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SPECIAL REPORT

# The Science of Memory

## Exciting findings about the mind's most intriguing faculty

INCLUDING

- How we remember the future
- Devices that prevent forgetfulness
- Portraits of memories

# FROM THE EDITOR

## Total Recall

Last year memory researchers John Wixted and Laura Mickes wrote on ScientificAmerican.com that while eyewitness testimony is widely considered unreliable evidence (eyewitness misidentifications have been shown to be involved in a whopping 70 percent of 349 wrongful convictions), we shouldn't throw the baby out with the bathwater. Eyewitness testimony collected under certain circumstances could still be invaluable. The trick about memory is that sometimes it's reliable and other times it's not. Memory is malleable.

Remarkably, discovery has only slowly progressed about how memories form in the brain, why certain memories are stored over others, and what preserves the integrity of those individual memories. In this issue's special report, we've included the latest findings on the tools researchers have devised to get at these questions. As Helen Shen describes in "Portrait of a Memory," scientists are refining their techniques to decode discrete memories with increasing precision, producing "engrams," images of brain activity. Investigators Matthias Kliegel and Nicola Ballhausen explain in "Foresee and Forget: How to Remember the Future," a fascinating area of research on "prospective" memory—that is, memory used to recall things that need to be done in the future—a vital skill for planning your day's activities. And Dana G. Smith reports in "Brain 'Pacemaker' Could Help You Remember Only What You Might Forget," on a new technology that might stimulate the brain to summon up something it seems to have forgotten, in case your prospective memory is lagging on that particular day.

As always, enjoy and let us know what you think!

**Andrea Gawrylewski**

Collections Editor: editors@sciam.com

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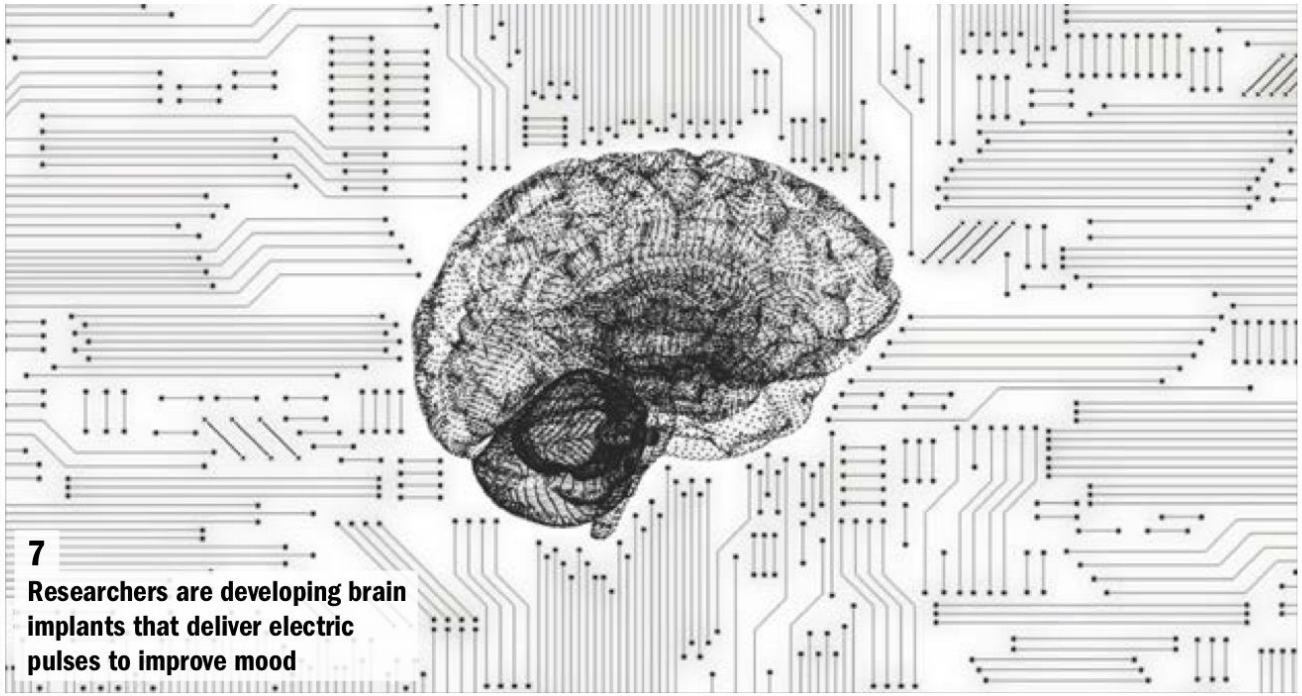

