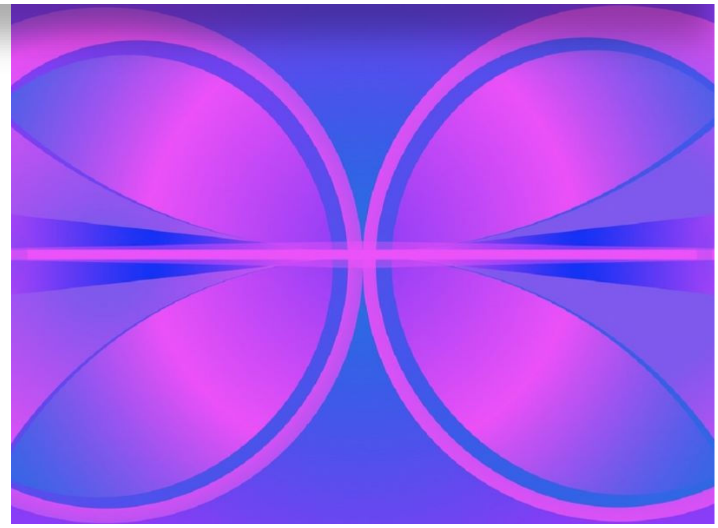
SCIENCE

# Scientists Unveil New Results in Hunt to Pinpoint the Seat of Consciousness

Shelly Fan Jun 27, 2023



SHARE

Trying to understand consciousness calls to mind images of pensive philosophers in a thinking pose. Soft rock and freestyle rap with lyrics based on theories of consciousness aren't exactly on the bingo card.

Yet the tunes galvanized an eager crowd at the 26th Association for the Scientific Study of Consciousness (ASSC 26) meeting in New York, as attendees awaited the results of the scientific face-off of the century: a head-to-head trial that pitted the two top theories of consciousness against each other.

It found that consciousness may emerge from a grid-like interconnection of neurons at the back of the head.

Launched in 2019, the $20 million project, COGITATE, sought to explore an age-old question: how does consciousness arise? The "outlandish" project threw the field into a tizzy for its audacity. But it set up a fair fight: the teams collaborated on specific experiment designs, published them online, and pre-registered predicted results based on each of their championed

Human brain scan data was then collected from six theory-neutral labs around the world, with the results judged by three experts with no money in the game to see how well the measured results matched predicted ones.

The reigning theory is just a first win. The opposing team—which thinks consciousness stems from the executive frontal parts of the brain—is ready to fight back with a new test design.

Meanwhile, as the theorist frenemies duked it out, scientists at the Human Brain Project took a stab at nailing down the neural circuits critical for consciousness—particularly why they're important. Scanning the brains of completely and partially comatose patients—with the help of reconstructed digital brains along the way—they honed in on two neural circuits that catastrophically fail as awareness slips away.

The results may sound familiar. One circuit is located at the back of the brain, and it struggles to receive and integrate information. The other, in the front and side regions, breaks down in its ability to broadcast signals to the rest of the brain. Without the ability to transmit and integrate signals from multiple sources—both from the environment and from internal computations—the biological framework of consciousness breaks down.

As for the team's thoughts on the consciousness theory battle? Their results "share similarities" with both theories, they said.

## The Nebulous Neural Enigma

Experimental methods to probe consciousness are as numerous as the word's definitions.

From Plato to Einstein to Newton, consciousness has teased the minds of intellectual greats for centuries. We still don't have an answer. I know I'm conscious. You're reading this, so you are too. But when it comes to people in a coma, or those "locked in" due to disease or injury, the question develop a measure, however crude, that could identify a spark of consciousness if it arises.

In very broad strokes, neuroscientists tackle the problem using two main methods. One is to scan volunteers' brains when they are awake, alert, and focused on a particular task. That's the route COGITATE took.

The other is tapping into the minds of people who are either in a vegetative state—known as unresponsive wakefulness syndrome—or those in a minimally conscious state who gradually regained awareness to light and touch (but remained unable to communicate effectively with the outside world). The Human Brain Project used this approach, with a digital twist: they recreated brain connections from the scans for each patient and ran simulations to model how brain regions receive, propagate, and integrate signals.

## A Poverty of Riches

Dozens of theories of consciousness have entered into respectable scientific fray, but two dominate.

