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 Venue 1(Room 1)

[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

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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

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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]

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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]

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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

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

Spatial tool use modulates time perception in near and far space

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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

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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