LOVE AND MURDER IN SUBURBIA: A TRUE STORY *page 38*

SCIENTIFIC AMERICAN
MIND
BEHAVIOR • BRAIN SCIENCE • INSIGHTS

September/October 2014
Mind.ScientificAmerican.com

Making New Memories

Why your brain never fills up
page 49

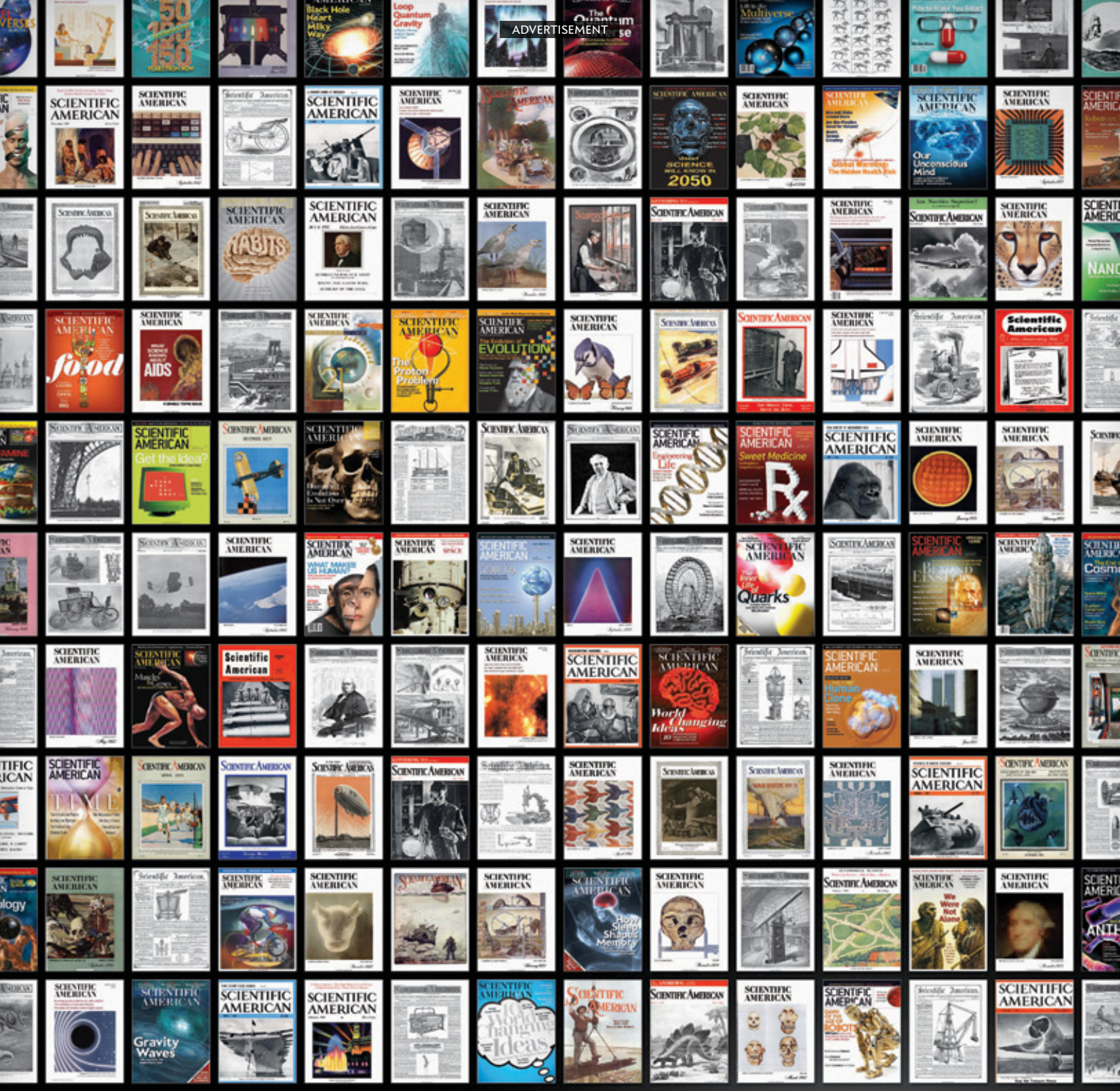
The Psychology of SUCCESS

It's not what you learn but *how* you learn

NEW CLUES TO EASE CHRONIC PAIN

DEPRESSED? TRY THE SOCIAL CURE

THE HIDDEN SIGNALS IN YOUR WORDS



What issue are you looking for?

We discovered a lot in our long history. Now we're opening our award-winning Archives for you to explore. Browse and download any single issue from any year—1845 to the present.

www.scientificamerican.com/archives

SCIENTIFIC AMERICAN™ | THE ARCHIVES

SCIENTIFIC AMERICAN
MIND™
BEHAVIOR • BRAIN SCIENCE • INSIGHTS

COVER IMAGE BY ABEL MITJA VARELA *Getty Images;* SEAN McABE (*Upson*)

Know Thyself

Five years ago I heightened my self-knowledge—abruptly. I had flown to Moscow to meet an executive in charge of Russia's railroads, and a press officer had offered a translator. I declined, believing that my conversational Russian would suffice.

How wrong I was. Seated at a conference table in the executive's capacious office, I was struck dumb by the streams of technical jargon zooming past my ears. It was swine flu season, and I couldn't tell if my forehead burned more from shame or genuine fever. I yearned to slide under that grand old table and curl up for a nap.

Faulty metacognition—our judgments of our knowledge and memories—had led me to overrate my language skills and perform poorly at a key moment. In "The Power of Reflection," starting on page 30, cognitive neuroscientist Stephen M. Fleming explains how metacognition underpins success in all walks of life. Fortunately, several techniques, such as meditation, can deepen self-knowledge.

A shared vocabulary is one aspect of successful communication, but raconteurs also swap subtle signals to intimate their thoughts. We focus on these enigmatic elements in this issue's special report on language. As linguists Mark Dingemanse and N. J. Enfield write in "Let's Talk," conversations everywhere share a unique rhythm, which is why silences can be packed with social meaning. Turn to page 64.

The language you speak—whether it is native or foreign—adds further social nuance. People tend to think more rationally when speaking a language other than their mother tongue, for example. Beginning on page 70, psychologist Catherine L. Caldwell-Harris explores the quirks of the multilingual mind in "Kill One to Save Five? *Mais Oui!*"

As Dingemanse and Enfield note, we spend most of our waking hours interacting with others. These exchanges are vital to well-being. In particular, socializing in groups can help people combat depression and avoid relapse. Starting on page 60, psychologists Tegan Cruwys, S. Alexander Haslam (an advisory board member) and Genevieve A. Dingle describe this healing effect in "The New Group Therapy."

As for my botched reporting trip, the saving grace was that I had taped the whole affair. My benevolent mother helped me decipher the bureaucratese. Yet for the presence of the tape recorder, I have to grudgingly thank my metacognition.

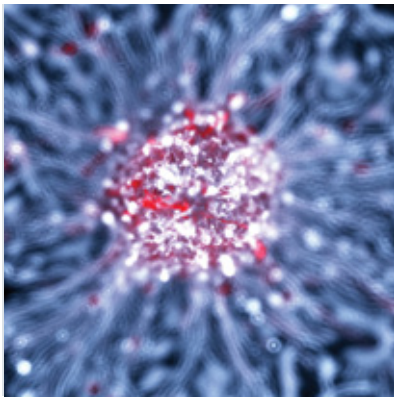
Sandra Upson
Managing Editor
editors@SciAmMind.com

VOLUME 25, NUMBER 5, SEPTEMBER/OCTOBER 2014

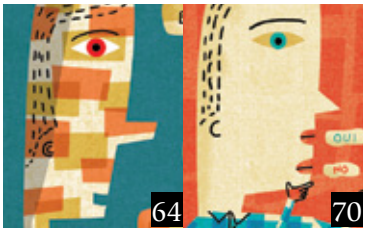
SCIENTIFIC AMERICAN MIND

CONTENTS

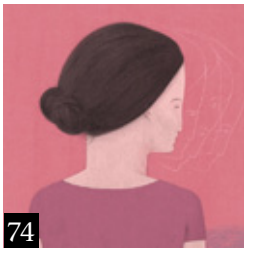
FEATURES



SPECIAL REPORT LANGUAGE



DEPARTMENTS



Editors' note: The Consciousness Redux column will return in the next issue of *Scientific American Mind.*

Scientific American Mind (ISSN 1555-2284), Volume 25, Number 5, September/October 2014, published bimonthly by Scientific American, a trading name of Nature America, Inc., 75 Varick Street, 9th Floor, New York, N.Y. 10013-1917. Periodicals postage paid at New York, N.Y., and additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Canada Post: Return undeliverables to 2835 Kew Dr., Windsor, ON N8T 3B7. Subscription rates: one year (six issues), $19.95; elsewhere, $30 USD. Postmaster: Send address changes to Scientific Americ-an Mind, P.O. Box 3187, Harlan, Iowa 51537. To purchase additional quantities: U.S., $10.95 each; elsewhere, $13.95 each. Send payment to SA Mind, P.O. Box 4002812, Des Moines, Iowa 50340.
For subscription inquiries, call (888) 262-5144. To purchase back issues, call (800) 925-0788. Printed in U.S.A.

SCIENTIFIC AMERICAN
MIND
BEHAVIOR • BRAIN SCIENCE • INSIGHTS

PRESIDENT: Steven Inchcoombe
EXECUTIVE VICE PRESIDENT: Michael Florek
VICE PRESIDENT AND ASSOCIATE PUBLISHER, MARKETING AND BUSINESS DEVELOPMENT: Michael Voss
DIRECTOR, INTEGRATED MEDIA SALES: Stan Schmidt
ASSOCIATE VICE PRESIDENT, BUSINESS DEVELOPMENT: Diane McGarvey
DIRECTOR, GLOBAL MEDIA SOLUTIONS: Jeremy A. Abbate
VICE PRESIDENT, CONSUMER MARKETING: Christian Dorbandt
DIRECTOR, E-COMMERCE: Scott Rademaker
ASSOCIATE CONSUMER MARKETING DIRECTOR: Catherine Bussey
E-COMMERCE MARKETING MANAGER: Evelyn Veras
SENIOR MARKETING MANAGER/ACQUISITION: Patricia Elliott
ONLINE MARKETING ASSOCIATE: Alexandra Egan
MARKETING AND CUSTOMER SERVICE COORDINATOR: Christine Kaelin
SALES DEVELOPMENT MANAGER: David Tirpack
PROMOTION MANAGER: Diane Schube
PROMOTION ART DIRECTOR: Maria Cruz-Lord
MARKETING RESEARCH DIRECTOR: Rick Simone
ONLINE MARKETING PRODUCT MANAGER: Zoya Lysak
CORPORATE PR MANAGER: Rachel Scheer
SENIOR INTEGRATED SALES MANAGER: Jay Berfas
SALES REPRESENTATIVE: Chantel Arroyo
INTEGRATED MEDIA SALES: Nate Murray
SENIOR ADMINISTRATOR, EXECUTIVE SERVICES: May Jung
CUSTOM PUBLISHING EDITOR: Lisa Pallatroni
RIGHTS AND PERMISSIONS MANAGER: Karin M. Tucker

HOW TO CONTACT US

FOR ADVERTISING INQUIRIES:
Scientific American Mind
75 Varick Street, 9th Floor
New York, NY 10013
212-451-8893
fax: 212-754-1138

FOR SUBSCRIPTION INQUIRIES:
U.S. and Canada: 888-262-5144
Outside North America:
Scientific American Mind
PO Box 5715, Harlan, IA 51593
515-248-7684
www.ScientificAmerican.com/Mind

TO ORDER REPRINTS:
Reprint Department
Scientific American Mind
75 Varick Street, 9th Floor
New York, NY 10013
212-451-8877
fax: 212-451-8252
reprints@SciAm.com

FOR PERMISSION TO COPY OR REUSE MATERIAL FROM SCIAMMIND:
Permissions Department
Scientific American Mind
75 Varick Street, 9th Floor
New York, NY 10013
212-451-8546
www.ScientificAmerican.com/permissions
Please allow three to six weeks for processing.

AGING MEMORIES

Thank you for an outstanding issue with many intriguing articles. In "The Engine of Memory," by Donald G. MacKay, one anecdote triggered a long-forgotten memory of my own. When Henry Molaison, MacKay's famous subject, replied "compass" when the answer was supposed to be "protractor," he may have been answering correctly, depending on what was taught in school.

In the early 1950s, when I was in elementary school in Louisiana, we were asked to bring in some math supplies, which included a "compass." I duly returned to school with a device for finding true north, only to produce a roomful of giggles. Everyone else had brought a protractor, which is what was expected when a "compass" was requested.

So not only do we have to be careful when selecting items to be used to test brain function, we also need to be aware of regional vocabularies!

Jill O. Goodwin
Alpine, Tex.

I am an avid reader of this valuable magazine and would like to see it keep its high quality indefinitely.

"The Engine of Memory" particularly interested me. I'm a Ph.D. biochemist approaching my 50th birthday, and I am very keen on keeping my memory young. I was eager to make plans to follow MacKay's suggestions for maintaining memory. But I believe I found a logical error in the author's reasoning.

MacKay writes: "In Henry's case, this hippocampal maintenance system was defunct. Henry had no way of rejuvenating depleted memories through experience and relearning—leading to his accelerated decline." If so, then, logically, Henry's memory decline should be across all the memories: infrequently used words as well as frequently used words and familiar but irregularly spelled words as well as regularly spelled words—not just the infrequently used and irregularly spelled words, as observed.

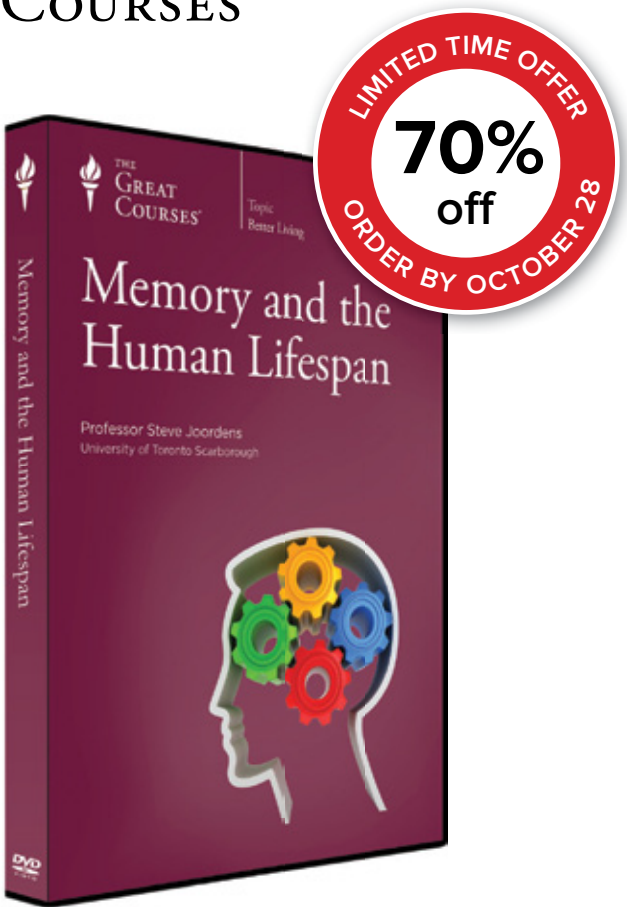
Therefore, although MacKay's conclusion could still be true that refurbishing old memory via a functioning hippocampus is necessary to form the memory anew, I do not believe it is a logical outcome of his observation of Henry's word-finding difficulties.

Yuan Chang
via e-mail

MACKAY REPLIES: *Regarding Yuan Chang's letter, frequent use of a word prevents memory degradation, independent of the hippocampus, whose role is limited to creating new memories and re-creating memories that have become degraded because of aging and infrequent use. Because use prevents loss, it follows that neither you nor I nor an amnesic such as Henry could ever lose our memory for the meaning or spelling of a frequently used word such as "he"—which we produce and encounter many millions of times over our lifetime. Only memories for words that people use rarely and not recently—say, "sanguine"—are vulnerable to total degradation from aging.*

When memory degradation does happen for rarely used words, older adults with unimpaired hippocampal mechanisms can relearn their meaning, spelling or pronunciation when they subsequently encounter them. But Henry could not relearn infrequently used information that became degraded in his later years, because his hippocampal system for creating memories to replace damaged ones was defunct. As a result, as Henry aged, more and more of his infrequently used words became unusable, at a faster than normal rate, relative to people of the same age who have intact hippocam-

THE GREAT COURSES®



Discover Startling Revelations about Human Memory

While many of us think of human memory as just a way to call up facts or episodes from our pasts, the truth is that it is much, much more. Your various memory systems, in fact, create the ongoing narrative that makes your life truly *yours*. Without them, you wouldn't be able to make decisions, learn, or even form a personality that sets you apart from others.