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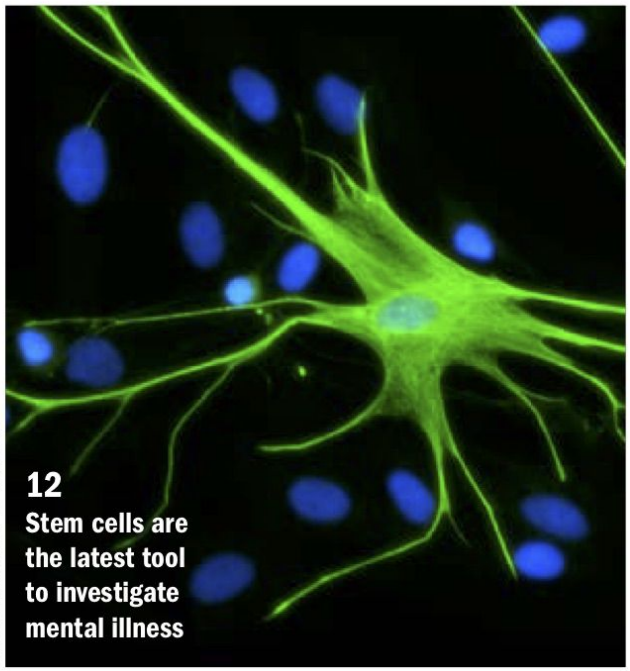

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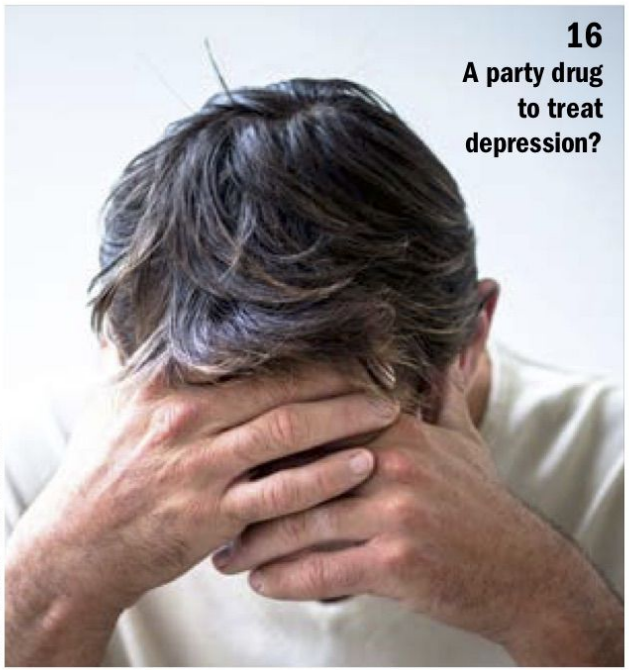

