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

*Chiara Zanonato[1,2], Richard Ivry[3,4], Assaf Breska[1,3]

1. Max-Planck-Institute for Biological Cybernetics, Tübingen, 2. University of Tübingen, 3. Department of Psychology, University of California, Berkeley, CA, 4. Helen Willis Neuroscience Institute, University of California, Berkeley, CA

Humans keep track of temporal intervals for various purposes, ranging from explicitly reporting perceived durations to implicitly orienting attention in time. Whether shared or segregated timing mechanisms subserve these timing processes is a key neuroscientific question. While neuroimaging studies revealed task-dependent functional dissociations, mostly at the cortical level, recent behavioral work hints at potential computational overlap. Moreover, separate lines of research have implicated the cerebellum in both explicit and implicit interval timing, but whether this reflects one shared or two task-specific cerebellar circuits is unknown. Here, we investigated how the cerebellum might act as a central timing circuit in implicit and explicit interval timing. Cerebellar Ataxia (CA) patients (N=18) and age-matched neurotypical controls (N=16) performed explicit (temporal discrimination) and implicit (cued temporal orienting for speeded detection) interval timing tasks, as well as a control task to account for non-temporal factors. Two intervals (S1, S2) were sequentially presented: S1 was either short (700ms) or long (1200ms), while S2 spanned between the short and long S1. CA patients' performance was impaired compared to healthy controls in both tasks, showing lower temporal sensitivity in temporal discrimination and smaller validity effect in temporal orienting, in line with previous studies. Critically, the performance in the two tasks was more strongly associated in the patient than the control group, with only the former showing a significant correlation, as predicted by a shared process model. Moreover, this was not explained by non-temporal factors. These findings establish the cerebellum as a central sub-second interval timing hub, causally involved in timing intervals independently of the final purpose.

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

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

*Christina Bruckmann[1,2], Assaf Breska[1]

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

Temporal prediction and preparation are essential for adaptive behavior, and can be generated based on various temporal regularities, including rhythms and interval memory. In rhythmic streams temporal predictions are thought to uniquely rely on phase-aligning neural oscillations to the external rhythm. However, in motor tasks, previous studies found similar behavioral benefits and neural phase alignment patterns for rhythm- and interval-based temporal predictions, questioning the unique role of entrainment in these phenomena. Yet, if rhythmic entrainment acts at low-level sensory circuits, its unique effect might only be revealed under high perceptual load. Here we address this using a challenging perceptual discrimination task, in which visual target timing is either non-predictable, is on-beat with a preceding rhythm (~1.11 Hz), or matches a previously presented interval (900 ms). Examining the differential effect of temporal expectation on multiple levels of perception, we collect both objective classification accuracy and subjective visibility reports, a fundamental distinction in consciousness research that has been overlooked in the temporal attention literature. In line with previous findings, both interval- and rhythm-based temporal expectations improve performance compared to the irregular stream, but to a similar degree, which is inconsistent with the idea that rhythmic entrainment provides a unique perceptual benefit beyond temporal prediction. In EEG, we critically found similar increases in occipital delta phase alignment in the rhythm and interval conditions. This was not found in central channels, demonstrating the independence of sensory from high-level phase alignment. Taken together, these results show that phase alignment can occur in the absence of oscillatory entrainment and call into question whether rhythmic entrainment provides perceptual benefits beyond what would be expected by temporal prediction alone.