In **Memory and the Human Lifespan**, Professor Steve Joordens—winner of the President's Teaching Award from the University of Toronto—guides you on a startling voyage into the world of memory. His 24 lectures explain what makes memory possible and how it works; how memory shapes your experiences of the past, present, and your expectations for the future; and how your memory develops during your life. The result is a highly informative, fascinating exploration you'll never forget.

Offer expires 10/28/14

THEGREATCOURSES.COM/7MIND

1-800-832-2412

Memory and the Human Lifespan

Taught by Professor Steve Joordens
UNIVERSITY OF TOTONTO SCARBOROUGH

LECTURE TITLES

1. Memory Is a Party
2. The Ancient "Art of Memory"
3. Rote Memorization and a Science of Forgetting
4. Sensory Memory—Brief Traces of the Past
5. The Conveyor Belt of Working Memory
6. Encoding—Our Gateway into Long-Term Memory
7. Episodic and Semantic Long-Term Memory
8. The Secret Passage—Implicit Memory
9. From Procedural Memory to Habit
10. When Memory Systems Battle—Habits vs. Goals
11. Sleep and the Consolidation of Memories
12. Infant and Early Childhood Memory
13. Animal Cognition and Memory
14. Mapping Memory in the Brain
15. Neural Network Models
16. Learning from Brain Damage and Amnesias
17. The Many Challenges of Alzheimer's Disease
18. That Powerful Glow of Warm Familiarity
19. Déjà Vu and the Illusion of Memory
20. Recovered Memories or False Memories?
21. Mind the Gaps! Memory as Reconstruction
22. How We Choose What's Important to Remember
23. Aging, Memory, and Cognitive Transition
24. The Monster at the End of the Book

Memory and the Human Lifespan
Course no. 1911 | 24 lectures (30 minutes/lecture)

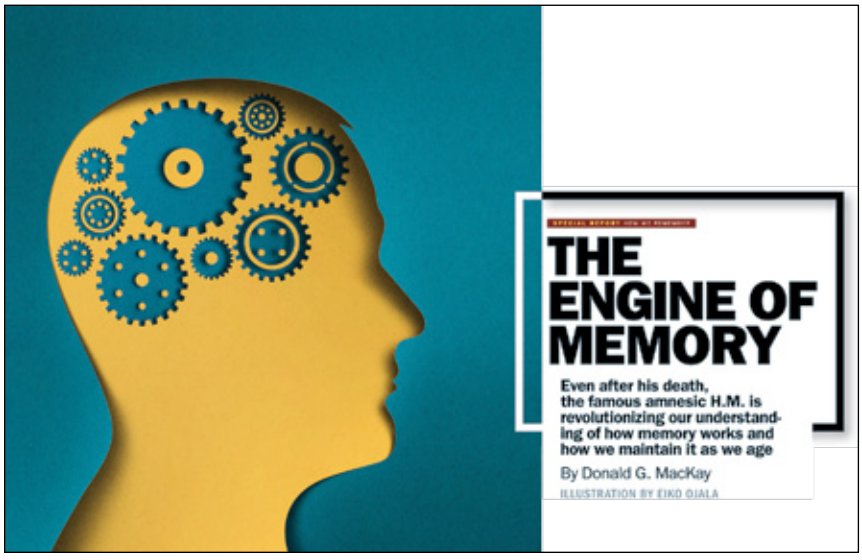
SAVE UP TO $185

DVD	~~$254.95~~	NOW $69.95
CD	~~$179.95~~	NOW $49.95

+$10 Shipping, Processing, and Lifetime Satisfaction Guarantee
Priority Code: 95715

For 24 years, The Great Courses has brought the world's foremost educators to millions who want to go deeper into the subjects that matter most. No exams. No homework. Just a world of knowledge available anytime, anywhere. Download or stream to your laptop or PC, or use our free mobile apps for iPad, iPhone, or Android. Over 500 courses available at www.thegreatcourses.com.

pal mechanisms and can therefore relearn and continue to use rare words, a process that reduces the overall extent and rate of memory degradation as aging progresses. Continued learning, use and encounters with rare words, spelling and other types of information therefore hold the key to maintaining your memories with aging.



Regarding Jill O. Goodwin's letter, when analyzing the hundreds of spectacular word substitutions that Henry produced in our experiments, my laboratory always ensured that they were genuine errors rather than acceptable regional variants related to Henry's Connecticut education and dialect.

A CAT THAT CATEGORIZES

Our cat Sammie, a female tortoiseshell, demonstrates on many occasions that she can think abstractly, like the animals described in "Categorically Smart," by Andrea Anderson [Head Lines]. We have a toy basket for our two cats, which contains around five dozen cat toys, always well mixed. In that assortment there are six small balls and six pillow-shaped toys of various colors, sizes and textures. There are also about half a dozen micelike toys in two distinct variations. The remaining toys are one-offs.

About once a month, Sammie will go to the basket in the middle of the night and begin categorizing (pun intended). The next morning, we'll find all the balls, all the mice or all the pillows scattered on the floor. She never mixes types, nor does she include any of the singletons.

This behavior is spontaneous and began (and continues) without any encouragement from us. In fact, we tend to discourage middle-of-the-night cat romps. We're asleep when she goes to work and only learn of her activity the next morning. If that isn't conceptual thinking by an animal, I don't know what is!

Richard Beard
Greeley, Colo.

ASPERGER'S AND AUTISM

I was extremely disappointed with Simon Baron-Cohen's answer to the boy with Asperger's [Ask the Brains]. He did not refer in any way to the differences between autism and Asperger's, as if Asperger's is merely a different name for autism. But there are many important differences. People with autism may "have difficulty integrating complex ideas," as he asserts, whereas people with Asperger's are actually exceptionally good at doing that. People with autism have difficulty speaking in general, but those with Asperger's speak very well—their problem is their lack of social skill and inability to use or understand pragmatics. It's too bad you couldn't find a "brain" whose field is Asperger's rather than autism.

Naomi Goldblum
via e-mail

As a person with Asperger's, I can say that many of the things Baron-Cohen wrote ring true to me. I like his use of "autism spectrum condition" (ASC) rather than "autism spectrum disorder." Although it really doesn't make a bit of difference to me, and I would suspect that many other Aspies might feel the same, calling our state a "condition" instead of a "disorder" could in some small way help change how neurotypical people view us.

That is not to say that difficulties for those with ASC are completely the result of societal views and expectations. There are any number of different ways that ASC can affect a person adversely. For instance, some of the sensory peculiarities that many with ASC have can cause varying levels of trouble depending on how they affect an individual. I have learned to keep a pair of earplugs on me at all times for when sounds become too intense or when I'm in an area where I find certain kinds of sounds irritating.

Of course, one thing to consider with ASC is that there are a large variety of ways it can manifest. Try looking up the different symptoms (though to complement the change of ASD to ASC, they might be better called "tells") of autism and Asperger's, and you'll wind up with a list as long as your arm. Still, if their differences can be accommodated, people with ASC can become a valuable asset rather than a burden.

I am reminded of an article I read a while back about a tech company that made it a point to hire a number of people with ASC. They would let them sit at a computer all day, churning out code. Set up the right conditions for these employees, and it's almost like having a bank of computers in the building that write code on their own.

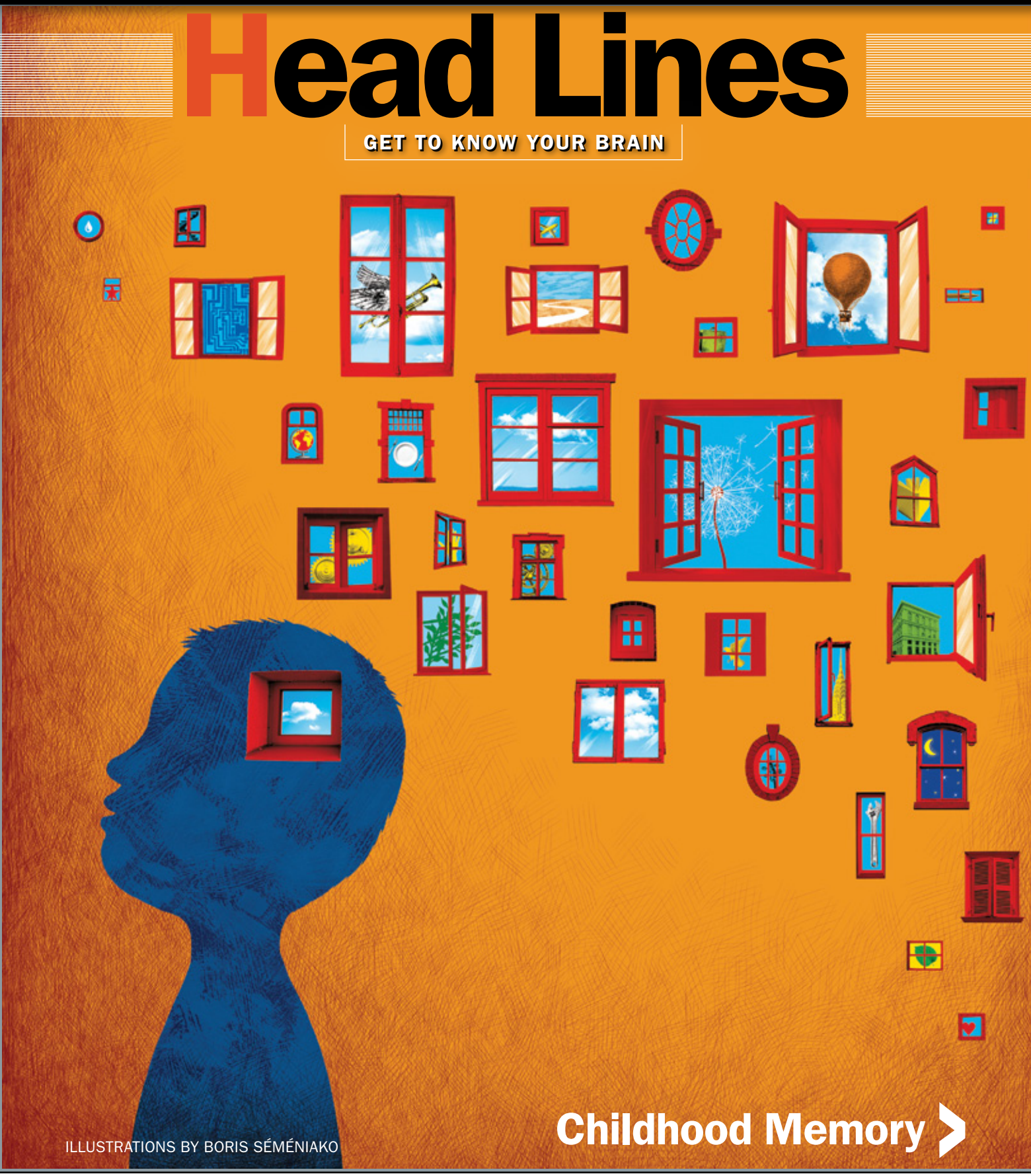
"z34aa"
commenting online at
Mind.ScientificAmerican.com

HOW TO CONTACT US FOR GENERAL INQUIRIES OR TO SEND A LETTER TO THE EDITOR:

Scientific American Mind
75 Varick Street, 9th Floor
New York, NY 10013
212-451-8200
editors@SciAmMind.com

Head Lines

GET TO KNOW YOUR BRAIN



ILLUSTRATIONS BY BORIS SÉMÉNIAKO

Childhood Memory

M NEWS FROM OUR WEB SITE | Taking notes on paper helps you understand and retain more material than typing on a laptop does.

FANCIFUL RECALL

The way kids learn causes them to generate more false memories than adults

Children are notoriously unreliable witnesses. Conventional wisdom holds that they frequently "remember" things that never happened. Yet a large body of research indicates that adults actually generate more false memories than children. Now a new study finds that children are just as susceptible to false memories as adults, if not more so. Scientists may simply have been using the wrong test.

Traditionally, researchers have explored false memories by presenting test subjects with a list of associated words (for instance, "weep," "sorrow" and "wet") thematically related to a word not on the list (in this case, "cry") and then asking them what words they remember. Adults typically mention the missing related word more often than children do—possibly because their life experiences enable them to draw associations between concepts more readily, says Henry Otgaar, a forensic psychologist at Maastricht University in the Netherlands and co-author of the new paper, published in May in the *Journal of Experimental Child Psychology*.

Instead of using word lists to investigate false memories, Otgaar and his colleagues showed participants pictures of scenes, including a classroom, a funeral and a beach. After a short break, they asked those participants whether they remembered seeing certain objects in each picture. Across three experiments, seven- and eight-year-old children consistently reported seeing more objects that were not in the pictures than adults did.

Past studies have shown that children tend to rely on the gist of a memory when making inferences about it—for instance, if they saw a classroom they might assume that they also saw pencils because pencils are usually found in classrooms. This pattern-recognition process helps kids learn quickly as they grow. Adults, on the other hand, draw more on specific details they recall to reconstruct a scene. By using pictures instead of word lists, the new study probably came closer to reflecting how false memories occur in real life—after all, most of us experience the world visually, Otgaar says.

The authors note that the study may hold clues to getting more reliable testimony out of both children and adults, as subtle shifts in framing could dramatically alter what witnesses remember. When talking to children, for example, lawyers should try to avoid giving out clues to jog their memory or using especially descriptive language, which could trigger activation of the pattern-making system in the brain that contributes to false memories. *—Roni Jacobson*

M Kids deemed "cool" in school are unlikely to maintain their panache in their 20s—as you may have noticed at your high school reunion.

Why We Forget Our Earliest Years

A baby's brain prioritizes learning over forming lasting memories

As soon as we are born, we begin figuring things out. We learn to ask for meals and fresh diapers, and we absorb an entire language between naps. Yet we recall little of those busy years. As it turns out, the same process that allows babies to learn rapidly might also disrupt the neuronal links that encode certain kinds of memories, according to a recent paper in *Science*.

Paul W. Frankland of the Hospital for Sick Children in Toronto and his colleagues suspected that the dramatic growth of neurons in the infant brain might interfere with the formation of memories. To test this idea, they ramped up neuron production in adult mice right after they learned something new. Unlike youngsters, adults grow neurons only slowly. But add exercise or drugs such as antidepressants, and neurons proliferate. When adult mice exercised after learning that a certain cage delivered a foot shock, the memory of the painful lesson diminished. Then the team turned to infant mice, whose brains naturally grow lots of neurons. These young mice rarely remember the foot shock for more than a day. When the researchers used a drug to slow the infants' neuron growth, the mice retained the memory for a week.

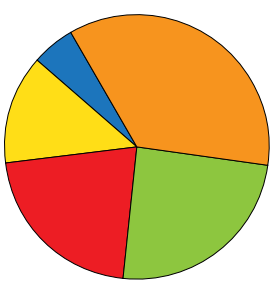
The findings suggest that new neurons disrupt the links that make a memory. In children up to about age three, the rapid-fire neuron growth that lets them learn about the world prevents memories of isolated events from sticking around. Infants and toddlers do form such memories—your 18-month-old may remember the dog she saw a few days ago—but unless the memory is reinforced, it will disappear as new neurons develop. After about age three, neuron growth slows, and the image of that dog may stick around for life. [For more on neuron growth in the brain, see " New Neurons for New Memories," on page 49.] *—Jenni Laidman*

What's Your First Memory?

You might expect that your earliest recollection would be dramatic—yet for most of us, it is fairly mundane. Only about a quarter of people report a first memory that involves a trauma, according to a 2005 study. Scientific American Mind's online survey of readers' first memories uncovered the same pattern [*see chart below*].

Young children are more likely to recall an event if they are prompted to talk about it and probed for details. Perhaps that is why the age at which a memory first sticks varies across cultures. Among the Maori of New Zealand, for example, most children's memories start a year earlier than they do in North America—a function of a culture in which memories are honored and much discussed, according to researcher Carole Peterson of Memorial University in Newfoundland. ***—Victoria Stern***

Memory Type
(from 135-person sample)



Age Reported
(in years, number size reflects frequency)

I remember the long dirt road leading to the house, and thinking that the other way might lead to heaven. *—Ben Alon*

Running toward the edge of a steep cliff. My father ran and caught me. *—Amalia Liontaki*

My mother came home from the hospital with my brother ... a small, white bundle. *—A. Adams*

Visiting the neighbors by sneaking through a gap in the fence. *—Nikki Stevenson*

When he drowned, I felt mortified ... I had wished him to disappear. *—Claudia Lieberwirth*

My aunt wrapping me up in a big blanket and picking me up. *—Kelly Banco*

Viewing the blue sky from my baby buggy. *—Joan Greenwald*

"The war's over." My question to her was: "What's a war, Mama?" *—Ben Lawler*

In anecdotes at right, border colors correspond to age and fill colors indicate type.

For interactive graphic of survey results, see www.ScientificAmerican.com/first-memories.

ISTOCKPHOTO (*figures*)

MEMORY MILESTONES

Infant (0–2 years): Research hints that infants form brief memories.

Toddler (2–3 years): Toddlers begin to form memories of facts and events. Yet they are ephemeral because the hippocampus—key for long-term memories—is still maturing.

