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

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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

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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

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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

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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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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