Keywords: temporal attention, rhythmic entrainment, interval, EEG, visual discrimination

Rationalizing temporal decision making and the neural representation of time

*Marshall G Hussain Shuler[1,2]

1. Johns Hopkins, 2. Kavli Neuroscience Discovery Institute

By what neural means do we represent the passage and structuring of time and decide how to spend time? How do these representations of value and time relate to evolutionary pressure to maximize reward accumulation? To address these questions, we evaluate whether the temporal difference reinforcement learning (TDRL) algorithm can rationalize temporal decision-making. First, we derive the *optimal solution* for reward accumulation and demonstrate that TDRL's value estimates—infinite sums of exponentially discounted future rewards—systematically deviate from this optimum. Then we show how TDRL, operating over a time state-space representation using regular intervals, fails to learn values that rationalize the curious pattern of decision-making errors exhibited by humans and animals. Our insight, however, is that this failure can be best mitigated by representing time using a time-dilating state-space, wherein the amount of time spent in a subsequent state increases by a precise proportion. TDRL applied to such a time-dilating state-space then learns values that rationalize the diverse suboptimalities observed over decades of investigating how animals and humans decide to spend time. Specifically, it affords optimal forgo behavior, minimizes a suboptimal bias toward sooner-smaller rewards in mutually exclusive choices, and leads to a suboptimal unwillingness to abandon engaged pursuits (sunk cost). In proposing PARSUIT theory (Pursuit-based Atomized Reinforcement of State-value Using Increasing Timesteps), we provide 1) a general, mechanistically descriptive explanation of temporal decision making, 2) a normative rationalization for why time takes the neural form that it does, and 3) advance TDRL as the learning algorithm used in temporal decision-making.

Keywords: Temporal Difference Reinforcement Learning, reward-rate maximization, dilating time state-space, temporal decision-making

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

*Oki Hasegawa[1], Shohei Hidaka[1]

1. Japan Advanced Institute of Science and Technology

The subjective experience of time slowing down during peak performance, or 'flow', suggests a link between cognitive processing speed and time perception. However, this relationship is not well understood due to the limitations of short-duration tasks, which are typically employed in psychological and neurological laboratory studies. This is a critical limitation, as the phenomena of interest typically emerge during continuous, sustained activities in the real world. Therefore, to properly test our central hypothesis—an extension of Treisman’ s internal clock model which posits that a high-arousal state accelerates an internal pacemaker to simultaneously improve information processing speed and extend subjective time —an experimental paradigm capable of inducing and continuously sustaining such a state is first necessary. Here, we present this paradigm, which involves an adaptive Tetris game designed to induce a flow-like state and enable a continuous study of the aforementioned link. The system uses a Markov process model to estimate players' abilities and adjust the task's difficulty in real time. To validate this approach, we first measured baseline performance in an ideal, untimed version of the task, confirming that player performance fell within the range predicted by our model. We then investigated the effect of three patterns of difficulty change —linear increase, linear decrease and random —on processing speed (lines cleared per minute). Although players achieved a similar maximum performance level at the end of the game in all conditions, performance improved most quickly under the linearly increasing difficulty condition. These results demonstrate that an adaptive challenge that continuously and predictably increases in response to a player's ability is a key factor for accelerating cognitive processing. At this conference, we will report on the preliminary performance evaluation of the developed task system.

Keywords: Flow State, Infomation Processing Speed

Sensory Reliability Shapes Sequential Effects in Human Duration Perception

*Taku Otsuka[1,2], Joost de Jong[1,3], Wouter Kruijne[1], Hedderik van Rijn[1]

1. University of Groningen, 2. The University of Tokyo, 3. Université de Paris

Perceived durations are biased towards immediately preceding percepts. Although such sequential effects in time perception have long been recognized, the Bayesian framework has recently emerged as a compelling account of these phenomena. Crucially, while the Bayesian framework posits that the magnitude of the sequential effect depends on the reliability of both the previous and current stimuli, empirical support for this prediction remains lacking. In order to test this central prediction of the Bayesian framework, we systematically manipulated the perceptual noise of to-be timed stimuli by embedding them in dynamic visual noise. We found that reproduced durations were biased towards the duration of the preceding stimulus, confirming the presence of a sequential effect. Importantly, the magnitude of this effect was modulated by the reliability of both the previous and current stimuli, in a manner consistent with Bayesian predictions. Furthermore, by fitting a Bayesian computational model that updated prior expectations on a trial-by-trial basis, we demonstrated that manipulating the uncertainty of the current sensory input (likelihood variance) enabled the model to capture the observed reliability-dependent modulation of the sequential effect. These findings provide direct empirical evidence for reliability-based integration in human duration judgements and highlight the sequential effect as an adaptive mechanism that dynamically adjusts to sensory uncertainty.