Young child (4–7 years): Short-term memory improves. Prospective memory—the ability to plan and remember to execute the plan—starts to emerge.

Child (8–10 years): Children have now forgotten about two thirds of their memories before age three. Recall of facts and spatial relationships improves greatly.

Early adolescent (10–12 years): As hippocampal growth cools down, connections in that region start to get pruned, and long-term memory improves. The ability to consciously suppress memories appears to increase as well.

Young adult (13–21 years): The superior temporal cortex, which helps to integrate information, and the dorsolateral prefrontal cortex, involved in short-term memory, continue to mature into our early 20s. This pattern might explain why memory becomes richer and more complex throughout the young adult years. *—V.S.*

A mother's lead exposure could harm a baby's brain. But calcium, iron or zinc supplements during pregnancy might counteract high blood levels of lead.

SCIENTIFIC AMERICAN™ Travel

BRIGHT HORIZONS™ 23

CANARY ISLANDS NOV. 30 – DEC. 12, 2014

For information on more trips like this, please visit **www.ScientificAmerican.com/Travel**

Travel with Bright Horizons 23 to the Canary Islands, a place of geologic splendor, evolutionary isolation, and great cultural charm. With dark starry skies above and tremendous biodiversity below, the Canaries invite us to relax and wonder. Our journey takes us to the island of Madeira with its UNESCO-reserve forests, and we'll sample Lisbon's big-city fun, too.

Nestled aboard Cunard's Queen Mary 2, we'll dig into paleontolgy, absorb developments in particle physics, and explore science news.

Come along with us and explore the Canary Islands' UNESCO World Biosphere Reserves with new friends. Sample local foods and wine with your special someone. Exercise your curiosity. Discuss, learn, and reflect amidst the unique and memorable venues of these Atlantic isles.

Cruise prices vary from $1,959 for an Interior Stateroom to $8,498 for a Queens Suite, per person (pp) based on double occupancy. For those attending our SEMINARS, there is a $1,575 fee. Add'l pp fees: port charges, gov't taxes, and fees are $339.75; gratuities are $11.50 per day. The Program, cruise pricing, and options are subject to change. For more information email us at Concierge@InsightCruises.com.

Black Holes

Speaker: Jenny Greene, Ph.D.

Black Holes: Galactic Gobblers

Lurking at the heart of every massive galaxy is a giant black hole. Learn what we know of these behemoths, thought to be nearly infinitely small and infinitely dense. Here the current laws of physics break down, but modern observatories can provide some hints of what lies inside.

Black Hole Origins

Which came first: giant black holes, or the massive galaxies that surround them? Black holes can form in multiple ways, and they influence the evolution of the galaxies they inhabit. Learn what we do and don't know about the birth of black holes, and how we stand to revolutionize our knowledge in the coming years.

Black Hole Evolution

Black holes feasting on matter are some of the most luminous objects in the universe. We know that many black holes grew up when most of the stars formed in the universe, yet the details of this process are mysterious. Learn how observations of gravity waves could help us understand black hole evolution.

Women in Astronomy & Physics

Women are underrepresented in many science fields, but especially astronomy and physics. We'll discuss the real numbers behind this problem, and the various factors that play into it, including sub-conscious bias in hiring and test-taking practices. We'll also examine ways to change this pattern in the future.

The Intelligent Brain

Speaker: Richard J. Haier, Ph.D.

Mysteries of Intelligence and the Brain

Yes, intelligence is something real and it can be defined and studied scientifically. We'll consider savants and geniuses, how to define intelligence, and discuss how intelligence tests work. We'll review the key research and discuss why a person's intelligence is both liberating and constraining. We'll also consider why smart people do dumb things.

The Origins of Intelligence

We know there is a strong genetic component of intelligence from studies of twins and investigations that combine genetic analyses and neuro-imaging. Surprisingly, research results showing the influence of specific environmental factors, including early childhood education, are rather weak. Learn why brain development, as revealed by neuro-imaging, may be a key.

For more info please email Concierge@InsightCruises.com or visit ScientificAmerican.com/travel

What Makes a Brain Smart?

Neuro-imaging research has identified brain features and specific areas distributed throughout the brain that are related to intelligence test scores. We'll review, in non-technical terms, how neuro-imaging works and we'll see some amazing dynamic views of intelligence at work in the brain during problem-solving, including some findings "hot off the press."

How Smart Do You Want To Be?

As we learn about the neural mechanisms of intelligence, prospects for enhancing intelligence become more likely. We'll discuss the ethical quandaries this raises. If there were an IQ pill, would you take it? What about enhancing intelligence in children? If we could enhance intelligence, do we have a moral obligation to do so?

Dinosaurs

Speaker: Darren Naish, Ph.D.

Predatory Dinosaurs and the Origins of "Birdiness"

Theropods, which included giants like Allosaurus and Tyrannosaurus, also had numerous lineages of smaller bird-like dinosaurs, and many theropods were feathered. Take a tour through theropod diversity, and examine the many controversial ideas of how they lived, how they hunted, and what they looked like when they were alive.

Sauropod Dinosaurs and the "Necks For Sex" Debate

Sauropod dinosaurs had immensely long necks, sometimes more than four times longer than their bodies. Some have suggested this evolved as a sexual signal, its length driven by sexual selection pressure. I'll discuss my work testing this hypothesis, and why the neck might actually have evolved for feeding and foraging.

Pterosaurs: Flying Reptiles of the Mesozoic

Ancient reptiles called pterosaurs flew on membranous wings supported by enormous fourth fingers. They had furry bodies, air-filled bones and many species possessed crested skulls. Little is known about pterosaur behavior and social life, but we can make some educated guesses. Learn about the diversity, anatomy and biology of this amazing group.

The Remarkable Azhdarchoid Pterosaurs

Among the most unusual of pterosaurs are the azhdarchoids—animals with huge wingspans that stood over 4 meters tall. They have been imagined as mud-probers, vulture-like scavengers, skim-feeders and heron-like waders. We'll discuss the newest data that has changed our view of these fascinating animals.

Eclectic Astronomy

Speaker: Donald Kurtz, Ph.D.

Planets and Pulsations: The New Keplerian Revolution

The Kepler space telescope has discovered more than 3,500 candidate exoplanets, and is closing in on finding another Earth—a rocky planet in the "Goldilocks zone" where life might exist. Kepler has also allowed us to see stars as never before. Learn how this mission is revolutionizing our knowledge of the galactic zoo we inhabit.

It's About Time!

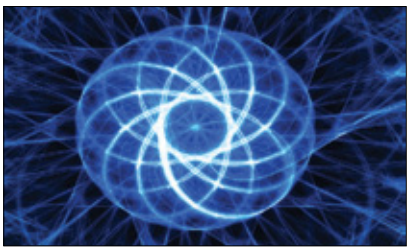
Days, weeks, months, years and more: Hear about Roman emperors, Zulu wars, Rider Haggard, Thomas Hardy, the English time riots, and how the days of the week got their names in an amusing and informative tour of the Western calendar.

The Stars are Ours!

"What good is astronomy?" Through colorful historical anecdotes and science, we'll answer that question. Hear stories of wealth and poverty, castles and dungeons, kings and princes, sailors and maidens, sea battles and Shakespeare, as we look back at the improbable, unpredictable path that gave us the Power of the Stars.

The Sun-Earth Connection

Learn how magnetic activity on the Sun affects Earth, from our planet's magnetosphere to the aurora lights. We'll see why the Sun is not the source of global warming, and we'll discuss weather on other stars. I'll also introduce you to a group of peculiar magnetic stars that I discovered.



Particle Physics

Speaker: Don Lincoln, Ph.D.

The Higgs Boson

Hear the saga of the Higgs boson particle, from its initial prediction in 1964 through its discovery to the 2013 Nobel Prize. As a member of one of the teams that discovered it, I will give an insider's perspective, including answering the very important question, "What's next?"

Accelerators and Particle Detectors

The Higgs boson, the top quark, dark matter—none of these particles are part of our everyday experiences. So how do scientists study these elusive particles? Learn about the complex technology we use to glimpse them, from 14,000-ton experiments with over a hundred million elements to particle observatories under the Antarctic ice.

History of Particle Physics

The search for the ultimate building blocks of matter has a long history. Hear the story, from the 1897 discovery of the electron to finding protons, neutrons and eventually particles that have no role in ordinary matter. Learn how we arrived at our current picture of quarks, leptons and a handful of force-carrying particles.

The Dark Side of the Universe

We understand the nature of the ordinary matter that makes up you and me, but ordinary matter is only 5% of the universe. Learn about the data that led us to conclude that a bizarre dark world must exist, and hear about current experimental efforts aimed at finding it.

SCIENTIFIC AMERICAN Travel HIGHLIGHTS

ROQUE DE LOS MUCHACHOS OBSERVATORY

Friday, December 5th, 1pm – 5:30pm

Join an optional field trip to one of the most renowned groups of telescopes in the world, La Palma's Roque de los Muchachos Observatory in the Canaries.

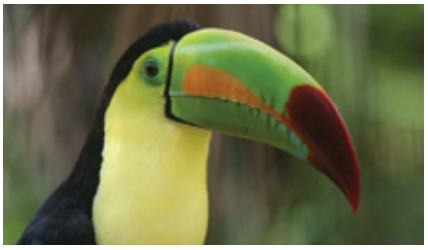
SCIENTIFIC AMERICAN™ Travel

BRIGHT HORIZONS™ 24

CENTRAL AMERICA, MARCH 15 – 22, 2015

For information on more trips like this, please visit **www.ScientificAmerican.com/Travel**

Unwind amidst the natural and cultural landmarks of the Maya world. Join Bright Horizons 24 as we mingle contemporary science and the many cultures, past and present, of Mexico, Honduruas, and Guatemala. Explore the beautiful and compelling monuments of the ancient Maya world, and meet the modern Maya people. Experience Central America's Afro-Caribbean culture. While aboard ship, we'll discuss the latest discoveries and wonders of science. Relax with water sports and encounter the UNESCO World Heritage Site Quirigua. Special memories, great lifelong learning, and the simple pleasures of a warm, sunny getaway await you on Bright Horizons 24. Make your reservation today!



Cruise prices vary from $769 for an Interior Stateroom to $5,699 for a Pinnacle Suite, per person (pp) based on double occupancy. For those attending our SEMINARS, there is a $1,475 fee. Add'l pp fees: gov't taxes and fees ($123), booking service fee ($99), cruiseline gratuities ($11.50 per day), and Tour Leader gratuities ($65). The Program, cruise pricing, and options are subject to change. For more information email us at Concierge@InsightCruises.com.

Lightning

Speaker: Joseph R. Dwyer, Ph.D.

The Mysteries of Lightning

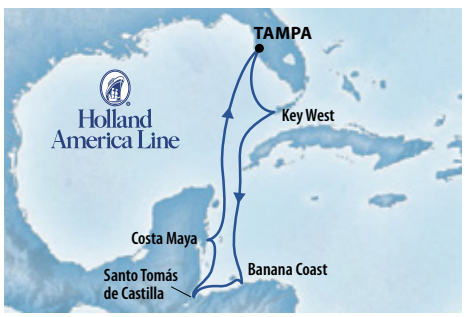
While lightning is one of the most widely recognized natural phenomena, it remains poorly understood. Learn what we do and don't know about lightning, including the recent discovery that lightning emits bursts of x-rays and gamma-rays. By measuring these high-energy emissions, researchers are gaining a better understanding of this fascinating phenomenon.

Ball Lightning

Ball lightning has been reported by eyewitnesses as a grapefruit-sized glowing sphere as bright as a 60-watt light bulb, often seen along with thunderstorms. Yet little is known about ball lightning, and it has never been replicated in the lab. We'll discuss amazing reports of ball lightning and some of the latest explanations.

Sprites, Pixies, and Other Atmospheric Phenomena

Although we spend our entire lives inside our atmosphere, there are surprisingly many things that we don't know about the air right over our heads. Learn about strange discharge phenomena dubbed sprites, elves, trolls, pixies, and gnomes, and other amazing atmospheric curiosities.



Lightning Safety

Lightning strikes our planet about 4 million times every day, causing billions of dollars in property damage and killing or injuring many people each year. Despite the dangers, many people don't know how to be safe during thunderstorms. Learn about the harmful effects of lightning, along with lightning protection and safety.

The Maya

Speaker: Joel Palka, Ph.D.

Archaeological Highlights of Maya Civilization

From over a century of excavations in Mexico and Central America, we understand when Maya society formed, how their cities flourished in the tropical forests, and how they lived their daily lives, yet some mysteries of the Maya remain. We'll overview this fascinating civilization and some of the questions we still have.

Maya Hieroglyphic Writing for Everyone

Maya hieroglyphs present exciting details on ancient Maya life including religion, politics, trade, and the organization of society. We'll cover the deciphering of Maya writing, the structure of the texts, and basic knowledge of Maya culture through their hieroglyphs.

Native Maya Perspectives of the Sea

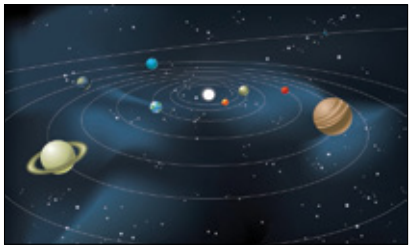
For many of us the sea represents beauty and wonder, but how did indigenous Maya people

For more info please email Concierge@InsightCruises.com or visit ScientificAmerican.com/travel

view the sea? We'll focus on Maya culture and the sea as seen in painted pottery, monumental sculpture, and colonial-era narratives.

Maya Pilgrimage to Ritual Landscapes

Recent archaeological and anthropological findings have shed new light on ancient Maya travel, religion, and views of the landscape. Islands, mountains, caves, and lakes made up sacred places to them. This session looks at the latest interpretations of ancient Maya pilgrimage, their ritual landscapes, and how these were central to Maya society.



Our Solar System

Speaker: Adriana C. Ocampo, Ph.D.

Cosmic Collision: The Search for the Dinosaur Killer

Around 65 million years ago a massive space rock hit Central America, setting off a biospheric disaster that wiped out the dinosaurs. Take a voyage back in time, via Belize and neighboring Mexico, to explore the impact site of the ancient asteroid that drastically altered the balance of life on Earth.

Our Neighborhood in the Solar System

In this extraordinary time for planetary science we are beginning to understand planetary formation processes that were wholly unknown to us just a short time ago. Guided by the latest scientific insights, we'll discuss how planets form, why asteroids and comets are important, and whether habitable environments exist beyond Earth.

Exploring our Solar System

NASA's robots have now taken us out to 180 astronomical units (AU), or about 180 times the distance from Earth to the Sun. We'll delve into some of their fascinating discoveries, such as the similarities and differences between the gas giant planets and the key role Jupiter plays for Earth.

Neuroscience

Speaker: Lary C. Walker, Ph.D.

Life and its Discontents

Disease is an inescapable fact of life, but our very existence is shaped by our relationship with potential disease agents. We'll explore the biological origins of disease to understand why the brain is vulnerable to a distinctive constellation of disorders as we age.

Scratching Sheep, Mad Cows, and Laughing Death

Follow the incredible scientific odyssey that began in the 18th century with a mysterious disease of sheep and, in the 20th century, bore two Nobel Prizes. Learn about the prion, an infectious protein and possibly the most controversial molecule in the history of medicine.

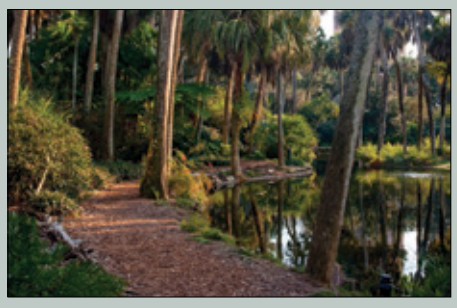
Why Old Brains Falter

One of the most feared diseases of old age is Alzheimer's disease, the most frequent cause of dementia. Learn how the brain changes in normal aging and in Alzheimer's disease, how Alzheimer's emerges and spreads within the brain, and why it is so difficult to stop.

Alzheimer's Therapies: Hype and Hope

No current treatment can stop the relentless progression of Alzheimer's disease. We'll explore the history of rational therapeutic approaches to Alzheimer's and take a frank look at the benefits and shortcomings of existing treatments. Finally, we'll consider how our growing knowledge of brain aging offers hope that an effective therapy is possible.

SCIENTIFIC AMERICAN Travel HIGHLIGHTS OUTER SPACE AND OPEN SPACE IN FLORIDA



BOK TOWER GARDENS:
Sunday, March 22, 11am – 4pm

KENNEDY SPACE CENTER (KSC):
Monday, March 23, 8am – 7:30pm

Continue the Bright Horizons fun with a two-day exploration of two very different central Florida gems: Bok Tower Gardens and Kennedy Space Center.

Bok Tower Gardens — a National Historic Landmark botanical garden and bird sanctuary — is an opportunity to relax amidst subtropical landscape gardens which help preserve 64 rare Central and North Florida plant species. We'll also hear the Garden's 60-bell carillon play.