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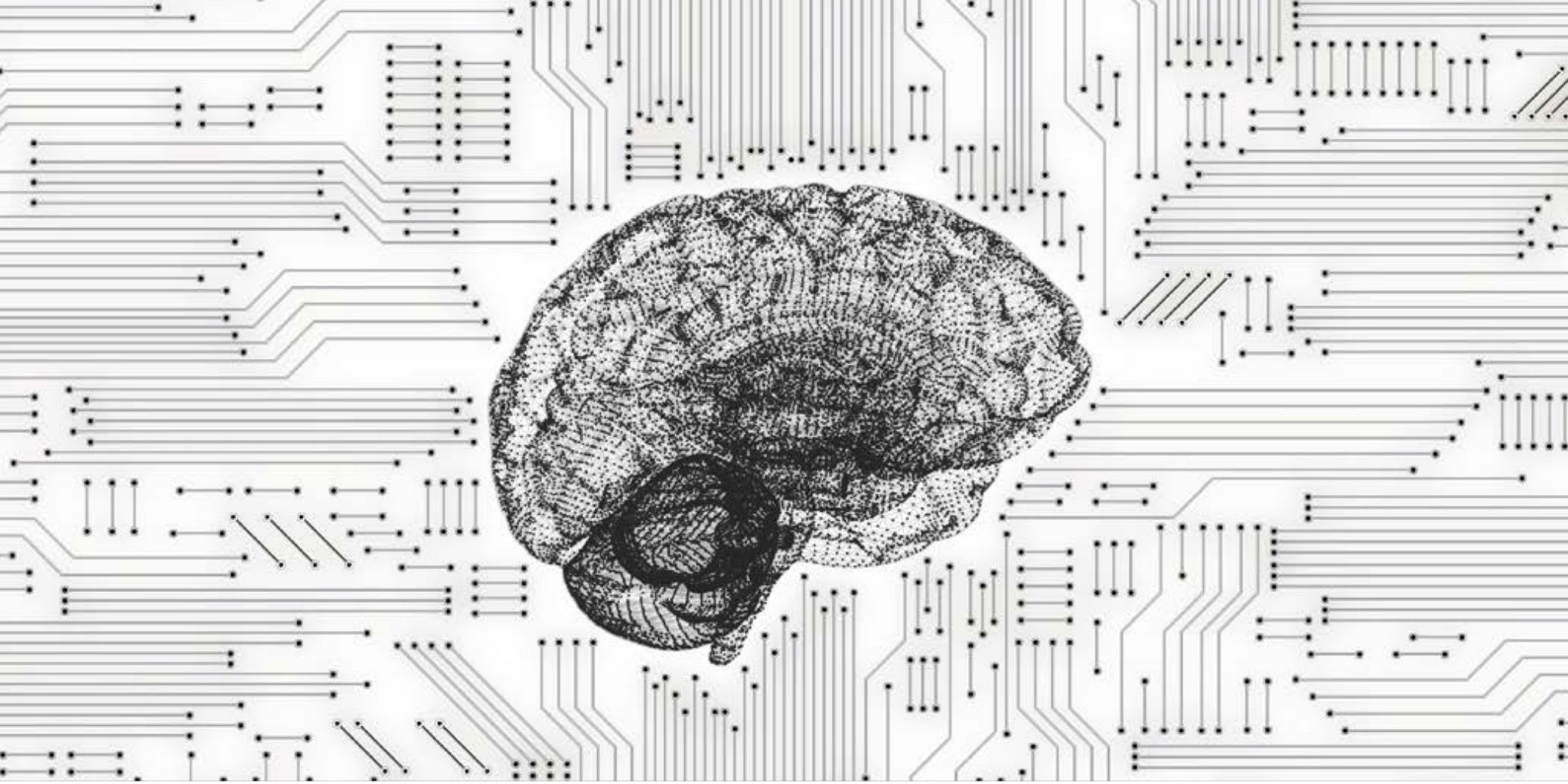

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# Brain Implants for Mood Disorders Tested in People

AI-controlled devices record neural activity and automatically stimulate the brain