Keywords: sequential effect, Bayesian modeling, duration reproduction, sensory reliability

Bach and Bayes: Prediction in Noisy Musical Sequences

*Akanksha Gupta[1], Alejandro Tabas[2,3]

1. INS, INSERM, Aix-Marseille University, Marseille, 2. Perceptual Inference Group, Basque Center on Cognition, Brain and Language, San Sebastian, 3. Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig

Information from the external environment is often uncertain and ambiguous, posing a challenge for the brain to accurately infer the state of the world. According to the predictive processing framework, prior knowledge pertinent to inference is compressed into predictions about imminent future states. These predictions are combined with sensory inputs using Bayesian belief updating. While this approach is optimal for inferring latent states in certain stochastic systems, it may not be useful when applied to more complex systems such as music or language. In this work, we examine whether neural networks trained to infer the current latent state in a musical sequence also develop a capacity to predict what comes next.

To investigate this hypothesis, we utilized tokenized Bach compositions corrupted with noise as sensory inputs and gated recurrent neural networks (GRUs) to model neural circuits. The training procedure involved two stages: first, to infer the current token, and then, to optimize a linear readout for predictions of the next token to see if the predictions are encoded in the network's internal states. Furthermore, we benchmarked the network's performance against an optimal Markovian model, which predicts the next token using only the current token. Our findings demonstrate that neural circuits fine-tuned for perceiving the current state can learn to predict future sensory input, suggesting that predictive capabilities emerge as a consequence of such optimization. This evidence strengthens the computational foundation of the predictive coding framework and offers insights into how biological systems may utilize prior knowledge to adaptively operate within uncertain environments.

Keywords: Predictive Processing, Bayesian Brain Hypothesis, Recurrent Neural Networks (RNNs), gated recurrent neural networks (GRUs)

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]

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Communicating and connecting with others relies on fine-tuned embodied coordination. Yet, as our social lives increasingly shift online where movement cues become impoverished, our ability to connect meaningfully is getting challenged. While Virtual Reality (VR) offers promising opportunities for embodied interaction in digital spaces, little is known about how to best capture, render and foster embodied coordination in this medium. Hence the ShareSpace project aims to better understand the constraints of virtual spaces on multi-agent embodied coordination, with the goal to optimize both motion capture and rendering.We report a series of studies on group movement coordination performed in both physical and virtual reality. In the first two studies, triads and quartets synchronized arm movements and reported their experiences of social connection. Results show that the kinematic and social benefits of group synchrony observed in physical reality transfer to VR. However, while people accelerated their pace when synchronizing in physical settings, this tendency was reversed in VR, showing how digital constraints can alter coordination strategies. In a subsequent VR study, we restricted participants’ field of view to examine their interaction strategies, and in some cases, replaced one human partner with an adaptive artificial agent. This agent shared a similar appearance but was driven by a cognitive architecture optimized for group coordination. The presence of the adaptive agent led to an increase in movement pacing, suggesting that it could counteract the decelerating effects of digital interaction on collective kinematics. Most participants did not detect the agent swap yet reported feeling less socially connected to partners who had been replaced. These findings show the critical role of subtle kinematic cues in social coordination and offer new guidelines to design hybrid digital spaces that support authentic group interaction.