Reconnect with the spirit and substance of space exploration on our visit to Kennedy Space Center. Guided by tour specialists, explore the world's largest launch facility.

First stop: Launch Control Center. Journey inside the firing room where the last 21 shuttle launches were controlled. Pass by the computer consoles at which engineers constantly monitored the launch controls. See the launch countdown clock and large video monitors on the walls. Enter the bubble room with its wall of interior windows through which the management team viewed all of the proceedings below. Re-live the last shuttle launch, Atlantis mission STS-135 (see takeoff photo, below), while watching the launch footage in the room where the launch became part of history.

Get the right stuff at lunch as we meet a veteran member of NASA's Astronaut Corps, have a hot buffet lunch, and participate in a 30-minute interactive Q&A during "Lunch with an Astronaut."

Onward to the Space Shuttle Atlantis, along with the interactive exhibits that bring to life the complex story of the shuttle and the thousands of people who created and maintained it.

Join us for a memorable look at KSC's role in the endeavor of exploration.

Price: $899 per person, based on double occupancy; $1,399 for a single. Kennedy Space Center launch facilities are transitioning to commercial missions and are under construction. Therefore the structures and vantage points we experience and the entire sequence of our day are subject to change. Regardless of our tour route, we will have an excellent tour of KSC!

A GUIDE TO MASTERING YOUR WORLD

How to Be a Better *time manager*

Throughout most of my 20s I was constantly late—to work, appointments, parties, whatever. People usually cut me slack for it, and I just chalked up my godawful time management to being overly busy. Now that I'm older, wiser and even busier, I know my lateness was less about a packed schedule and more about a cloudy, unorganized mind. We've all heard (and probably failed at) tried-and-true "time management" tips, such as when to reply to e-mails and how to structure a to-do list. Here's what brain science has to say about taking control of your time.

#1 Meditate mindfully. I will never forget it: a former boss and I were walking through Times Square after a business lunch, and she turned to me and said, "What is up with you these days? You're so on top of everything. Whatever it is you're doing, keep doing it." The truth is, I'd started meditating—just simple deep breathing for 10 minutes every morning while repeating a mantra like "Breathe in calm, breathe out anxiety" or "Breathe in clarity, breathe out confusion." There may not be any research linking meditation directly to time management, but mindfulness meditation has been shown to speed up information processing in the brain, improve memory, boost concentration and make tasks feel easier—all necessary for making the most of your minutes.

#2 Figure out why you waste time. Everyone procrastinates, at least a little bit. And researchers have theorized that we have different reasons for it: arousal procrastinators get a rush from waiting until the last second, avoidant ones don't want to face an undesirable task, and indecisive procrastinators are somewhat paralyzed by how to even start. Most of us are some combination of all three, says Srini Pillay, an assistant clinical professor of psychiatry at Harvard Medical School. "If you're getting a high from waiting, you can ask yourself, What are some other ways I can get that rush? You might find that finishing early and giving yourself a few hours off can feel just as good," he says. To avoiders, Pillay points out that although you think you're putting this task out of your mind, it's still in there: "On an unconscious level, you are having anticipatory anxiety about it, and it's still taxing your brain because that anxiety center is not really at rest." Indecisive procrastinators may find that they're catastrophizing what would happen if they took the "wrong" approach to a project. "You can always go back and course-correct," Pillay suggests.

#3 Be a little more grateful. Often when we're busy, we can resent the people or tasks that are making us so—but that may just add to the stress. "When you are thankful and grateful for what you're doing in life, even when you are spread thin, it helps immediately with giving you the energy and motivation to get things done," says Larry Marks, a clinical psychologist at the University of Central Florida. In one study at the University of California, Davis, participants who kept a daily journal of things they were thankful for showed more enthusiasm, energy and determination than people who wrote neutral entries or kept track of annoyances. Bonus: They were also more likely to have taken steps toward achieving an important personal goal.

#4 Try pomodoro. No, not the pasta sauce—this "pomodoro" is a pop-psychology technique created by entrepreneur and productivity consultant Francesco Cirillo. The basics: Set a timer and work for 25 minutes straight, without any interruptions or distractions, then take a five-minute break. After four cycles, take a longer, 15- to 20-minute break. Repeat until your task is finished. No research has been done on this technique, but it's become a word-of-mouth phenomenon through sites such as Lifehacker.com, and Cirillo's book *The Pomodoro Technique* has been read by more than two million people. I've never read the book (too busy!), but I've used the technique regularly since my husband told me about it. In fact, I used it just now while writing this piece, and I am happy to say I saved myself a good hour and a half of hemming and hawing. Sure, a clear mind free from psychological baggage may be the best tool in your time-management kit, but once in a while all you really need to get something done is an iPhone timer kicking you in the butt. —*Sunny Sea Gold*

PAUL PANTAZESCU *iStockphoto (globe icon);* MÁGOZ *(illustration)*

M Introverts are often seen as more introspective, sensitive and socially anxious than extroverts. In reality, none of these traits is linked with introversion.

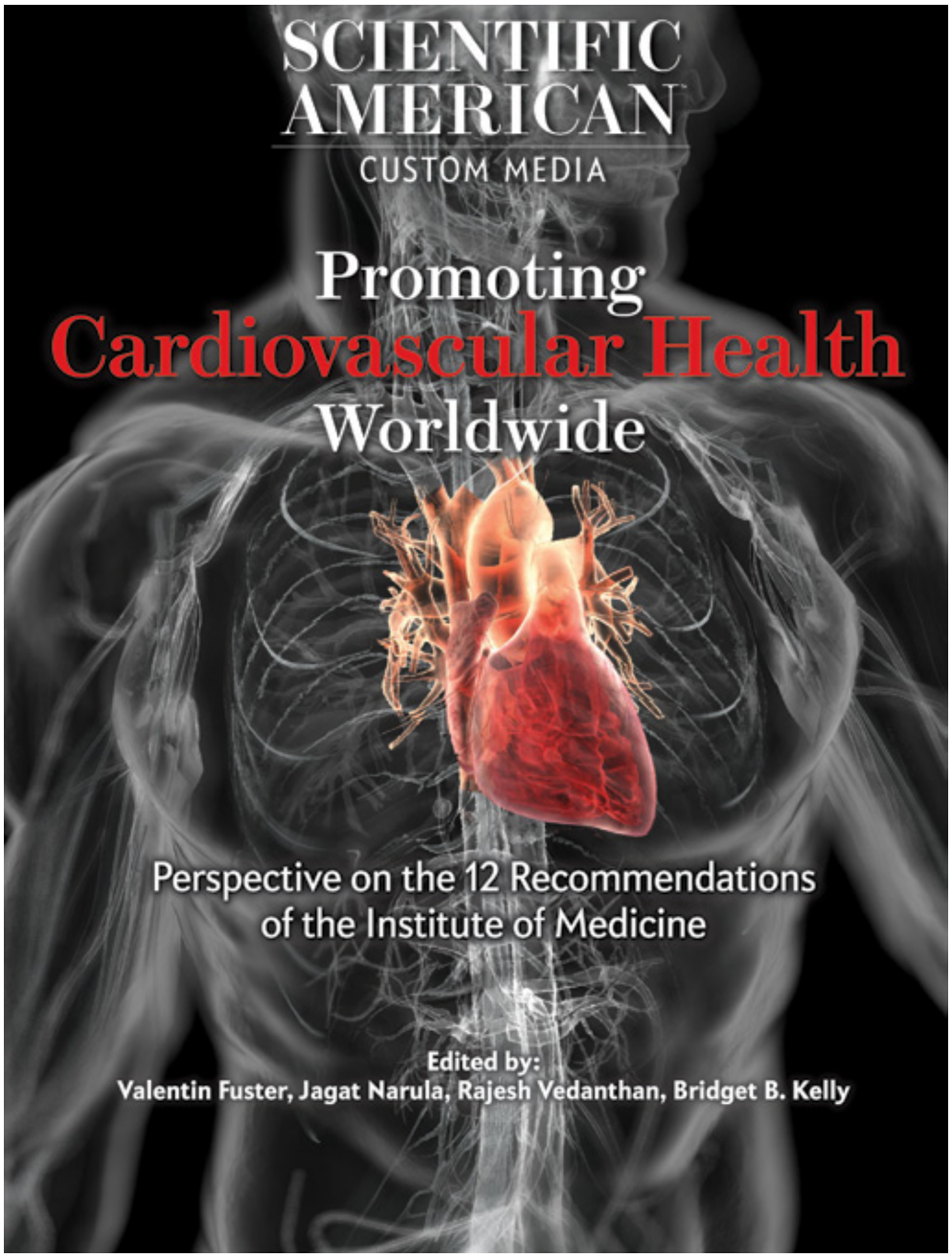
PROMOTING **CARDIOVASCULAR** HEALTH WORLDWIDE

A compelling look at one of the most pressing issues of our time...

Heart disease and related non-communicable diseases were once considered a problem that only wealthy, industrialized nations faced. Together, they now rank as the leading cause of death across the globe.

This special issue, ***Promoting Cardiovascular Health Worldwide***, explores the problem – and outlines the solutions.

Brought to you by SCIENTIFIC AMERICAN CUSTOM MEDIA and ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI — this special issue is a follow up on the 12 Recommendations from the Institute of Medicine for promoting cardiovascular health in the developing world.



For a free digital issue visit:
ScientificAmerican.com/products/cardiovascular-health

THE BEAUTY OF MATH

Elegant equations evoke the same activity in mathematicians' brains as gorgeous art or music

Mathematicians have long likened the experience of mathematical beauty to that of visual and musical beauty. Now scientists in England and Scotland have determined that despite the abstract nature of mathematics, mathematical beauty is linked to activity in the same region of the brain as beauty from sensory sources.

The researchers asked 15 mathematicians to view a series of 60 mathematical equations and rate each one on a scale of –5 (ugliest) to +5 (most beautiful). Then they scanned the subjects' brains with functional MRI as they looked at the equations again. Follow-up surveys revealed that understanding the math was necessary but not sufficient for a participant to see beauty in an equation—some equations were well understood but did not strike the mathematicians as beautiful. The distinction allowed the researchers to factor out the brain activity associated with understanding and home in on the area responsible for the feeling of beauty: the medial orbitofrontal cortex, an area thought to integrate sensory experience, emotion and decision making. Previous studies have shown that this area is highly active when subjects see or hear something—for instance, art or music—that they perceive as beautiful.

Beauty is a tricky concept for scientists to study because of its subjective and personal nature. Study author Semir Zeki, a neuroscientist at University College London, suggests that by considering beauty mathematicians may be touching on a deep connection between the human brain and the natural world. Because "we have evolved in this universe," Zeki posits, "the experience of beauty may be a pointer to truth about the universe." Many mathematicians say they strive for beauty the way a composer or a painter would. Zeki points out that this approach has sometimes led to incredible insights: "Relegating beauty to the study of art and leaving it out of science is no longer tenable." —*Seth Newman*

Evocative Equations

"Traditionally mathematicians have regarded simplicity as an important criterion for beauty," explains neuroscientist Semir Zeki. The equation most frequently rated as beautiful by the mathematicians who participated in Zeki's study was Leonhard Euler's identity:

$$e^{i\pi} + 1 = 0$$

This equation relates the five most important mathematical constants with three basic arithmetic operations, each occurring once.

The equation that participants most often rated as ugly was Srinivasa Ramanujan's infinite series for $1/\pi$:

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801} \sum_{k=0}^{\infty} \frac{(4k)!(1103 + 26390k)}{(k!)^4 396^{4k}}$$

This equation defines the reciprocal of pi using integers, which is useful for mathematicians seeking to understand pi, one of the most important mathematical concepts. —*S.N.*

Justice through Forgiveness

Face-to-face meetings between victim and perpetrator bring relief to both parties

Our legal system often fails to help either victim or offender. Years after a crime, victims may still suffer from post-traumatic stress. Offenders, too, can struggle after their release from prison; limited rehabilitation means that they often return to a life of crime. To help remedy these wrongs, proponents of "restorative justice" methods advocate for face-to-face meetings between victims and offenders.

Victims who participate in such discussions with a perpetrator report feeling they can forgive their attacker, and offenders say they feel responsibility for their actions—a change in trajectory for both parties. Two recent randomized controlled studies add to mounting evidence for the effectiveness of these restorative practices.

Caroline M. Angel, a criminologist at the University of Pennsylvania, and her colleagues examined the effects of restorative justice for London robbery and burglary victims and their perpetrators. The victims were randomly assigned either to go through both the court system and a restorative justice conference or to go through just the court system. In the restorative justice group, trained facilitators led meetings where offenders discussed the effects of the crime with their victims and the victims' family and friends. About a quarter of the victims who went through the criminal justice system showed clinical symptoms of post-traumatic stress, but only 12 percent of the group who also had restorative justice conferences had symptoms. "Restorative justice gives victims that chance to reframe the story and heal in the process," Angel says.

The second study, conducted by University of Cambridge criminologists Lawrence Sherman and Heather Strang and their colleagues, focused on whether these methods can reduce reoffending. The research, published in March in the *Journal of Quantitative Criminology,* analyzed 10 trials that used randomized controls to examine the effect of restorative justice conferences on criminals. They found that offenders who participated in the conferences committed fewer subsequent crimes and that the method was also cost-effective.

Overall, research from the past 20 years has shown that restorative justice works—yet such practices are uncommon in the American criminal justice system. Advocates say the reluctance stems from our culture of harsh punishment and politicians' need to be seen as "tough on crime." Nevertheless, pilot programs have sprung up at a few locations across the country in recent years, and researchers hope that these findings will spur more change soon. —*Cara Tabachnick*

TOM GRILL *Getty Images*

M The first aromatic e-mail crossed the Atlantic in June. Using a platform that lets people label the scents associated with a message, researchers in

FACT CHECK

Does Marijuana Harm the Brain?

THE CLAIM
Casual cannabis use harms young people's brains.

THE FACTS
A study found differences in the brains of users and nonusers, but it did not establish that marijuana use caused the variations or that they had any functional significance.

THE DETAILS
Researchers at Northwestern University and Harvard Medical School conducted MRI scans of two groups of 20 young adults ages 18 to 25. One group reported using marijuana at least once a week, smoking 11 joints a week on average, whereas the other had used it less than five times total and not at all during the last year. Neither group had any psychiatric disorders, and the users were psychiatrically assessed as not dependent on the drug.

The study focused on two brain regions involved in processing rewards, the nucleus accumbens and the amygdala. These areas create pleasurable experiences of things such as food and sex, as well as the high associated with drugs, and have been shown to change in animals given THC, the main psychoactive component of cannabis.

The researchers found that cannabis users had more gray matter density in the left nucleus accumbens and left amygdala, as well as differences in the shape of the left nucleus accumbens and right amygdala. The left nucleus accumbens also tended to be slightly larger in users. They concluded that recreational cannabis use might be associated with abnormalities in the brain's reward system. News reports have proclaimed that scientists have shown that even casual cannabis use harms young people's brains.

REALITY CHECK
Cannabis use has been found to:

- Cause dependence, at some point in their lives, in about 9 percent of people who try it.
- Impair various aspects of cognitive function, particularly memory. Impairments can remain for several days. One study showed that performance returns to nonusers' levels after 28 days of abstinence, but evidence is mixed about how long the impairments last.
- Potentially reduce the volume of the hippocampus, which is critical for memory—but only after heavy and prolonged use. The evidence linking cognitive impairments to specific brain changes is inconclusive, and the degree to which such changes are reversible is hotly debated. —*S.M.*

THE CAVEATS
The most obvious problem with leaping to that conclusion is that the scans were conducted at only one point. This approach can compare the two groups, but it cannot prove cannabis *caused* any differences between them—or even that the differences represent changes over time. They could be preexisting variations, or cannabis use and brain changes may both be related to a third factor, such as tobacco (although the study did attempt to take levels of smoking into account).

That said, it is plausible that the dissimilarities were a result of using cannabis. By definition, all psychoactive substances cause changes in the brain. Recreational drugs such as cannabis stimulate our reward system, triggering the nucleus accumbens to release dopamine and generate an experience of pleasure—which is why people take them. Increasing dopamine activity will subtly alter the brain, but even playing the lottery on a regular basis might produce such a change. "I think that's all we're seeing here," says Robin Murray, professor of psychiatry at King's College London. "It's likely these are adaptive changes, which will probably disappear when they stop taking cannabis."

More important, the scientists did not measure cognitive performance, and they found no links between their data and the occurrence of mental health problems. Calling the finding "damage" is therefore arbitrary. "These differences were not associated with any problems," says Tom Freeman, a researcher at University College London. "So further evidence is needed to conclude [the differences] are harmful in any way."

—*Simon Makin*

CAN MARIJUANA CAUSE PSYCHOSIS?

Many studies show that teens who use marijuana face a greater risk of later developing schizophrenia or symptoms of it, especially if they have a genetic predisposition. For instance, one 15-year study followed more than 45,000 Swedes who initially had no psychotic symptoms. The researchers determined that subjects who smoked marijuana by age 18 were 2.4 times more likely to be diagnosed with schizophrenia than their nonsmoking peers, and this risk increased with the frequency of cannabis use. The connection still held when researchers accounted for participants' use of other drugs.

