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 Venue 4(KOMCEE W B1F-011)

[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?

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

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

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

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

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

*Tereza Nekovarova[1,2], Veronika Rudolfova[1,2], Kristyna Maleninska[1], Ondrej Skrla[1], Jakub Svoboda[1], Jana Koprivova[1,3], Martin Brunovsky[1,3], Vlastimil Koudelka[1]

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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).

References

Klimesch, W. The frequency architecture of brain and brain body oscillations: an analysis. *European Journal of Neuroscience* 48, 2431–2453 (2018).
Criscuolo, A., Schwartze, M. & Kotz, S. A. Cognition through the lens of a body–brain dynamic system. *Trends Neurosci* (2022) doi:10.1016/J.TINS.2022.06.004.

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

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

*Pier-Alexandre Rioux[1], Nicola Thibault[1,2], Daniel Fortin-Guichard[3], Émilie Cloutier-Debaque[4], Simon Grondin[1]

1. Laval University, 2. CERVO, Brain Research Center, 3. McGill University, 4. University of Montreal Hospital Center

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

Keywords: Rhythm, Preferred Tempo, Entrainment, Development

Representational dynamics of subjective duration in the human brain

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

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

Mouse Strain Differences in Time Estimation are Related to Impulsive Behavior

*MARIELENA EUDAVE-PATIÑO[1], JONATHAN BURITICÁ[2], JAIME EMMANUEL ALCALÁ TEMORES [2]

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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