Keywords: Group synchronization, Virtual Reality, Social connection, Artificial Agent

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

*John Rehner Iversen[1], Akilesh Sathyakumar[1], Hyeonseok Kim[2], Makoto Miyakoshi[2], Wanhee Cho [3], Hirokazu Tanaka[4], Takahiro Kagawa[5], Makoto Sato[3], Scott Makeig[7], Hiroyuki Kambara[6], Natsue Yoshimura[3]

1. McMaster University, 2. Cincinnati Children's Hospital Medical Center, 3. Institute of Science Tokyo, 4. Tokyo City University, 5. Aichi Institute of Technology, 6. Tokyo Polytechnic University, 7. University of California San Diego

Many commonly used rhythmic timing tasks can be easily varied in tempo, revealing important scaling laws of timing behavior and aiding learning. In contrast, it is more challenging to vary the tempo of real-world physical tasks like three-ball juggling. To address this, our collaborators have developed a realistic VR visuo-haptic simulation of juggling under reduced gravity using a novel force-generating input device to realistically simulate the physics and proprioception of ball throwing and catching (Kambara et al, *Proc IDW*, 2022). The setup enables the experimental modification of juggling tempo in a way that is not possible in physical settings. Our prior work has shown that juggling training in reduced gravity can enhance skill acquisition in novices, potentially by facilitating the learning of bimanual motor sequencing. (Cho et al., *IEEE VRW*, 2025). Here we shift focus to expert jugglers adapting to slow tempo juggling to test hypotheses about temporal scaling in motor control: proportional scaling vs. constant hold time (which relate to the continuous vs. discrete timing duality in the rhythmic timing literature). We measured motor kinematics (hand trajectories and timing of ball catches and throws) in relation to ball trajectory to describe how these scale with juggling tempo manipulated by changing simulated gravity. Our initial results (though n=2) are that a third alternative is suggested: jugglers attempt to increase tempo in low gravity by using shorter throws. This behavior may reflect VR-specific constraints, such as narrower field of view and less realistic proprioceptive feedback, prompting design improvements including pacing stimuli and visual apex targets to encourage slower juggling. This behavioral foundation supports planned neural studies of temporal scaling of neural dynamics using new methods for movement artifact rejection (Kim et al., *Sensors*, 2023; *J Neur Meth*, 2025).

Keywords: motor learning, adaptation, timing, rhythm, tempo, juggling

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

*Ségolène M. R. Guérin[1,2], Emmanuel Coulon[2], Tomas Lenc[2,3], Rainer Polak[4], Peter Keller[5], Laurie Gallant[2], Antoine Boveroux[2], Sylvie Nozaradan[2]

1. URePSSS, Université du Littoral Côte d'Opale, 2. Institute of Neuroscience (IoNS), Université Catholique de Louvain (UCLouvain), 3. Basque Center on Cognition, Brain, and Language (BCBL), 4. RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, 5. Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg

Music naturally induces human movement through its rhythmic structure. Conversely, synchronised body movement can shape rhythm perception –a short-term effect that is likely influenced itself by lifelong cultural exposure. Yet, direct experimental evidence for both short- and long-term modulation of rhythm processing through movement remains limited.
To address this, we present a registered report using electroencephalography (EEG) and hand-clapping responses to a highly syncopated, metrically ambiguous rhythm derived from West/Central African musical traditions (N = 80). These neural and behavioural responses were recorded separately in participants from West/Central Africa and Western Europe before and after a body-movement session involving stepping and clapping to a cued beat (either three- or four-beats meter, the latter concurring with original music-cultural conventions).
African participants exhibited a significant short-term effect, clapping more consistently and in closer alignment with the beat as cued in the body-movement session. They also more reliably interpreted the rhythm in line with cultural conventions, both before and after movement. In contrast, European participants showed no significant short-term movement effect. A sibling study was then conducted on an additional Western cohort (N = 40), where the body movement session was replaced by watching audiovisual clips of individuals performing the same body movement as in the first study, while remaining still. In contrast with Study 1, behavioural responses to the cued beat were found to be significantly more consistent after the training session, suggesting that multisensory inputs, possibly activating motor representation without actual movement production, can elicit a short-term effect even when production of actual movement does not.
Finally, inconsistencies between neural and behavioural data in both studies suggest that a brief training session alone may not robustly stabilise a beat interpretation that can be automatically reactivated in neural activity after the movement cessation, particularly in response to a complex, syncopated rhythm. Nonetheless, when participants are compelled to move to such a rhythm, they can draw on learnt beat–rhythm association to guide movement timing.