Yet despite these results and an uptick in marijuana use in the 1970s and 1980s, other researchers have not uncovered an increase in the incidence of schizophrenia in the general Swedish population—suggesting that perhaps people who were going to develop schizophrenia anyway were more likely to use marijuana. Another study, conducted in Australia over a 30-year period, also found no increase in schizophrenia diagnoses among the general population, despite rising rates of teen marijuana use. These authors concluded that although cannabis most likely does not cause schizophrenia, its use might trigger psychosis in vulnerable people or exacerbate an existing condition. —***Victoria Stern***

GETTY IMAGES (*marijuana leaf*)

Paris sent a photo of French delicacies. In New York, a device called an oPhone received the message and emitted whiffs of champagne and macaroons.

ON THE HORIZON

TINY LIGHTS THAT ILLUMINATE BRAIN ACTIVITY

Step aside, huge magnets and radioactive tracers—soon some brain activity will be revealed by simply training dozens of red lights on the scalp. A new study in *Nature Photonics* finds this optical technique can replicate functional MRI experiments, and it is more comfortable, more portable and less expensive.

The method is an enhancement of diffuse optical tomography (DOT), in which a device shines tiny points of red light at a subject's scalp and analyzes the light that bounces back. The red light reflects off red hemoglobin in the blood but does not interact as much with tissues of other colors, which allows researchers to recover an fMRI-like image of changing blood flow in the brain at work. For years researchers attempting to use DOT have been limited by the difficulty of packing many heavy light sources and detectors into the small area around the head. They also needed better techniques for analyzing the flood of data that the detectors collected.

Now researchers at Washington University in St. Louis and the University of Birmingham in England report they have solved those problems and made the first high-density DOT (HD-DOT) brain scans. The team first engineered a "double halo" structure to support the weight of 96 lights and 92 detectors, more than double the number in earlier arrays. The investigators also dealt with the computing challenges associated with that many lights—for example, they figured out how to filter out interference from blood flow in the scalp and other tissues. The team then used HD-DOT to successfully replicate fMRI studies of vision and language processing—a task impossible for other fMRI alternatives, such as functional near-infrared spectroscopy or electroencephalography, which do not cover a large enough swath of the brain or have sufficient resolution to pinpoint active brain areas. Finally, the team scanned the brains of people who have implanted electrodes for Parkinson's disease—something fMRI can never do because the machine generates electromagnetic waves that can destroy electronic devices such as pacemakers.

Although HD-DOT can penetrate only about two centimeters, which means the method will never totally replace fMRI, commercial versions will cost about a tenth as much and be more portable, says lead author Adam Eggebrecht, a physicist at the Washington University School of Medicine. And that two-centimeter depth is enough to investigate many of the brain's higher-order cognitive functions, which largely take place in the cerebral cortex, the outer folds of the brain. Researchers are already using HD-DOT to study brain function in Parkinson's patients and children with autism, Eggebrecht says. *—Nathan Collins*

Why Mental Rehearsals Work

Imagined practice may activate the same neural circuits as real experience

Imagining your tennis serve or mentally running through an upcoming speech might help you perform better, studies have shown, but the reasons why have been unclear. A common theory is that mental imagery activates some of the same neural pathways involved in the actual experience, and a recent study in *Psychological Science* lends support to that idea.

Scientists at the University of Oslo conducted five experiments investigating whether eye pupils adjust to imagined light as they do to real light, in an attempt to see whether mental imagery can trigger automatic neural processes such as pupil dilation. Using infrared eye-tracking technology, they measured the diameter of participants' pupils as they viewed shapes of varying brightness and as they imagined the shapes they viewed or visualized a sunny sky or a dark room.

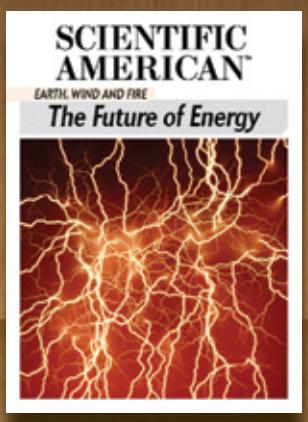
In response to imagined light, pupils constricted 87 percent as much as they did during actual viewing, on average; in response to imagined darkness, pupils dilated to 56 percent of their size during real perception. Two other experiments ruled out the possibility that participants were able to adjust their pupil size at will or that pupils were changing in response to mental effort, which can cause dilation.

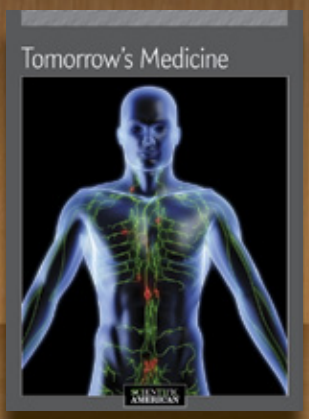
The finding helps to explain why imagined rehearsals can improve your game. The mental picture activates and strengthens the very neural circuits—even subconscious ones that control automated processes like pupil dilation—that you will need to recruit when it is time to perform. *—Tori Rodriguez*

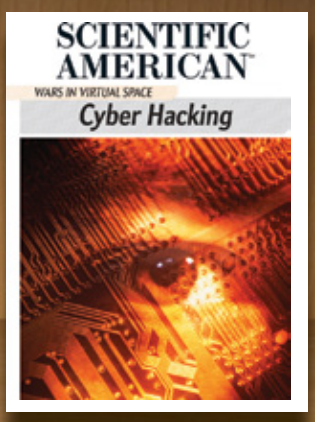
FROM "BIOIMAGING: WATCHING THE BRAIN AT WORK," BY ROBERT J. COOPER, IN *NATURE PHOTONICS*, VOL. 8; JUNE 2014 (*brain scanning*); ALAMY (*athlete*); SCOTT DUNLOP *iStockphoto (sun icon)*

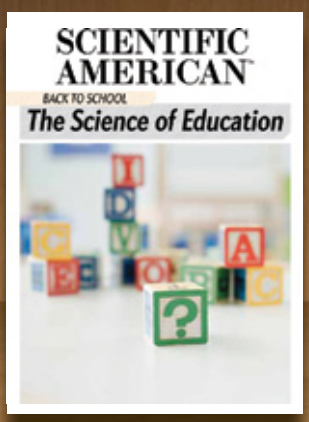
M Hearing dissonant musical intervals leads people to sort information into broader, more inclusive categories than listening to consonant intervals.

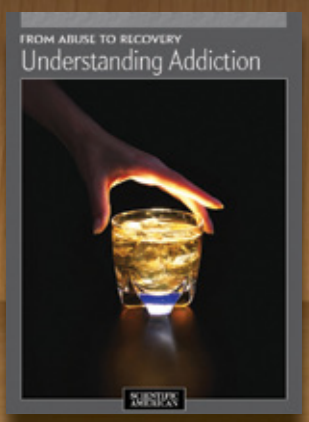
eBooks From the Editors of SCIENTIFIC AMERICAN™





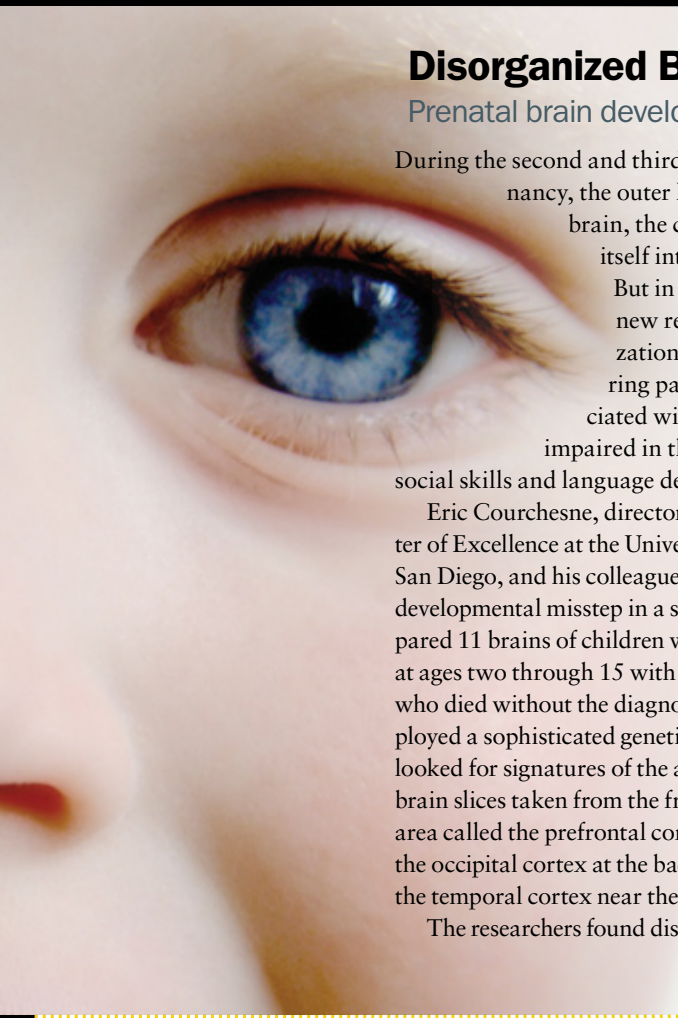






Start your SCIENTIFIC AMERICAN eLibrary today:

books.scientificamerican.com/sa-ebooks



Disorganized Brain Cells Help to Explain Symptoms

Prenatal brain development may get jumbled in key areas implicated in autism

During the second and third trimester of pregnancy, the outer layer of the embryo's brain, the cortex, assembles itself into six distinct layers. But in autism, according to new research, this organization goes awry—marring parts of the brain associated with the abilities often impaired in the disorder, such as social skills and language development.

Eric Courchesne, director of the Autism Center of Excellence at the University of California, San Diego, and his colleagues uncovered this developmental misstep in a small study that compared 11 brains of children with autism who died at ages two through 15 with 11 brains of kids who died without the diagnosis. The study employed a sophisticated genetic technique that looked for signatures of the activity of 25 genes in brain slices taken from the front of the brain—an area called the prefrontal cortex—as well as from the occipital cortex at the back of the brain and the temporal cortex near the temple.

The researchers found disorganized patches, roughly a quarter of an inch across, in which gene expression indicated cells were not where they were supposed to be, amid the folds of tissue in the prefrontal cortex in 10 of 11 brains from children with autism. That part of the brain is associated with higher-order communication and social interactions. The team also found messy patches in the temporal cortices of autistic brains but no disorder at the back of the brain, which also matches typical symptom profiles. The patches appeared at seemingly random locations within the frontal and temporal cortices, which may help explain why symptoms can differ dramatically among individuals, says Rich Stoner, then at U.C. San Diego and the first author of the study, which appeared in the *New England Journal of Medicine*.

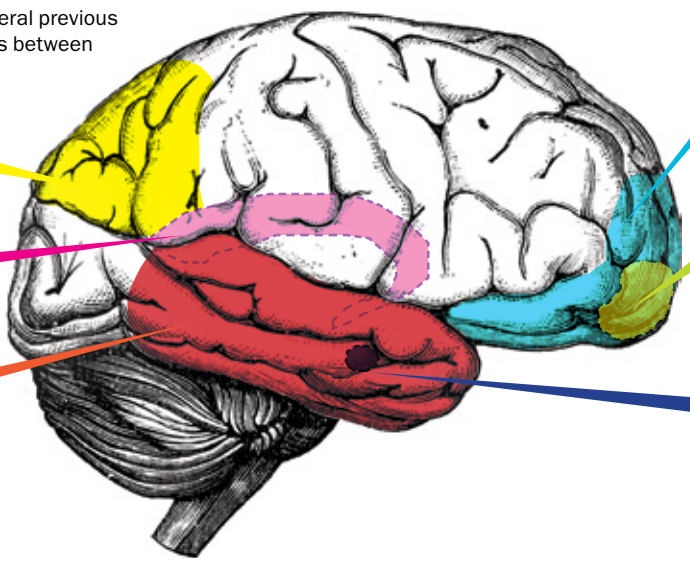
Courchesne's earlier research had shown that the brains of children with autism have more neurons in the prefrontal cortex as well as flawed genetic signaling in this region. The absence of markers for cells that should have formed in the second and third trimester strongly suggests a time frame for the developmental error—and for future preventive interventions.

—Jenni Laidman

THE AUTISTIC BRAIN

The study described above and several previous studies have discovered differences between autistic and typical brains.

TYPICAL FUNCTION ■ CHANGES IN AUTISM ■



POSTERIOR PARIETAL CORTEX
- Visual and spatial perception
- Underactive, possibly indicating higher efficiency in processing

CORPUS CALLOSUM
- Connects the right and left hemispheres
- Smaller

TEMPORAL CORTEX
- Empathy and attention
- Disorganized patches of cells

PREFRONTAL CORTEX
- Abstract thinking and social communication
- Disorganized patches of cells and extra neurons

VENTROMEDIAL PREFRONTAL CORTEX
- Linked to our ability to imagine other people's thoughts and feelings, known as theory of mind
- Underactive

AMYGDALA
- Emotional processing
- Impaired connectivity to other regions

CHARLY FRANKLIN Getty Images (*child*); ISTOCKPHOTO (*brain*)

M Obese people who read an article arguing that obesity is a disease, as compared with those who read one stating the opposite, expressed less concern

GUT BACTERIA MAY PLAY A ROLE

Evidence is mounting that intestinal microbes exacerbate or perhaps even cause some of autism's symptoms

Autism is primarily a disorder of the brain, but research suggests that as many as nine out of 10 individuals with the condition also suffer from gastrointestinal problems such as inflammatory bowel disease and "leaky gut." The latter condition occurs when the intestines become excessively permeable and leak their contents into the bloodstream. Scientists have long wondered whether the composition of bacteria in the intestines, known as the gut microbiome, might be abnormal in people with autism and drive some of these symptoms. Now a spate of new studies supports this notion and suggests that restoring proper microbial balance could alleviate some of the disorder's behavioral symptoms.

At the annual meeting of the American Society for Microbiology held in May in Boston, researchers at Arizona State University reported the results of an experiment in which they measured the levels of various microbial by-products in the feces of children with autism and compared them with those found in healthy children. The levels of 50 of these substances, they found, significantly differed between the two groups. And in a 2013 study published in *PLOS ONE,* Italian researchers reported that, compared with healthy kids, those with autism had altered levels of several intestinal bacterial species, including fewer *Bifidobacterium,* a group known to promote good intestinal health.

One open question is whether these microbial differences drive the development of the condition or are instead a consequence of it. A study published in December 2013 in *Cell* supports the former idea. When researchers at the California Institute of Technology incited autismlike symptoms in mice using an established paradigm that involved infecting their mothers with a viruslike molecule during pregnancy, they found that after birth, the mice had altered gut bacteria compared with healthy mice. By treating the sick rodents with a health-promoting bacterium called *Bacteroides fragilis,* the researchers were able to attenuate some, but not all, of their behavioral symptoms. The treated mice had less anxious and stereotyped behaviors and became more vocally communicative.

Researchers do not yet know how exactly gut bacteria might influence behavior, but one hypothesis is that a leaky gut may allow substances to pass into the bloodstream that harm the brain. In the mouse study, the probiotic may have helped reshape the microbial ecosystem and made the intestines more robust, preventing the leakage of such substances, says co-author Elaine Y. Hsiao, a microbiologist at Caltech.

So could autism one day be treated with drugs designed to restore a healthy microbial balance? Perhaps, but autism is the result of a "complex interplay of genetic and environmental factors," explains Manya Angley, an autism researcher at the University of South Australia, so the solution may not be that simple. Caltech biologist Sarkis K. Mazmanian, co-author of the mouse study, agrees. "Many more years of work will be needed before we are confident that gut bacteria impact autism and whether probiotics are a viable treatment," he says.

Bacteroides fragilis

CNRI/SCIENCE SOURCE (*bacteria*); ANDREW RICH *iStockphoto* (*kids*)

—Melinda Wenner Moyer

Theater as Therapy

Kids with autism may learn valuable social skills in drama-based therapies

Science and the arts have never made easy bedfellows, but three projects that unite psychology and theater could help treat autistic spectrum disorders (ASD). The skills developed in drama training closely correspond with three of the main impairments seen in autism: social interaction, communication and flexibility of imagination.

One drama-based intervention is the SENSE Theatre project, which aims to help children with ASD improve their social skills. "I knew from experience that acting can have a profound impact on how we interact with others," says Blythe A. Corbett, a psychiatrist at Vanderbilt University and former actor, who started SENSE in 2009. "It can facilitate more flexible thinking and behavior."

So far the SENSE project has run two summer camps that served as pilot studies. The camps begin with improvisation and role-playing games, move on to scripted sessions and culminate in the performance of a play. Corbett's team measured social perception and interaction skills before and after the camps. The children showed increases in social awareness and memory for faces after camp, as reported in *Autism Research* earlier this year.