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NEWS

# Talking with—Not Just to—Kids Powers How They Learn Language

Back-and-forth exchanges build the brain's language center and verbal ability

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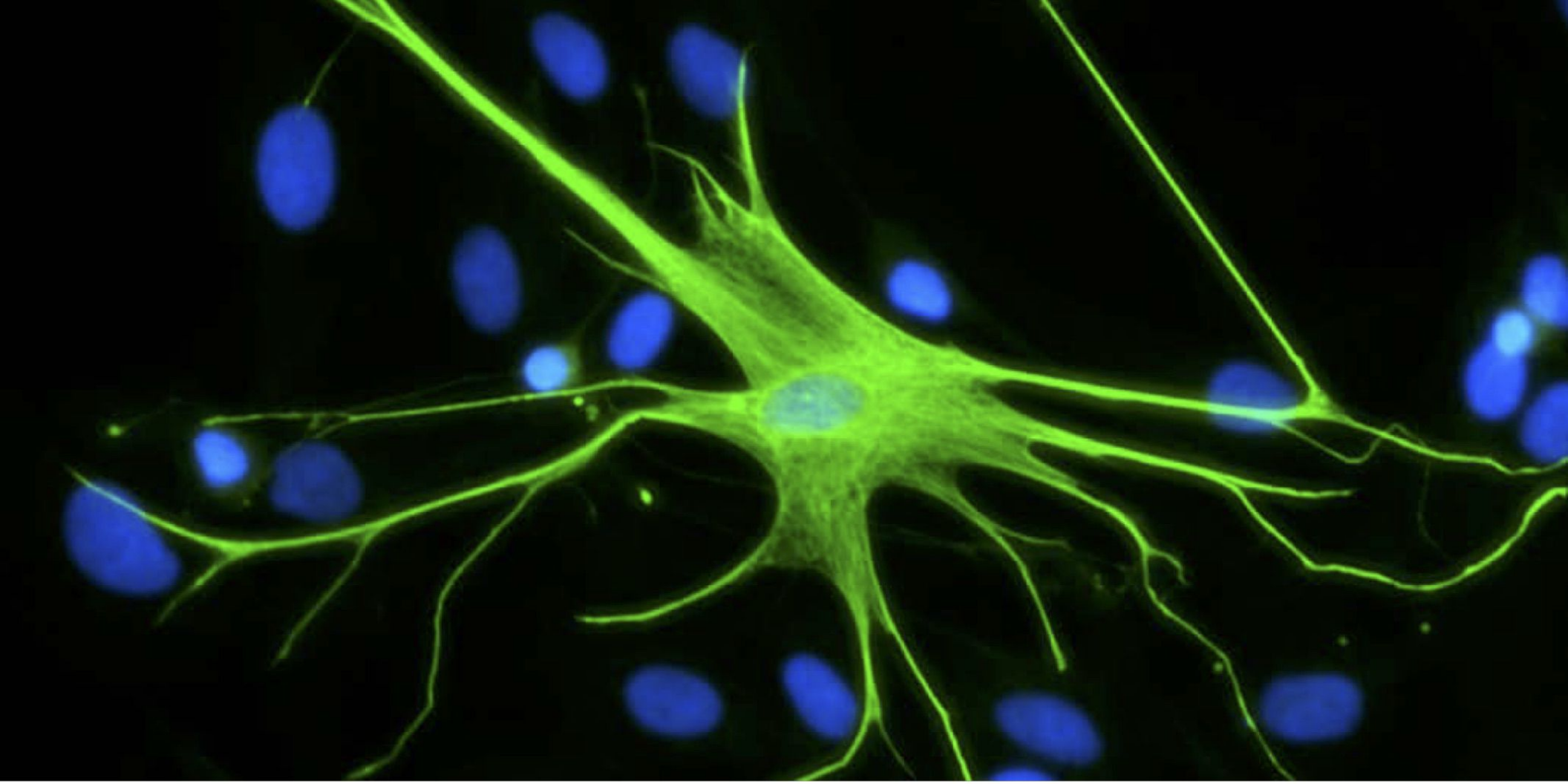

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A fresh wave of research involves reprogramming ordinary skin cells into those found in the brain

RICCARDO CASSIANI-INGONI *GETTY IMAGES*

NEWS

# Getting the Inside Dope on Ketamine's Mysterious Ability to Rapidly Relieve Depression

The notorious party drug may act as an antidepressant by blocking neural bursts in a little-understood brain region that may drive depression