Keywords: cross-cultural, EEG, frequency tagging, rhythmic entrainment, body movements

Evidence for neural categorization of rhythm in human newborns

*Francesca M. Barbero[1], Tomas Lenc[1,2], Alban Gallard[3], Nori Jacoby[4,5], Rainer Polak[6,7], Arthur Foulon[3], Sahar Moghimi[3], Sylvie Nozaradan[1,8]

1. Institute of Neuroscience (IoNS), University of Louvain (UCLouvain), 1348 Louvain-la-Neuve, 2. Basque Center on Cognition, Brain and Language (BCBL), Donostia-San Sebastian, 3. Groupe de Recherches sur l’ Analyse Multimodale de la Fonction Cérébrale (GRAMFC, Inserm UMR1105), Université de Picardie, 80054 Amiens, 4. Computational Auditory Perception Group, Max Planck Institute for Empirical Aesthetics, Grüneburgweg 14, 60322 Frankfurt am Main, 5. Department of Psychology, Cornell University, Ithaca, NY 14853, 6. RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, 7. Department of Musicology, University of Oslo, 8. International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal

Humans show an outstanding capacity to perceive, learn, and produce musical rhythms. These skills rely on mapping the infinite space of possible rhythmic sensory inputs onto a finite set of internal rhythm categories. What are the brain processes underlying rhythm categorization? One view is that rhythm categories stem from neurobiological predispositions constraining internal representations of rhythmic inputs. However, a growing body of work suggests that rhythm categorization is plastic, open to be shaped by experience over the course of life. To tease apart the relative contributions of neurobiological predispositions and experience in rhythm categorization, we measured neural responses to rhythm in healthy full-term human neonates, capitalizing on their minimal post-natal experience.
Scalp electroencephalography (EEG) was recorded from newborns while they were exposed to acoustic sequences consisting of repeating patterns of two inter-onset intervals ranging from isochrony (1:1 interval ratio) to long-short patterns (2:1 ratio). In a second experiment, we separately recorded neural (EEG) and behavioral (sensorimotor synchronization) responses to the same rhythms in adult participants. The data were analyzed using a novel approach combining frequency-domain and representational similarity analyses.
Preliminary results indicate significant rhythm categorization in neonates, with categories encompassing the 1:1 and 2:1 integer ratio rhythms, and with a categorical structure similar to the neural and behavioral responses of adults. These findings suggest that internal representations of rhythm may be biased towards categorical structure by neurobiological properties already in place at birth. This study thus paves the way to further investigate the neural processes by which these internal categories would be further shaped by individual and cultural experience, leading to the diversity in music perception and behaviors observed worldwide.

Keywords: musical behavior, development, rhythm perception, electroencephalography

Oral | Timing & Time Perception

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

[O9] Oral 9: Timing & Time Perception

Chair:Sae Kaneko(Hokkaido University)

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

[O9-01]

How each heartbeat shapes neural processing of duration?

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

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

[O9-02]

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

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

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

[O9-03]

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

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

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

[O9-04]

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

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

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

[O9-05]

Representational dynamics of subjective duration in the human brain

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

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

[O9-06]

Mouse Strain Differences in Time Estimation are Related to Impulsive Behavior

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

How each heartbeat shapes neural processing of duration?