Similarly encouraging pilot studies have come from two other groups. The Shakespeare and Autism project, a collaboration between Kelly Hunter, a British actress with the Royal Shakespeare Company, and Marc J. Tassé, an expert in developmental disabilities at Ohio State University, and their colleagues, uses drama games based on scenes from William Shakespeare's plays and the rhythm of iambic pentameter to implicitly teach social skills. And Imagining Autism, led by drama professors Nicola Shaughnessy and Melissa Trimingham, both at the University of Kent in England, is a weekly program for kids with autism that incorporates performance, puppetry and interactive digital elements.

None of these studies has compared the youngsters in drama with a group who did not get the intervention, so they cannot yet rule out other explanations, such as natural development over time. The SENSE and Shakespeare teams are now nearing completion of more rigorous studies that compare participants with kids who were wait-listed. Only time and scientific testing will tell if these methods work, but the existence of three independent groups, all claiming encouraging preliminary results, suggests they may be on to something. *—Simon Makin*

about their weight and chose higher-calorie foods. | Today's heroin user is, on average, whiter and more suburban than the users of 50 years ago.

KIRK MASTIN *Aurora*

HEAD INJURY MAY CAUSE MENTAL ILLNESS

A single blow to the head may increase the risk of subsequently developing a disorder

The safety of football continues to be a heated topic for players and parents, with mixed evidence regarding the effect of head injuries on mental illness. Past studies on the connection have often been methodologically flawed or yielded ambiguous results. Now a paper in April in the *American Journal of Psychiatry,* the largest study yet to investigate the link, finds that even a single head injury indeed increases the risk of later mental illness, especially if the injury occurs during adolescence.

Using Danish medical registries, researchers led by physician Sonja Orlovska of the University of Copenhagen studied 113,906 people who had been hospitalized for head injuries over a 23-year period. They discovered that in addition to cognitive symptoms caused by structural damage to the brain (such as delirium), these people were subsequently more likely than the general population to develop several psychiatric illnesses. Risk increased by 65 percent for schizophrenia and 59 percent for depression. Risk was highest in the first year postinjury but remained significantly elevated throughout the next 15 years. After the team controlled for several potential confounders, such as accident proneness and a family history of psychiatric problems, they found the strongest injury-related predictor for later onset of schizophrenia, depression and bipolar disorder was a head trauma experienced between the ages of 11 and 15.

"Previous studies have shown that head injury induces inflammation in the brain, which causes several changes—for example, an increased permeability of the blood-brain barrier," Orlovska says. Normally the barrier protects the brain from potentially harmful contents in the bloodstream, but injury-induced inflammation may allow these substances access to the brain. "For some individuals, this might initiate damaging processes in the brain," she says.

Because the exact mechanisms that lead from head injury to mental illness are still unknown, it is not clear whether there are specific ways to reduce the risk of mental illness after such an injury. For now the best a patient can do is follow established postinjury guidelines, such as getting plenty of rest and avoiding physically and mentally demanding activities for a specified period depending on the severity of the injury. Early detection can help improve the prognosis for mental illness, so Orlovska also recommends seeing a doctor as soon as any symptoms appear.

—Tori Rodriguez

M On average, only half of new hires meet or exceed expectations. Even a simple algorithm can make better hiring choices than humans.

ADDICTION IS HOPELESS WITHOUT YOU

Share your story of recovery or message of hope with someone who needs to hear it. **Visit drugfree.org and join the "Stories of Hope" community.**

Partnership™ for Drug-Free Kids
Where families find answers

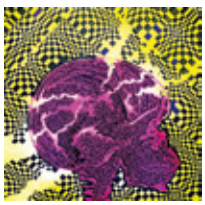
(PHARMA WATCH)

MYSTICAL MEDICINE

Psychedelic drugs are poised to be the next major breakthrough in mental health care

Almost immediately after Albert Hofmann discovered the hallucinogenic properties of LSD in the 1940s, research on psychedelic drugs took off. These consciousness-altering drugs showed promise for treating anxiety, depression, post-traumatic stress disorder (PTSD), obsessive-compulsive disorder (OCD) and addiction, but increasing government conservatism caused a research blackout that lasted decades. Lately, however, there has been a resurgence of interest in psychedelics as possible therapeutic agents. This past spring Swiss researchers published results from the first drug trial involving LSD in more than 40 years. —*Roni Jacobson*

Drug	Recreational Use	Experimental Treatment	Mechanism of Action	Clinical Forecast
MDMA (aka ecstasy)	MDMA induces feelings of euphoria and often synesthesia. Taking MDMA also arouses feelings of intimacy and connectedness with others.	PTSD, anxiety	In the brain, MDMA triggers neurons to release several neurotransmitters that in turn spur the release of oxytocin, which can dampen fear and facilitate trust. These effects may help people with PTSD work through painful emotions.	Researchers are currently studying the effects of MDMA on war veterans, firefighters and police officers with treatment-resistant PTSD. An earlier trial found the drug plus psychotherapy effective in about 80 percent of patients.
Ketamine (aka special K)	Ketamine is an anesthetic and painkiller that can also put users in a detached, trancelike state for up to three hours. Higher doses induce hallucinations.	Depression	A single dose of ketamine can relieve symptoms of depression for days after injection. It may do so by strengthening connections between the prefrontal cortex and the hippocampus—brain areas important in learning and memory.	In drug trials from 2013 and 2014, ketamine alleviated stubborn depression in 30 to 45 percent of patients. Ketamine is less restricted than other psychedelics because it is a Schedule III drug, so it may enter clinical practice faster.
Psilocybin (aka magic mushrooms)	Psilocybin produces feelings of transcendence and spirituality, as well as visual hallucinations and distortions in time perception.	OCD, PTSD, anxiety	Psilocybin binds to some serotonin receptors in the cortex, kicking off a process that ultimately decreases brain activity there, which may calm anxiety and OCD symptoms.	In the largest psychedelic study in more than 40 years, scientists at the New York University School of Medicine are currently examining whether psilocybin helps to reduce anxiety and depression in cancer patients.
LSD (aka acid)	An LSD trip is characterized by intense visual hallucinations—potentially including flashing, vibrant colors and geometric patterns—an altered sense of time and unusual perceptions.	Alcoholism, anxiety	A 2012 analysis of studies from the 1960s and 1970s determined that alcoholics who took LSD had decreased rates of alcohol abuse, with the effect lasting for months. PET scans have shown that LSD, which binds to certain serotonin receptors, primarily activates the frontal lobe and the anterior cingulate and insular cortices, brain areas tied to consciousness and emotion.	The first study of LSD-assisted therapy in 40 years reported that cancer patients who took the drug felt their anxiety improve by about 20 percent, whereas those who took a placebo got worse. Although the trial was small, it highlights the need for more research.



Time for a Psychedelic Spring?

Although the freeze on psychedelic research is thawing, scientists say that restrictive drug policies are continuing to hinder their progress. In the U.S., LSD, psilocybin, MDMA, DMT, peyote, cannabis and ibogaine (a hallucinogen derived from an African shrub) are all classified as Schedule I illegal drugs, which the U.S. Drug Enforcement Administration defines as having a high potential for abuse and no currently accepted medical applications—despite extensive scientific evidence to the contrary. In a joint report released in June, the Drug Policy Alliance and the Multidisciplinary Association for Psychedelic Studies catalogue several ways in which they say that the DEA has unfairly obstructed research on psychedelics, including by overruling an internal recommendation in 1986 that MDMA be placed on a less restrictive schedule.

The DEA and the U.S. Food and Drug Administration maintain that there is insufficient research to justify recategorization. This stance creates a catch-22 by basing the decision on the need for more research while limiting the ability of scientists to conduct that research. The June report recommends transferring responsibility for drug scheduling from the DEA to another agency or nongovernmental organization without a history of antidrug bias, such as the U.S. National Academy of Sciences. No matter how it happens, until the drugs are reclassified, bringing psychedelics from research into clinical practice will be an uphill battle.

ISTOCKPHOTO (*pills icon*); NICOLAS NEUBAUER *Alamy* (*skull*)

Your gut can taste sugar, a discovery that is spawning new diabetes treatments. | **For full stories: ScientificAmerican.com/Mind/sep2014/stories**

Out of This World

Superpower your imagination

> *Superhero science has taught me this: Entire universes fit comfortably inside our skulls. Not just one or two but endless universes can be packed into that dark, wet, and bony hollow without breaking it open from the inside.*
>
> —Grant Morrison, *Supergods,* 2011

An eclectic crowd of cosplay zombies, manga characters, and assorted villains and heroes, all sweltering under their makeup in the Arizona summer heat, presses us along at the 2014 Phoenix Comicon convention. We descend a four-story escalator into the immense Phoenix Convention Center, which sprawls across multiple city blocks of subterranean floor space. As we watch the bottom of the pit rise toward us, demons are brandishing crossbows, war hammers and lightsabers.

Comic book characters live in an augmented reality, a realm where individuals transcend natural capacities. Their stories are human dramas writ large: Superman soars to the rescue, and Spider-Man clambers up buildings to escape villains. The human nervous system offers many ways to be part of this world. Our eyes can take in the tremendous array of colors, light and movement that surround us, and the brain translates this visual maelstrom into something intelligible. In particular, our perceptual and cognitive systems rely largely on seeking out, embellishing and identifying contrast, a principle that is also fundamental to comic stories, with their central themes of good versus evil.

Nobel laureate Haldan Keffer Hartline of the Rockefeller University first discovered the brain's contrast-detecting ability in the neurons of the retina, which in humans lines the inner surface at the back of the eye. Hartline found that excitation in a neuron leads to suppression of surrounding, competing neurons, so that an enhanced neural response to visual stimuli goes hand in

© MARVEL, COURTESY OF UNIVERSAL STUDIOS JAPAN (*Spider-Man*); SEAN McCABE (*Macknik* and *Martínez-Conde*)

WEB OF DECEPTION

Distinguishing a hero from a villain is often all a matter of perspective. In this image by Kurt Wenner, exhibited at Universal Studios Japan to celebrate its 10th anniversary in 2011, only someone viewing from the correct angle (much like the vantage point of a *Scientific American Mind* reader) will see Spider-Man swinging through a New York City canyon, preparing to shoot webs back at the tightrope walkers. The people walking the ropes see the superhero for what he is, a huge, flat painting on the floor below them, and have no fear of falling to their death. This illusion, called an anamorphic painting, takes advantage of how the visual system uses cues such as shading, perspective and relative size to produce our perception of distance, depth and shape.

BY STEPHEN L. MACKNIK AND SUSANA MARTINEZ-CONDE

Stephen L. Macknik and Susana Martinez-Conde are professors of ophthalmology at SUNY Downstate Medical Center in Brooklyn, N.Y. They serve on *Scientific American Mind*'s board of advisers and are authors of *Sleights of Mind,* with Sandra Blakeslee, which won the 2013 Prisma Prize for Best Book of the Year (http://sleightsofmind.com). Their forthcoming book, *Champions of Illusion,* will be published by Scientific American/Farrar, Straus and Giroux.

Send suggestions for column topics to **editors@SciAmMind.com**

hand with the active inhibition of nearby opponent stimuli. Hartline called this process "lateral inhibition."

Excitation versus inhibition enhances the contours of objects as compared with their interiors, and similar computations operate outside the visual system to have a part in virtually every known brain area. Lateral inhibition may also play a role in how we compare ideas and arguments. Disambiguating the world—heightening the difference among entities—appears to be a neural mandate. We cannot perceive greenish-red or bluish-yellow, for example, because the corresponding colors are processed as *opponent* types of information in visual neurons. They are like oil and water to the mind.

On the Phoenix Comicon exhibition floor, one of our favorite comic book creators, Dennis Calero, explains that managing dualities is also crucial to superhero lore. Heroes often internalize opposing personas: readers identify with Clark Kent and Peter Parker rather than with Superman and Spider-Man. Yet just as important, the villain makes the hero. Without a compelling villain, stories fall flat. Contrast between light and dark forces creates the narrative.

The images in this article play on the idea of superpowers and heroes. They challenge your visual and cognitive circuits to classify them as possible versus impossible. The ambiguity inherent to the visual inputs you are about to experience makes this task a feat worthy of the Man of Steel himself. M

CHAMELEON CAMOUFLAGE

Chinese artist Liu Bolin uses his body as a canvas to disappear in plain sight. He and his team can spend days preparing for a photo shoot. Bolin has blended into landmarks, bookstores and even a bulldozer with the transformative ease of the Teen Titans shape-shifter Miss Martian, who can control her molecular structure to camouflage in any environment. Our eyes struggle to detect Bolin because his body paint reduces the contrast between the edges of his body and the background, subverting the same principles of lateral inhibition that help us find contours in other images.

INVISIBLE GIRL

Sue Richards, aka the Invisible Woman of Fantastic Four fame, could manipulate light waves to make herself invisible. This superselfie of 18-year-old photographer Laura Williams of Cambridge, England, is fantastic in that our brain at first glance does not hesitate to perceive the young woman as partially invisible, instead of outright concluding that this is an impossible scenario.

We all have mental models of the human body, so we conclude that a girl is sitting behind the frame rather than that she is a disembodied head and limbs. Yet our visual system's capacity to link the landscape in the background to the image inside the frame—which should reflect what is in front of, not behind, the girl—is even more powerful than our brain's schemas of the human frame. This kind of perceptual stitching, which the German Gestalt psychology movement called "the law of good continuation," trumps the brain's assumptions about the shape of the human body. As a result, we imagine an invisible girl sitting behind an empty frame rather than a landscape reflected on a mirror.

GETTY IMAGES (*Liu Bolin in shelving*); BERND WEISSBROD Getty Images (*Bolin inset*); LAURA WILLIAMS (*invisible girl*)

EVERYDAY SUPERHEROES

Artist Leandro Erlich's interactive installation *Bâtiment,* exhibited at the 2004 edition of La Nuit Blanche festival in Paris, consists of a detailed facade that lies flat on the ground. With a large, angled mirror facing it, the entire facade is reflected vertically, along with viewers, who can assume poses in which they appear to cling from windowsills by their fingertips or to climb walls Spider-Man-style. Much like Wenner's Spider-Man floor mural, this illusion all comes down to perspective, giving visitors an eerie, impossible experience.

SUPERDAD

Italian photographer Giulia Pex has a series of Father's Day–inspired images entitled *Dad, you are my favourite superhero* that mixes drawing, illustration and photography to showcase her father's superpowers as she sees them. Artists learn that a line in a drawing or painting is often visual shorthand for the contour of an object, which we perceive using lateral inhibition.

In addition, neurons in the first stages of visual processing cannot distinguish between a solid form and an empty frame. As a result, the eye readily accepts line drawings despite the fact that they offer only the edges of a form. The extra effort required to interpret the image may actually make line drawings more compelling to our visual systems, holding our attention for a longer time. Here Pex tricks our line-finding neurons by drawing in a cape with just enough detail to make us see her dad's superhero status.

PAUL ET HENRIETTE (*Erlich installation*); GIULIA PEX (*superdad*)

FURTHER READING

- **Asphalt Renaissance: The Pavement Art and 3-D Illusions of Kurt Wenner.** Kurt Wenner. Sterling Signature (Sterling Publishing), 2011.
- **Supergods: What Masked Vigilantes, Miraculous Mutants, and a Sun God from Smallville Can Teach Us about Being Human.** Grant Morrison. Spiegel & Grau (Random House), 2011.
- **Adaptive Neural Coding in Frontal and Parietal Cortex.** John Duncan and Earl K. Miller in *Principles of Frontal Lobe Function.* Second edition. Edited by Donald T. Stuss and Robert T. Knight. Oxford University Press, 2013.
- **The Importance of Mixed Selectivity in Complex Cognitive Tasks.** M. Rigotti et al. in *Nature,* Vol. 497, pages 585–590; May 30, 2013.
- **Bâtiment.** Leandro Erlich. Image available on the artist's Argentine Web site: **www.leandroerlich.com.ar**
- **Dad, you are my favourite superhero.** Online portfolio by Giulia Pex: **www.behance.net/gallery/dad-you-are-my-favourite-superhero/9101573**

ON THE JOB

Should You Tell Your Boss about a Mental Illness?

Discrimination and stigma are concerns, but coming out can be a boon to your career—if the conditions are right

By Roni Jacobson

Dave, a 52-year-old U.S. Navy veteran, suffers from post-traumatic stress disorder stemming from a difficult childhood. In his job at a government agency, raised voices during meetings triggered thoughts of his abusive father, and his social anxiety occasionally prevented him from leaving his house in the morning. He felt uncomfortable hiding his condition, but he struggled to decide whether to tell his employer about it. "I didn't have a broken arm or anything that would be easy for them to understand," he says. "I didn't know how they would react."

The World Health Organization reports that mental illness is among the leading causes of disability across the globe. In a 2011 survey of more than 2,000 people, about a quarter reported experiencing a mental health problem on the job, according to the Chartered Institute of Personnel and Development, a British human resources agency. In the U.S., depression alone causes employees to miss 200 million days of work every year, costing employers $31 billion in lost revenue.