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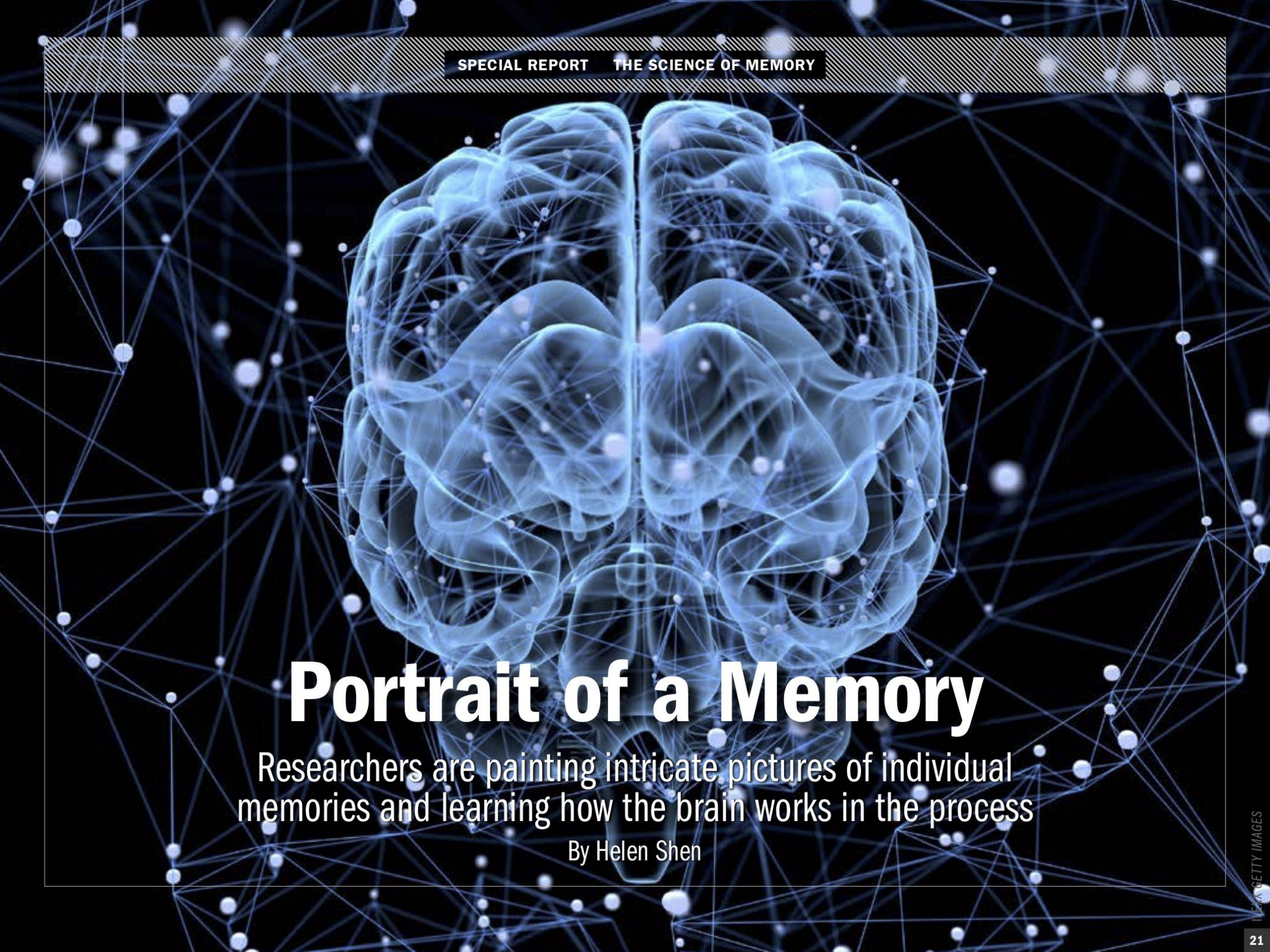

# Portrait of a Memory

## Researchers are painting intricate pictures of individual memories and learning how the brain works in the process

By Helen Shen

## In Search of the Engram

The physical trace of a single memory—also called an engram—has long evaded capture. Psychologist Karl Lashley was one of the first to pursue it and devoted much of his career to the quest. Beginning around 1916, he trained rats to run through a simple maze, and then destroyed a chunk of cortex, the brain's outer surface. Then he put them in the maze again. Often the damaged brain tissue made little difference. Year after year, the physical location of the rats' memories remained elusive. Summing up his ambitious mission in 1950, Lashley wrote: "I sometimes feel, in reviewing the evidence on the localization of the memory trace, that the necessary conclusion is that learning is just not possible."

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Memory, it turns out, is a highly distributed process, not relegated to any one region of the brain. And different types of memory involve different sets of areas. Many structures that are important for memory encoding and retrieval, such as the hippocampus, lie outside the cortex—and Lashley largely missed them. Most neuroscientists now believe that a given experience causes a subset of cells across these regions to fire, change their gene expression, form new connections and alter the strength of existing ones—changes that collectively store a memory. Recollection, according to current theories, occurs when these neurons fire again and replay the activity patterns associated

# Foresee and Forget: How to Remember the Future

Thanks to memory, we are able to recall the past. But we also need it to implement new ideas in the future

