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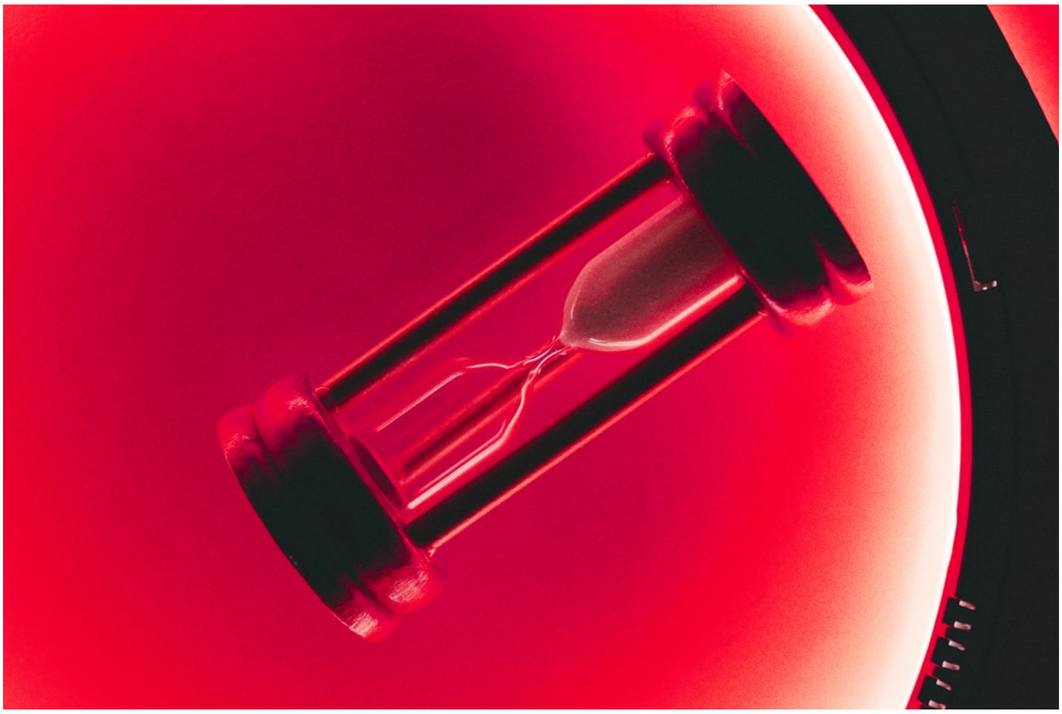
**PRESS RELEASE**

# Perceived time is not absolute time – what we can learn from the rat brain

**A new publication in *Neuron* sheds light on how the brain generates the feeling of the passage of time**



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Sensory systems are bound to sensory receptors – vision to the retina, hearing to the cochlea. There is a striking exception; the sense of time is precise and guides all our behaviors, yet time receptors do not exist. The brain must build up a neuronal representation of time using circuits free from any dedicated receptors. New research carried out by the SISSA Tactile Perception and Learning Lab, directed by Mathew Diamond, investigates the role of a specific area of the rat brain, the dorsolateral striatum (DLS) in time perception. The report argues that this brain region holds a clock for absolute time, but that clock is not converted into a percept of elapsed time.

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“Recent work suggests that dorsal striatum is critical in encoding the perception of time” Alessandro Toso, first author of the paper, says. “We show for the first time that DLS, while a reliable counter of elapsed time, is likely not the substrate of the perceived duration of ongoing sensory stimuli. Our current work points to other mechanisms for generating the feeling of time.”

As rats judged the duration of sensory stimuli, precise temporal information was in fact contained within DLS neuronal activity. The DLS time code does not solve the perception puzzle, however, since the code was more tightly coupled to the sequence of events than to the rat’s judgment of stimulus duration.

**Time coding and the brain**

An incoming phone alert is sensed as a vibration, but it is also sensed as brief or long. The neuronal mechanisms underlying the perception of elapsed time remain unknown. Recent studies have indicated a systematic representation of time in the DLS. Diamond explains that “Our group has been working on the dual nature of sensory experiences; how does the same sensory input lead to two feelings simultaneously – the stimulus itself, as well as the feeling of the time occupied by that stimulus? In light of important studies pointing to DLS, we decided to apply our behavioral paradigms while measuring the neuronal representation in this brain region.”

To assess the DLS role in time coding, the SISSA investigators recorded neuronal activity as rats compared the durations of two sequential tactile vibrations. They found that through sequential activation of populations of neurons whose activity was either increasing or decreasing over time (defined as “ramping” neurons), DLS represents the unfolding of each stimulus across time. To this point, the new findings agree with earlier claims that DLS serves as the brain’s substrate for the feeling of time. However, further analyses demonstrated a distinction between the encoding of “trial time” versus the perceived duration of vibrations. First, DLS did not show a privileged representation of the stimulus durations as compared to other time spans. Rather, DLS neurons encoded the time before the first stimulus, the time between the first and second stimulus, and the time elapsed as the rat collected a reward. The coding of stimulus duration – the percept critical to the behavior – was repeatedly substituted by the coding of each new trial event.

Second, while higher-intensity vibrations were perceived as longer by the animals, time decoded from DLS was unaffected by vibration intensity. “We have carried out many studies showing that, both for humans and for rats, a stronger vibration is felt as lasting longer,” adds Toso. “If DLS is the basis of the time percept, then the stronger stimulus must be encoded as longer. But DLS neurons did not show the stronger-feels-longer bias." Third, if DLS is the basis of the time percept, then errors due to misperception of stimulus duration should be found within the population code of DLS. But DLS did not encode stimulus duration differently on correct versus incorrect trials.

Finally, in rats trained to compare the intensities of two sequential vibrations, stimulus duration was encoded even though it was a perceptually irrelevant feature.

"Our analyses seek to distinguish between the encoding of trial time – that is, the passing of external, absolute time – and the encoding of the subjective percept of time" concludes Diamond. "The results confirm that time information is explicitly encoded within the DLS neuronal population but point to the need for further studies to ascertain the role of DLS population activity in the rat's percept of duration as opposed to its role in other ongoing behavioral operations. Finding the brain's representation of the subjective experience of time is one object of current research."

**USEFUL LINK**
Full paper available here
https://www.cell.com/neuron/fulltext/S0896-6273(21)00617-6#secsectitle0020

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