Despite its prevalence, mental illness is steeped in stigma, and people who call in sick or otherwise fall behind at work because of mental health issues often fabricate excuses to cover up the real reason for their lapse. They have reasons to be wary: other people may begin to perceive them differently, and the repercussions, such as being excluded socially or passed over for assignments, could damage their careers. On the other hand, revealing a psychiatric disability entitles you to workplace adjustments—and it might even improve your mental health and your relationship with your supervisor.

A few companies are offering accommodations that help employees with mental health needs avoid challenging situations and maintain productivity. If current trends continue, more people may become comfortable revealing their emotional and cognitive limitations, to everyone's benefit. "On the one hand there is needless suffering … but it's also costing [employers] in terms of lost productivity and absenteeism," says Clare Miller, director of the Partnership for Workplace Mental Health. People work better and more efficiently when they feel supported, she adds.

Battling Stigma

Historically, people who have revealed their mental illness at work have faced discrimination. For instance, in a 2010 survey of U.K. employers, about 40 percent said they considered hiring someone with a mental illness to be a "significant risk" to the company. Many employers believe that people with mental illnesses are difficult to get along with and unreliable. People with mental illness may be denied promotions and other opportunities for advancement. Even in supportive office environments, employees with mental illness sometimes feel increased scrutiny from their co-workers. "There's this overshadowing, where every time someone gets unhappy or upset people

RONI JACOBSON is a Brooklyn, N.Y.–based science journalist specializing in psychology and mental health.

Send suggestions for column topics to **editors@SciAmMind.com**

DAVIDE BONAZZI

start thinking, 'Oh, maybe they're relapsing,'" says psychiatrist and mental health services researcher Claire Henderson of King's College London.

If your employer is at all sympathetic to your problem, however, talking about your illness can offer benefits. For one, it may relieve the stress that comes from hiding personal information. You can also control the timing and message; otherwise your manager, who may already have noticed something is going on, may draw his or her own conclusions.

Furthermore, the Americans with Disabilities Act (ADA), passed in 1990, prohibits discrimination in hiring and firing decisions based on physical and mental disabilities and entitles people to "reasonable accommodations" from their employers. In the case of mental disabilities, these fixes may include flexible working hours, access to a quiet area and additional feedback from supervisors. In many cases, the modifications cost little to no money and can make a big difference to employee happiness and productivity.

The ADA protections are not ironclad, however. Many managers are not familiar with the details of the law, and people who experience discrimination often lack the resources to bring their case to court, says Susan G. Goldberg, a lawyer and clinical psychologist at Duquesne University. In practice, discrimination is difficult to prove: about 90 percent of plaintiffs who bring suits under the ADA lose their cases.

Researchers suggest that employees considering broaching a mental health concern should know what they hope to gain. If your work has started to suffer, disclosing a mental illness may help you explain the situation and get assistance. On the other hand, if you are getting along fine, offering this sensitive information is probably not worth the risk.

A critical consideration is the workplace climate. You can try to gauge your employer's response ahead of time by looking for certain signs. Those with a history of hiring people from diverse backgrounds may be more understanding. But supervisors may frown on your disclosure if you hold a job with stringent requirements, such as security clearance, as was the case for Dave.

Coming Out

If you decide to share your mental health status with your boss or human resources manager, consider doing so soon—but not immediately—after being hired. In most situations, experts suggest waiting six months to a year, after you have built relationships with your employer and colleagues. But do not delay too long. Although technically the ADA allows for disclosure anytime during employment, courts have been less inclined to see the employee's side if he or she is close to getting fired, Goldberg says.

Before telling your supervisor, sketch a script for the conversation. Experts suggest first highlighting your skills and abilities and coming prepared with specific adjustments that could improve your work even more. More important, decide how much you are going to divulge. If you are not comfortable getting into specifics, you can say you have a "medical condition" that causes you to need certain accommodations and leave it at that.

Some employers have begun opening up to mental illness. JPMorgan Chase, IBM and DuPont were early adopters of progressive mental health policies. DuPont, for instance, has a program called ICU Mental Health that encourages employees to notice signs of emotional distress and reach out to co-workers who might be having problems. In 2012, the year the program started, the number of employees using mental health services grew at least 15 to 20 percent. Last year shoe company Zappos implemented a similar program, called Right Direction, aimed at raising awareness about depression. If more companies start talking about mental health issues without judgment, more employees will feel comfortable seeking out behavioral health services and accommodations, Miller says. Ultimately, she adds, the changes would decrease disability costs and turnover.

HIGHLIGHT YOUR SKILLS AND COME PREPARED WITH SPECIFIC ADJUSTMENTS THAT **COULD IMPROVE YOUR WORK EVEN MORE.**

But the progress is uneven. Although the stigma of mental illness has lifted in some quarters, "I don't think it has changed for the vast majority of people who have significant mental health conditions," Goldberg says. Many employers still have a limited understanding of workplace mental health issues.

When Dave approached his supervisor about accommodations, including a potential transfer to a position where he could have less direct contact with other employees, he was met with some hostility. He felt his boss brushed his concerns aside, and in May he left the organization. Now he has a new job as a peer specialist counseling people who are currently dealing with similar mental health issues. He has told his supervisors about his post-traumatic stress disorder. "I know they're not going to judge me, because they have been through their own story," he says. M

FURTHER READING

- **Development and Preliminary Evaluation of a Decision Aid for Disclosure of Mental Illness to Employers.** Elaine Brohan et al. in *Patient Education and Counseling,* Vol. 94, No. 2, pages 238–242; February 2014.
- Job Accommodation Network: **https://askjan.org**

The Power of Reflection

Insight into our own thoughts, or metacognition, is key to high achievement in all domains

By Stephen M. Fleming

PHOTOGRAPHY & PHOTO ILLUSTRATION BY BRANDON HILL

Judith Keppel was a single question away from taking home £1 million. She was in the final round of a British quiz show, and she had to face one last challenge to become the show's first victor: "Which king was married to Eleanor of Aquitaine?"

After a brief discussion with the show's host, Chris Tarrant, she settled on Henry II. Then Tarrant asked her the killer question, the moment when contestants often agonize the most: "Final answer?" Without missing a beat, Keppel confirmed. The audience broke into cheers as it was revealed she had won.

Keppel did not waver on that November day in 2000 because of her metacognition. The term, coined by psychologist John Flavell in the 1970s, refers to our ability to evaluate our own thinking. Is the answer to a password prompt correct? Is a particular memory from childhood accurate? Will we find it easy or difficult to learn a new language? Metacognition is an internal tribunal that rules on the soundness of our mental representations, such as a memory or judgment. Keppel's metacognition gave her answer a resounding endorsement.

This knack for reflecting on our thoughts is often viewed as a hallmark of the human mind. It is also a vital survival skill. Metacognition is how we identify our limitations and compensate for them. A student who thinks she is unprepared for a chemistry exam, for example, can devote an extra evening to brushing up on atomic orbitals. When you set an alarm to remind yourself of something you suspect you will forget or make a to-do list to keep track of the day's activities, metacognition has stepped in to save you from your own deficiencies.

Metacognition is not only for spotting weakness. It also kicks in when you assess your strengths, such as when a new swimmer kicks off his floaties or a budding cyclist removes the training wheels. A person with accurate metacognition can move on to the next challenge as soon as she is ready, wasting no time in her journey to mastery.

Ultimately metacognition serves as a foundation for learning and success. When it is impaired, however, performance in school or at work may suffer. You become less able to recognize a bad decision and correct course. Several psychiatric disorders include deficits in metacognition, which can prevent individuals from identifying their own problems. But with new techniques to quantify metacognition in the laboratory and relate it to brain function, researchers are beginning to understand how metacognition works and why it might go awry. Centuries after Socrates counseled the average Athenian to "know thyself," psychologists are discovering the tools to do a better job of it—to train metacognition and to improve our judgments of our own abilities.

FAST FACTS

THINKING ABOUT THINKING

1. Metacognition is the ability to make judgments about our own thoughts—for example, assessing whether a memory is accurate or a decision is appropriate.
2. People vary in the accuracy of their metacognition. Certain psychological disorders, including dementia and schizophrenia, can impair this ability.
3. Several strategies appear to shore up metacognition, including meditation and taking breaks while studying to reflect on one's own learning.

The Metacognitive Mind

Reflecting on our own thoughts is as old as human civilization. The scientific study of it gained its first big boost from Sigmund Freud and his notion that a person's self-knowledge can be inaccurate, with a large portion of the human mind inaccessible to consciousness. He believed that with enough excavation, we could unearth the hidden forces guiding our actions, thus bringing our true beliefs into the light of consciousness. Yet psychologists soon realized that such analysis was unreliable, and pure introspection as a method for gaining insight into our own minds was gradually discarded.

Flavell, a longtime observer of child development, proposed that one aspect of introspection—metacognition—was key to educational success. In a test of memory, for example, he found that "older subjects studied for a while, said they were ready, and usually were," whereas "younger children studied for a while, said they were ready, and usually were not."

His observation hinted that as the brain matures, certain areas or networks might need to firm up in young minds for children to become better judges of their own learning. To study this idea in

The knack for reflecting on our own thoughts is often viewed as a hallmark of the human mind. It is also a vital survival skill.

the lab, however, researchers have had to grapple with a conundrum: how to test people's thoughts about their thoughts.

Because there are no obvious markers of metacognition, my colleagues and I use a shortcut. We measure individuals' confidence in a judgment and see whether their certitude was warranted. Examples of misplaced confidence crop up in daily life all the time. When an inexperienced cook decides it is a good idea to try out new recipes on a dozen friends but then burns the salmon, undercooks the paella and forgets to dress the salad, he or she might be demonstrating poor metacognition.

In my studies, the task is much simpler than pulling off a four-course meal. Participants sit in front of a computer screen and see two big circles flash briefly. The circles are filled with dots, and the goal is to decide which patch contains more dots. Most people find it pretty challenging. Getting the answer right is not what interests me here—I want to know how sure people are of their selections. Trial after trial, subjects pick circles and rate their faith in their answers, and eventually a pattern emerges. If your confidence is high only when you do well, and vice versa, your metacognition is in fine form. Similar test setups can quantify metacognition related to other aspects of behavior, such as learning and memory.

Using such experiments, my colleagues and I have found that metacognitive accuracy varies widely across the population. Some people have very poor insight into their own thinking, whereas others appear capable of excellent mental self-assessment. Yet it is important to note that a person's metacognitive prowess does not predict performance. You can have little concept of your own skill level but do a marvelous job of counting dots (or throwing dinner parties).

The Anatomy of Insight

Using the tools of contemporary neuroscience, scientists are now beginning to identify the brain mechanisms that govern metacognition. The first clues came from patients with a peculiar form of brain damage. In the mid-1980s neuroscientist Art Shimamura was a postdoctoral student working with Larry R. Squire of the University of California, San Diego. They were studying patients with amnesia, all of whom had damage to the hippocampus, a critical memory region, when they noticed an odd pattern in their data. Most of their patients had poor memory, as expected, but only some of them were aware of their problems with recall. The am-

nesic patients who were unaware of their deficits—they had poor metacognition—suffered from Korsakoff's syndrome, a disorder often associated with alcoholism. Patients with this condition not only become amnesic from an injured hippocampus, they also endure damage to the frontal lobe of the brain. That insight led Shimamura and Squire to suspect that metacognition is governed by the brain's frontal lobe.

To confirm their hunch, they needed to find patients with damaged frontal lobes but intact memory regions. Working with their colleague Jeri Janowsky, they found seven individuals with lesions to the frontal lobe and observed that their metacognition was indeed impaired: when the scientists showed them a list of sentences and asked them how likely they were to recognize those sentences later, the subjects made inaccurate predictions. Their memory for the sentences remained intact, however. These studies were the first to show that metacognition is an independent function of the brain and not simply part and parcel of everyday abilities.

The frontal lobe of the brain covers a vast swath of neural real estate, and my colleagues and I wanted to pinpoint the hubs of metacognition more precisely. Research we published in 2010 set out to do just that. In a study carried out with Rimona S. Weil, Geraint Rees and other colleagues at University College London, we briefly showed volunteers two images and asked them which one looked brighter. Then they reported how confident they were in their answer. After a series of trials, we calculated a metacognition score for every subject.

To rule out any differences in visual perception, we made sure our subjects were equally capable of identifying the brighter patch, which they did approximately 70 percent of the time. After we scored them, we scanned their brains and found that the people with better metacognition had more gray matter in the anterior prefrontal cortex (aPFC), a brain region toward the front of the frontal lobe that is disproportionately enlarged in humans as compared with other primates. Gray matter consists mostly of neuron cell bodies, as opposed to the white matter of slender axons, which extend from the cell body and transmit electrical impulses to other neurons. More metacognitive individuals also had denser white matter tracts connecting the aPFC to the rest of the brain.

Other brain-imaging studies have suggested that neural activity in the aPFC is more tightly correlated with confidence in people with better metacognition. In addition, zapping that general area with magnetic pulses, which temporarily interferes with the activity of neurons, has been found to impair subjects' metacognition without affecting other aspects of their perception or decision making.

Many of these studies quantify metacognition in highly artificial scenarios, and naturally my colleagues and I were curious whether the principles and brain regions we were identifying for simple judgments also play a role in more complex decisions. Together with neuroscientists Benedetto De Martino, Ray Dolan and Neil Garrett, all then at University College London, we designed a more lifelike experiment, albeit inside a brain scanner. We asked participants to decide which of two snacks they prefer, for example, Pringles versus KitKats. Then they told us how confident they felt that they had picked the superior food. After they climbed

THE AUTHOR

STEPHEN M. FLEMING is a cognitive neuroscientist who studies how the brain analyzes its own computations, or metacognition. He is currently a Sir Henry Wellcome Postdoctoral Fellow, based at both New York University and the University of Oxford.

out of the scanner, they reported how much they would be willing to pay for either snack, and again they rated their confidence, this time in the dollar amounts they had named.

This elaborate procedure helped us to tease apart the brain activity supporting our actions from the neural hubbub governing our thoughts about our actions. As it turned out, not everyone said they would pay more for the item they claimed to prefer—the seemingly logical response. Yet some individuals were more aware than others of their inconsistent behavior. As we reported in 2013, these individuals had stronger connectivity between a region of the brain involved in value computation and the aPFC. Although they did not always make optimal choices, at least they knew they were floundering.

We still have much to learn. For example, we do not yet know how the aPFC contributes to metacognition or why greater brain volume in this region leads to changes in insight. Yet these findings are a crucial first step toward identifying ways to shore up metacognition, whose absence can produce devastating effects.

Lack of Insight

When a person with a disorder is unaware of his or her impairments, clinicians use the term "anosognosia," from Greek roots meaning "without knowledge of disease." Patients with dementia, for instance, may not notice that their memory is

Metacognition in Mammals—and Machines

Is metacognition unique to humans? We cannot ask animals for a verbal judgment about their behavior, but ingenious animal-friendly tests can nonetheless probe whether other creatures form thoughts about their own thoughts.

In a pioneering experiment, psychologist David Smith of the University at Buffalo trained a dolphin named Natua to swim

Dolphins can be trained to report their confidence in their own judgments.

JOE RAEDLE *Getty Images*

toward one of two levers when he heard either a low- or high-pitched sound. When Natua answered correctly, he scored a fish. But some sounds were more difficult for him to distinguish. So Smith introduced a third lever, which triggered an easier trial and let Natua collect his fish. The dolphin learned to press this lever only on more difficult trials.

Smith reckoned that for Natua to choose the third lever, the dolphin must recognize the absence of knowledge and thus must be reflecting on how much he knows. Additional support for this conclusion came from observations that the longer the dolphin hesitated or wavered between the two response options, the more likely he was to choose the third lever. So his opt-out choices appeared to be based on bona fide feelings of uncertainty. As later experiments demonstrated, macaques also show similar metacognitive behaviors, but another species of monkey, capuchins, do not.

A different metacognition test mimics the confidence judgments we ask of humans in the lab. As in the dolphin experiment, an animal decides which of two answers it thinks is correct. Then it is given a chance to commit to that choice or go for a separate, safe option that always delivers a small snack. Betting on the original selection is riskier—it garners a larger treat if correct but no food otherwise. Macaques pass with flying colors: they take the riskier bet when they are more likely to be correct. The activity of neurons in the monkeys' frontal cortex also tracks their confidence, providing a window on how metacognition is implemented at the level of neural circuits. Even rats can learn to pass a version of this test.

Yet the evidence is not enough to conclude that animals have metacognition. For one thing, the anterior prefrontal cortex, a key brain area for human metacognition, is larger in humans than in monkeys and does not exist in rats. This anatomical difference does not necessarily eliminate the possibility of introspective rodents, because metacognition might have evolved in more than one form. It might manifest both as an implicit feeling of uncertainty that animals share with us, as well as the conscious self-knowledge that might be unique to humans.