By Matthias Kliegel and Nicola Ballhausen

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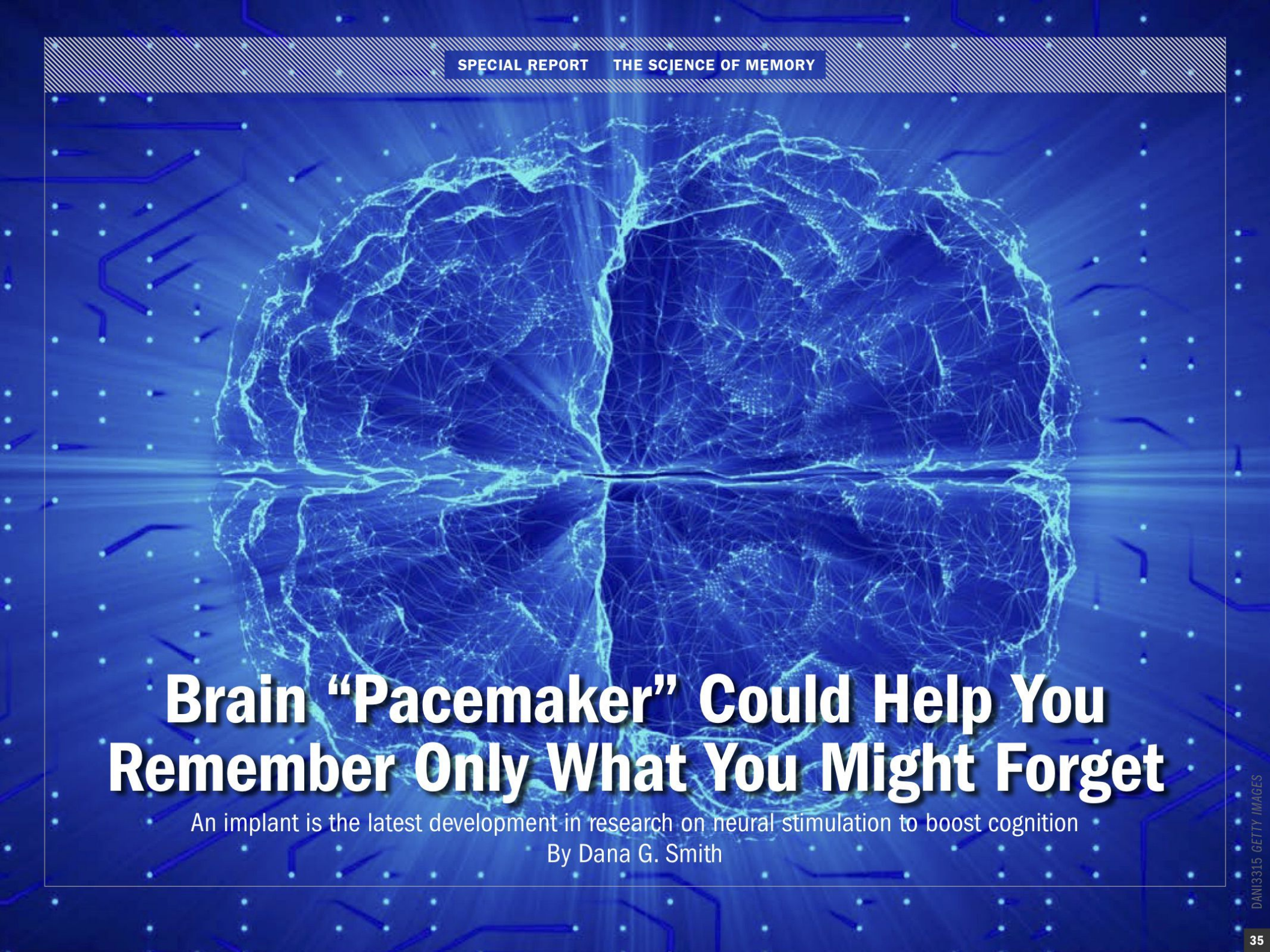

# Brain "Pacemaker" Could Help You Remember Only What You Might Forget

An implant is the latest development in research on neural stimulation to boost cognition

By Dana G. Smith

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OPINION

# To Combat Loneliness, Promote Social Health

Mounting evidence shows that relationships should be a public health priority

By Kasley Killam

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OPINION

# What Makes Us Vibe?

We like other people in part because they think the way we do—but we may also think alike as a result of being friends

By Daniel Barron

VINCENT BESNAULT GETTY IMAGES

OPINION

# What Is "Normal," Anyway?

In psychology and psychiatry, it really means average or typical, but we too easily think of it as a synonym for how everyone is supposed to think and feel

By Jim Kozubek

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OPINION

# The Case for the Self-Driven Child

In a new book, an argument for giving children more of a sense of control over their lives

By Gareth Cook