*Irena Arslanova[1], Magda Jaglinska[2], Manos Tsakiris[1]

1. Royal Holloway University of London, 2. University College London

We previously showed that perceived stimulus duration was distorted by autonomic signals arising from the heart, and that this temporal distortion was modulated by experienced arousal (Arslanova et al., 2023; Current Biology). Here, we present two studies that reveal the neural mechanisms underlying these effects using electroencephalography (EEG), testing if and how the subjective experience of duration arises from an intricate brain-heart interplay.

The first EEG study examined the neural correlates of temporal distortions when cardiac signals impacted emotionally neutral stimuli (i.e., participants judged the duration of visual Gabor patches), whereas the second EEG study focused on cardiac effects on duration perception under different levels of experienced arousal (i.e., participants judge the duration of faces showing neutral of fearful expression). The first EEG study (N = 40) showed that cardiac signalling supressed later stages of visual processing, which was correlated with contraction of perceived durations. The second EEG study (N = 41) revealed distinct mechanisms by which arousal and cardiac signals shape subjective duration perception –an early modulation by arousal, followed by a later modulation by cardiac signal.

Overall, these results reveal how cardiac signals shape subjective time experience by exerting top-down attenuation of sensory processing, how temporal information may be intrinsic to sensory response, and how affective context drives the effect of the heart on our sense of duration.

Keywords: duration perception, heart, cardiac phase, interoception, EEG

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

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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

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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).

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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

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According to the entrainment region hypothesis, the range of tempi with which individuals can synchronize broadens during childhood. This developmental change is accompanied by a slowing of rhythmic preferences, as covered by the preferred period hypothesis. The later hypothesis posits that both motor and perceptual rhythmic preferences slow down throughout childhood, reflecting an increase in the common period of endogenous oscillations. This study aimed to provide a developmental profile of rhythmic performances (counting and tempo discrimination), while investigating the related contributions of a preferred period (spontaneous motor tempo and perceptual preferred tempo). The study ($N = 70$) included three groups of children (5-6, 8-9, and 11-12 years) and one group of young adults (21-30 years), all tested at the same time of day. The results show a change in rhythmic performances between the ages of 8-9 and 11-12, as well as a variable contribution of rhythmic preferences, depending on the task employed. Moreover, results indicate a significant effect of rhythmic context in tempo discrimination, suggesting that young children can discriminate tempi slower than their rhythmic preferences. This study nuances the bias of rhythmic performance towards rhythmic preferences, notably because the tasks employed to measure rhythmic performance indicate different developmental trajectories, in addition to varying in their relationships to rhythmic preferences. It is suggested that the cognitive demands relative to the task employed to measure rhythmic performances could underlie developmental differences and mask biases towards rhythmic preferences, particularly in younger children.

Keywords: Rhythm, Preferred Tempo, Entrainment, Development

Representational dynamics of subjective duration in the human brain

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How is time represented in the mind and brain? While durations are often thought to be mapped along a mental timeline (*i.e., a unidimensional spatialized representation of durations*), such a view may oversimplify the complexity of temporal representations. In this talk, I will present a project that investigates the geometry of duration representations by combining behavioral similarity judgments and representational similarity analysis of EEG data. We asked participants to rate the similarity of pairs of auditory durations and, in a separate session, recorded EEG while they performed an oddball detection task with the same stimuli. These data were used to construct representational dissimilarity matrices, which we projected into lower-dimensional spaces to visualize and compare the conceptual and neural structure of duration representations. Crucially, we explored whether the structure of neural responses could predict participants' behavioral similarity judgments, and whether these shared structures reflected non-linear or multi-dimensional embeddings—such as helical structures—rather than simple linear mappings. We further examined how classic EEG markers of timing, such as the contingent negative variation, relate to these geometrical structures. This work contributes to a growing line of research aiming to uncover the geometry of mental representations and offers a new perspective on how durations may be encoded in the brain.

Keywords: temporal cognition, subjective duration, neural dynamics , representational dynamics

Mouse Strain Differences in Time Estimation are Related to Impulsive Behavior

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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]

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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

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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

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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