Medical Xpress

Hallucinations from flickering lights: What happens in our brain?

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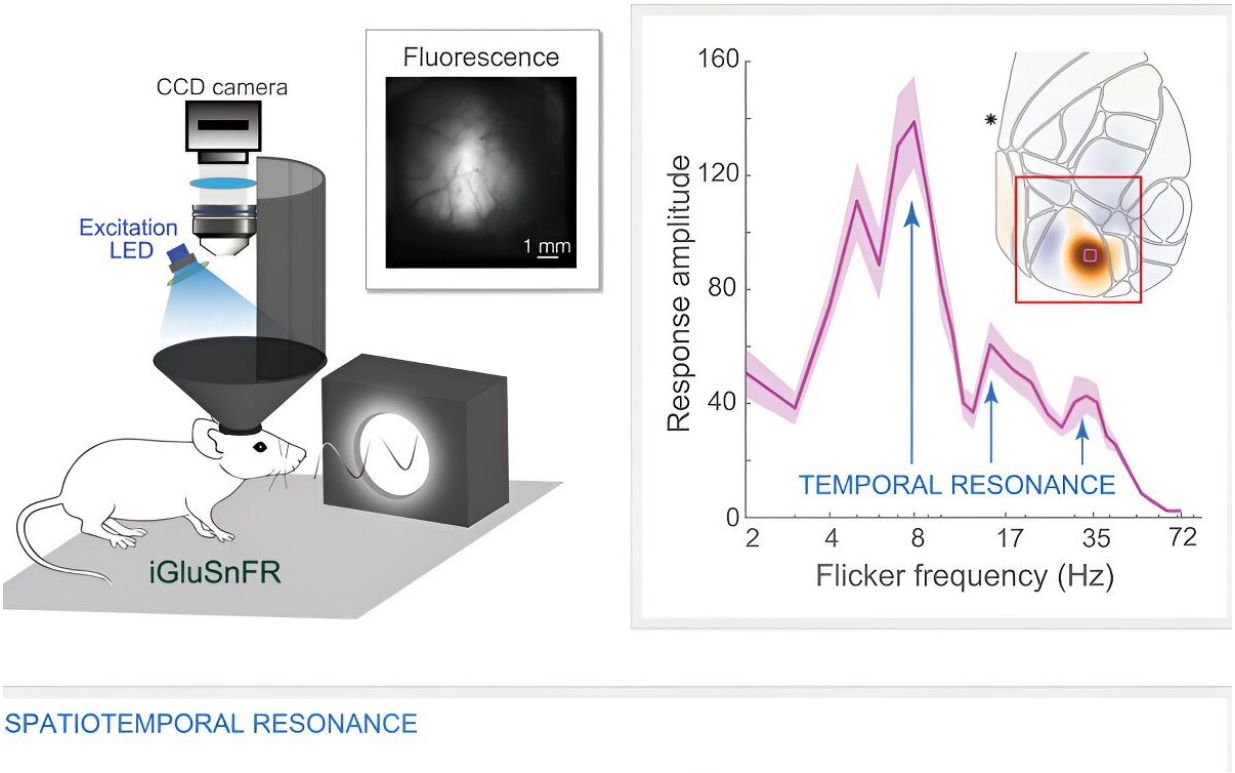

Credit: *Current Biology* (2024). DOI: 10.1016/j.cub.2024.07.091

A new study from the Netherlands Institute for Neuroscience shows how flickering light can cause hallucinations in our brain: it produces "standing waves" of brain activity.

The work is published in the journal *Current Biology*.

You're sitting on the bus or train and close your eyes. Sunlight flickering through the trees suddenly fills your mind with kaleidoscopic hallucinatory patterns. This is what Brion Gysin experienced during his trip to Marseille in the late 1960s. The fact that flashing lights can cause hallucinations was not surprising to scientists. Stroboscopic light, familiar to many from dance floors, has been used in neuroscience research for 200 years. In 1819, neuroscientist Jan Purkinje discovered that bright full-field light flashes can make our brain spontaneously perceive geometric patterns and images.

Flickering-light stimulation in the scientific community was picked up by members of the 1960s underground—the Beat Generation—who sought mind-altering experiences and manufactured their own stroboscopes that could induce vivid hallucinations without drugs. Both scientists and artists were fascinated by how stroboscopic light creates vivid images that are not there. What is the mechanism behind flicker-induced hallucinations?

Traveling wave versus standing wave

Mathematicians hypothesized that these hallucinatory patterns could be standing waves, or striped patterns, of neural activity in the visual cortex. Due to specific wiring of our visual system, the direction of these striped patterns would determine what is perceived: a pinwheel, bullseye or rotating spiral.

There are different types of waves: traveling and standing waves. Traveling waves appear as ripples spreading from a raindrop in a still pond, while standing waves occur when two people shake a skipping rope at both ends synchronously. This creates a pattern of waves moving up and down. But is there evidence that standing waves can form in our

brain?

Waves in the mouse brain

To investigate this, Rasa Gulbinaite and her colleagues looked at the formation of standing wave patterns in the mouse brain.

Gulbinaite explains, "I study brain waves and the effect rhythmic lights, sounds, and touch have on our brain rhythms. In humans, this is difficult to measure because our brain has folds and what happens on the bottom of the lake is not necessarily what we can measure on the surface.

"But mice have a flat brain, making it easier to map the activity on the surface. In our experiments, we exposed mice to flickering lights. These mice were genetically modified and had a fluorescent label attached to specific neurons. When these neurons were active, they fluoresced, allowing us to track brain activity. We used a high-speed camera to take pictures of the brain while the animals looked at the flickering light."

"When we stimulate a specific location in the visual field, we expect to see activity in the corresponding area of the visual cortex that represents this location. This is precisely what we observed. However, we also noticed waves of neural activity propagated through the visual cortex, originating from the stimulated spot," Gulbinaite continues.

"These waves resembled the ripples created by a raindrop falling into a pond. When raindrops fall at regular intervals, their ripples spread out, bounce off the banks, interfere with each other, and can create patterns similar to standing waves. Some parts of the pond's surface appear still, while others oscillate with maximum amplitude. This is exactly what occurred at higher strobe light frequencies in our experiment. The traveling waves transformed into standing waves, with some regions of the visual cortex becoming more active and others less so.

"Our findings prove the earlier hypothesis that flickering light can cause standing waves in the visual cortex. Whether mice also hallucinated geometric patterns, we cannot tell because we cannot ask: this is the most challenging part of our research.

"However, there is good reason to believe that the standing waves we observed could be the mechanism behind flicker-induced hallucinations. People report that when the flickering light frequency is higher, they perceive finer hallucinatory patterns. And that is exactly what we also saw in the brains of mice. As the frequency increased, the patterns in the visual cortex became finer. We don't have a definitive answer yet, but we are now showing convincing evidence for the first time."

More information: Rasa Gulbinaite et al, Spatiotemporal resonance in mouse primary visual cortex, *Current Biology* (2024). DOI: 10.1016/j.cub.2024.07.091

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