One is the Global Neuronal Workspace Theory (GNWT), championed by its creator Dr. Stanislas Dehaene, Director of the INSERM-CEA Cognitive Neuroimaging Unit in France. Here, the front of the brain forms a "sketchpad" that combines sensory signals—for example, vision, smell, or taste—with stored memories and emotions. This "neuro-software update" is then broadcast across the brain. If the theory holds, the seat of consciousness is likely at the front of the brain.

The other, integrated information theory (IIT), looks to the back of the brain. There, a "hot zone" of interconnected neurons in a grid-like framework integrates data that sparks the initial stage of consciousness. The resulting signals then generate awareness and sensations.

scenario, they passively viewed the images; in another, they pressed a button when asked to respond to a target image out of two.

The test was carefully constructed to tease apart the two theories. GNWT predicts that the brain activates similarly regardless of the need to respond. IIT has another take: passively looking at the images only activates the back of the brain, whereas engaging in the task will also stir up frontal brain activity.



At the heart of the analysis are algorithms to hunt through the cacophony of neural signals. Each was pre-trained on a participant's unique brain signature using their recordings. One, the multivariate pattern decoder, takes brain activity patterns to predict the image the person saw at a particular point in time. It's a clever trick: because GNWT subscribes to a more "global theory," the decoder should be able to generalize data between the two scenarios. For example, if trained on data from passive viewing, it could predict those from the active task as well. But for IIT, this type of cross training would only work if the data came from the back of the brain.

Results? The algorithm wasn't able to decode neural signals for passive and reactive tasks, except for those from the posterior brain, favoring the theory that the seat of consciousness is at the back of the head (IIT).

have won the first round, the battle continues. For now, the results aren't yet peer-reviewed or published.

## The Neutral Zone

Meanwhile, a team from the Human Brain Project, led by Dr. Jitka Annen at the University of Liège in Belgium, took a neutral approach. Rather than focusing on a particular theory, why not gather data from those whose consciousness is partially or fully impaired and compare it to data from non-impaired people?

Annen has a powerful tool at her disposal: a platform that digitizes parts of the brain pertinent to the problem at hand—a personalized ebrain of sorts—to run simulation tests. For example, when given a digital "jolt," how would a neural simulation react?

To be clear, these models are not exact replicas of a person's brain. Rather, they paint a wide stroke of their likely neural interaction based on brain scans.

Here, the team scanned the brains of 26 people who were minimally conscious and 14 who were in a vegetative state. As a control, they also read brain activity from 33 healthy people—matched in age and gender—as they relaxed inside an MRI machine.

Rather than focusing on any particular brain regions, the team compared the data from all three groups to hunt down neural circuits that differ between each consciousness state.

Two circuits jumped out. One sat in the posterior brain and receives information; the other is a broadcasting network more towards the brain's sides and front. The networks are partially repaired in minimally conscious people, suggesting that both front and back brain regions are potentially

The somewhat frustrating conclusion is that the mystery of consciousness rages on. Dahaene, the maestro behind the GNWT theory, is looking to present his study design at next year's ASSC meetingusing video games for a more dynamic setup. The idea is to capture conscious neural signals as the gamers constantly switch their attention so that only some information enters their awareness as an alternative test.

In the meantime, Annen is further pursuing the hard problem of consciousness—that is, how it arises from billions of electrical chatterings in the brain. As for the ferocious frenemy debate between the two leading theories, Annen thinks it's possible to bridge the divide.

Although they "have distinct concepts of consciousness, our results suggest that they might represent two sides of the same coin," she said.

*Image Credit: Beyond Timelines from Pixabay*

NEUROSCIENCE

## Shelly Fan

Dr. Shelly Xuelai Fan is a neuroscientist-turned-science-writer. She's fascinated with research about the brain, AI, longevity, biotech, and especially their intersection. As a digital nomad, she enjoys exploring new cultures, local foods, and the great outdoors.

RELATED ARTICLES

Time Expansion Experiences: Why Time Slows Down in...

Steve Taylor Jan 08, 2025

This Molecule Mimics the Antiaging Effects of Dieting—Withou...

Shelly Fan Jan 07, 2025

Four Clinical Trials We're Watching That Could Change...

Shelly Fan Jan 02, 2025

WHAT WE'RE READING

OpenAI Has Created an AI Model for Longevity Science

MIT Technology Review

Jeff Bezos' New Glenn Rocket Lifts Off on First Flight

The New York Times

An
Wri
Car

Wirec