Even some computers may embody a form of metacognition. When Watson, IBM's *Jeopardy*-playing machine, beat two champion human players in 2011, it relied on a skill very similar to human self-knowledge. Watson not only came up with answers but also generated a confidence rating for them. The supercomputer then used the rating to decide whether to hit the buzzer. As it turned out, Watson knew that it knew—it calculated a rating—faster than the human *Jeopardy* champs knew that they knew, giving IBM's machine the edge it needed to win. —*S.M.F.*

slipping away. As a result, they may not seek help, remember to take medications or recognize that they can no longer safely drive a car. Schizophrenia, addiction and stroke can also harm metacognition. A parent's or sibling's lack of insight into his or her own illness can be heartbreaking to a family, causing the shared reality on which social relationships are built to crumble.

Psychiatrists have traditionally believed that such patients were simply in denial. In this view, patients recognized their deficits but were reluctant to admit them to physicians and family members. Now, however, metacognitive failure is seen as a consequence of certain disorders. For instance, most alcoholics do not see their own drinking as problematic—even though they also believe that excessive drinking is unhealthy. As psychiatrist Rita Z. Goldstein and her colleagues wrote in 2009, "one of the greatest challenges in drug addiction treatment is that the individuals who require treatment do not even recognize the need for therapeutic help."

Whether metacognition and anosognosia are two sides of the same coin is not yet clear, although we do know they are closely related. Patients with schizophrenia who lack awareness of their illness, for example, tend to have a smaller frontal lobe than those who recognize their disorder—the same pattern seen in the healthy individuals with impaired metacognition mentioned earlier. (Because psychiatric illness has multiple effects on the brain, dysfunction in a network of brain regions most likely underpins anosognosia.)

We may learn that anosognosia is simply one kind of metacognitive failure. Recent studies hint that a person's capacity for introspection can differ across various domains; perhaps anosognosia is one such category. In support of this view, scientists have documented differences in the brain activity associated with metacognition of memory ("I doubt I'll remember to pay the rent tomorrow, so I better make a note to myself") and metacognition of perception ("Did I really spot an endangered Henslow's sparrow—or just another humdrum song sparrow?"). My collaborators at New York University and I have similarly found that individuals with damage to the aPFC struggle with perceptual metacognition but seem to have no trouble making accurate judgments of their memories. Uncovering the neural roots of different kinds of introspective failure will help researchers home in on therapies targeting anosognosia—and potentially help patients manage their ailments or seek treatment.

Because meditation involves consistent self-focus and the ability to zero in on your own mental states, it might also hone our self-appraisal abilities.

A Metacognitive Boost

Efforts to restore metacognition first began in the late 1990s. A small-scale trial looked into the effects of clozapine, an antipsychotic drug, on people with schizophrenia. The study found that patients' insight into clinical symptoms improved after six months of treatment. The medication also lifted their schizophrenic symptoms, so the researchers could not surmise which aspect of their recovery aided metacognition.

More recently, psychologist Robert Hester of the University of Melbourne in Australia and his colleagues found that methylphenidate (Ritalin) could enhance metacognition in healthy volunteers. In these experiments, subjects performed a difficult color-detection task under time pressure and noted whenever they thought they made an error—a metacognitive judgment. The participants given Ritalin—but not subjects given other drugs, such as citalopram, a common antidepressant—could consciously recognize more of their own errors.

Electrical brain stimulation might also serve to enhance metacognition. Using the same task, a team at Trinity College Dublin found that passing a weak electric current through the frontal cortex

of elderly volunteers increased their awareness of their own errors. These weak currents temporarily excite neurons, which may place the frontal lobe in a "primed" state that improves metacognition. But we are still a long way from understanding how drugs or brain stimulation may enhance our ability to reason about our own thoughts.

A more readily available way to improve self-judgments is through meditation. In a 2014 study led by psychologists Benjamin Baird and Jonathan W. Schooler of U.C. Santa Barbara, engaging in two weeks of meditation training increased metacognition during a memory test (but not during a task involving visual discrimination). Because meditation involves consistent self-focus and the ability to zero in on your own mental states, it might also hone our self-appraisal abilities. Indeed, other studies have found that meditation leads to changes in the structure, function and connectivity of the aPFC, raising the tantalizing possibility that such training induces neuroplasticity in brain circuits involved in both meditation and metacognition. But this idea remains speculative: no one has yet documented neural changes that persist after improvements in metacognition.

Simple psychological strategies can shore up metacognition in the classroom. In the early 1990s the late psychologist Thomas O. Nelson and his student John Dunlosky, then at the University of Washington, reported an intriguing effect. When volunteers were asked to reflect on how well they had learned a list of word pairs after a short delay, they were more self-aware than if asked immediately. Many studies have since replicated this finding. Encouraging a student to take a break before deciding how well he or she has studied for an upcoming test could aid learning in a simple but effective way.

Learners could also trigger better insight by coming up with their own subject keywords. Educational psychologist Keith Thiede of Boise State University and his colleagues found that asking students to generate a few words summarizing a particular topic led to greater metacognitive accuracy. The students then allocated their study time better by focusing on material that was less well understood.

Yet we might not always want to increase insight. In some scenarios, it might prove traumatic. A patient with Alzheimer's disease, for instance, may be troubled by an awareness of his failing memory. This and other ethical questions will need to be grappled with as the field of metacognitive neuroscience matures.

Through the lens of metacognition we experience our thoughts and feelings, but the focus of this lens is finely tuned and fragile. Overly distorted metacognition can lead to failures of self-knowledge and poor decision making. In extreme cases, such as in psychiatric disorders, a person may fail to connect with the shared social reality that others enjoy. Refocusing the lens may be the key to ameliorating some mysterious and devastating aspects of psychiatric illness. Through the marriage of cognitive neuroscience, psychology and computational models, the tools for doing so may soon be within our grasp. **M**

FURTHER READING

- **Metacognition.** John Dunlosky and Janet Metcalfe. Sage, 2009.
- **Relating Introspective Accuracy to Individual Differences in Brain Structure.** Stephen M. Fleming et al. in *Science,* Vol. 329, pages 1541–1543; September 17, 2010.
- **The Neural Basis of Metacognitive Ability.** Stephen M. Fleming and Raymond J. Dolan in *Philosophical Transactions of the Royal Society B,* Vol. 367, pages 1338–1349; May 19, 2012.
- **Domain-Specific Enhancement of Metacognitive Ability following Meditation Training.** Benjamin Baird, Michael D. Mrazek, Dawa T. Phillips and Jonathan W. Schooler in *Journal of Experimental Psychology: General*. Published online May 12, 2014.

From Our Archives

- **Being in the Now.** Amishi P. Jha; March/April 2013.
- **What Works, What Doesn't.** John Dunlosky et al.; September/October 2013.

LOVE AND DEATH

ONE FAMILY'S TRAGEDY UNDERSCORES THE PERILS OF CONCEALING ABUSE BY AN INTIMATE PARTNER

By Allison Bressler

During the early morning hours of September 9, 2002, Peter Clancy arrived at his house in upscale Cortlandt Manor, N.Y., armed with a large kitchen knife. He tried the garage, which did not respond to his opener, and then the front door, but the lock had been changed. So he picked up a chair from the deck and hurled it through a kitchen window.

Hearing the breaking glass, Debbie Clancy called the police and told them her husband had just broken into her house. Debbie then ordered her two young sons, ages nine and four, who had been asleep in her bed, to stay put. She grabbed a golf club and ran past the bedrooms of her other two sleeping children, a 10-year-old boy and seven-year-old girl. Facing Peter on the stairway, she turned, ran back to her bedroom and slammed the door, but Peter chased after her. With the knife in his hand, he approached Debbie and stabbed her in the stomach. Debbie fell onto the bed. While Debbie screamed and kicked, her

Crime scene photographs depict a side view of the Clancy home from above (left, center house), *its broken kitchen window* (middle) *and kitchen* (right).

children begged, "Stop! Stop!" Even the dog went after Peter, biting him in an attempt to protect Debbie. Debbie slid to the floor, where Peter stabbed her repeatedly with the knife—seven times, according to newspaper accounts. Debbie was still breathing, so Peter pinched her nose and mouth until she stopped.

Peter then lay down next to Debbie's body and waited for the police to arrive. "Why, Daddy?" the children sobbed. As the police rushed up the staircase, he took those moments to explain to his children why Mommy had to die.

I did not know Debora Riggs Clancy. I met the family the day of the funeral. As then the senior domestic violence counselor at the Northern Westchester Shelter, now named Hope's Door, I was there to provide emotional support, solace and perhaps insight to the family. It was the first domestic violence homicide in northern Westchester County I had ever heard of, and it stunned residents throughout the county. Unfortunately, I had entered the picture far too late.

Despite a decline in the rate of domestic violence in recent years, the problem remains widespread—and hugely significant. Between 2003 and 2012, intimate partners committed 15 percent of all violent crimes, according to the National Crime Victimization Survey (NCVS), conducted by the U.S. Department of Justice. In the NCVS for 2010, about 1 percent of females aged 18 to 49 reported being a victim of such crimes, which include rape, robbery, and sexual and other forms of assault by an intimate partner over the past year. Lifetime rates of serious violence between intimate partners are far higher. In a 2010 survey, the U.S. Centers for Disease Control and Prevention revealed that one in four women and one in seven men have at some point experienced severe violence—like being hit hard, beaten or slammed against something—by a current or former spouse or partner.

Short of death, the results of such altercations include brain injury, broken bones and hearing loss. The psychological fallout can be as brutal as the physical damage. Nearly half of victims suffer from depression, 64 percent suffer from post-traumatic stress disorder and 18 percent are suicidal, according to a 1999 statistical analysis by psychologist Jacqueline Golding of the University of California, San Francisco. Killings are not unheard of either. According to the U.S. Bureau of Justice Statistics, intimate partners committed 39 percent of the 3,032 homicides of females in 2010; the corresponding figure for the 10,878 male homicides was 3 percent.

Most fighting between couples is intermittent, triggered by disagreements about explosive topics such as money or sex. Both parties may be yelling, but because males tend to be more violent than females, a man is more likely to start a physical fight with a female partner, and his likely greater size and strength mean he can inflict far more damage. According to the NCVS, more than 80 percent of the victims of violence between intimate partners are female.

FAST FACTS

DANGEROUS LIAISONS

1. Between 2003 and 2012, intimate partners committed 15 percent of all violent crimes.
2. A woman is in greatest danger of serious assault or murder in the first months after she leaves an abusive partner.
3. Men who commit murders seemingly out of the blue are psychologically very similar to perpetrators with prior convictions.

PRECEDING PAGE: PHOTOGRAPH COURTESY OF DEBORA RIGGS'S FAMILY; THIS PAGE AND OPPOSITE PAGE: PHOTOGRAPHS COURTESY OF NEW YORK STATE POLICE, VIA FREEDOM OF INFORMATION LAW REQUEST

(Because of this gender gap, I use "she" to refer to the abused in this story.)

Partner violence does not always emerge from mutual combat but can, at times, represent a persistent, escalating and more calculated pattern of cruelty that males virtually always instigate. In one 2002 report, sociologist Michael S. Kimmel of Stony Brook University wrote that "the more systematic, persistent, and injurious type of violence … is overwhelmingly perpetuated by men.... More than 90% of this violence is perpetrated by men."

Debora Riggs Clancy was a victim of such relentless brutality. No amount of wealth or privilege could protect her from the psychological and societal forces that drove her husband's behavior. In fact, in some ways, as I later learned, the upscale town in which she lived made her situation particularly problematic.

"You're So Damn Stupid"

Debora Riggs met Peter Clancy when his family moved from England to quiet Throggs Neck, N.Y., when he was just a boy. Peter was three years older than Debbie, but they ran in the same circles. He was highly intelligent and surpassed all academic expectations. He was also a self-proclaimed know-it-all, which did not help him make close friendships. Debbie's mother, Joan DiNapoli, remembered Peter as an altar boy and honor student who looked like he had a promising future.

Debbie was outgoing; she loved animals and had a lot of friends. She was not always the best student and was drawn to Peter's self-confidence and intellect. At age 16, Debbie had her first boyfriend in Peter.

By outside accounts, Peter was the one in charge in their relationship. He had an opinion about virtually everything. He dictated how she wore her makeup and her hair. He was extremely jealous and would not allow Debbie to socialize without him, even with her own family. Over time, her friends became fewer as they tired of being around Peter and of telling Debbie how they felt about her boyfriend.

Peter's behavior often confused Debbie and made her doubt the relationship, Debbie's sister, Darlene Alberts, says. Yet Peter could be loving and kind, and Debbie had come to rely on him for direction. She convinced herself that he was just a very protective boyfriend who wanted the best for her. "How could he not, he loves me so much," she would say.

Indeed, Peter's actions may have perversely drawn Debbie closer to him. Since the 1980s researchers have acknowledged the possibility of "traumatic bonding," in which deep emotional attachments develop from two features of abusive relationships: a power imbalance and unpredictable shifts between warmth and malice. These dynamics keep a victim working ever harder to make her abuser happy, in hopes of earning a bit of kindness from him. Because she is told she is the cause of any relationship problems, she feels responsible for fixing them. As the pattern persists, it begins to seem normal, and the ties between abuser and victim grow stronger. As if to fortify this bond, Peter defended his actions with statements of

Peter then lay down next to Debbie's body and waited for the police to arrive. "Why, Daddy?" the children sobbed.

Because Peter had to focus on his studies, Debbie took a job 10 miles from their home. Peter bought a car to drive the three miles to school and gave his new wife a bike.

love, insisting he had Debbie's best interests at heart. He would remind Debbie that he was in her life to help make her better. Without him, he added, she would go nowhere.

In reality, such toxic treatment by male partners is not motivated by love so much as insecurity and a need for power and control. Such men "only feel secure if someone else is less secure," says psychiatrist Rahn Kennedy Bailey of Meharry Medical College, who has treated many victims of intimate partner violence. Peter's attempts to isolate Debbie from her friends and family deepened her insecurity. Demeaning comments are another common means of putting a partner in her place and consolidating power. According to Darlene, Peter repeatedly told Debbie she was "stupid and brainless." (Later, after her pregnancies, she was a "lard-ass.")

After high school, Peter lived with Debbie in a low-income apartment owned by his family in a rough section of the Bronx. While Peter was attending Manhattan College to become a civil engineer, Debbie took a job to bring in what money she could. After graduation, Peter decided to change careers and attend graduate school. He was accepted to Harvard Business School, an achievement that made it easy for him to convince Debbie they would have a wonderful future together.

According to Darlene, in June 1983 the couple wed and moved to Boston. Because Peter had to focus on his studies, Debbie took a job as a secretary 10 miles from their home. Peter bought a car to drive the three miles to school and gave Debbie a bike. Even in rain or snow, Debbie biked to and from work. She handed Peter her paychecks. When Darlene expressed concern over this arrangement, Debbie said, "He is focused on making our family better. It is my job to support him."

"He bossed her around constantly," Darlene remembers. "I suspected that she did as she was told so as to avoid his wrath." Hearing of her disapproval, Peter claimed his sister-in-law was jealous of their happiness and trying to break up the marriage.

After Peter finished school, they moved to New York City. Debbie wanted to be a chef and began taking classes at a local culinary school while Peter got his first job in banking. Although Peter did not like her new freedom, he occasionally helped her with her schoolwork. Darlene was happy that her sister was getting out more, but she remained wary of her brother-in-law. One night when Darlene and her husband, Larry Alberts, were visiting Debbie and Peter, Darlene and Larry watched Peter slap Debbie across the face for not understanding an assignment. "You're so damn stupid!" he yelled in disgust. Deeply shaken, Darlene spoke to her sister in another room. Debbie admitted this was not the first time Peter had hit her.

Darlene remembers that the emotional and physical assaults had started to wear on Debbie. Her new friends at culinary school helped her realize that her relationship was not normal. She also knew that despite the classes Peter was paying for, he was too controlling to actually allow her to become a chef. They had a more basic conflict, too: Peter did not want children, and she did. She told Darlene that she wanted to meet someone new and have a family. She left their home and stayed with a friend.

The separation lasted one month. Peter told Debbie he could not live without her. He promised to work on their marriage and agreed to have a family.

No One Is Protected

Peter secured a high-level position at Barclays. He and Debbie purchased a large, four-bedroom colonial home in picturesque Cortlandt Manor. By 1998 they had four children. Debbie was very involved with her children and their schooling. On weekends, Peter would take the older kids off on ski adventures. They drove a big, expensive truck to shuffle the kids around to their many activi-

THE AUTHOR

ALLISON BRESSLER has been a domestic violence advocate, counselor, hotline worker, outreach coordinator and program director for 15 years. She has devoted her career to empowering victims of abuse and educating first responders as co-founder of A Partnership for Change, a New Jersey–based nonprofit (www.apartnershipforchange.org).

ties. Beneath the veneer of normalcy, however, Peter's reign continued.

Although Debbie had to run the household day to day, Peter devised clever ways to micromanage her, many of them involving finances. He provided Debbie with money, but it did not always cover expenses. It was not unusual for Debbie to knock on her neighbor Eileen's door to borrow $10 or $20 for milk or other essentials for the kids. Peter paid close attention to what she spent. When Debbie bought clothes or toys for the kids, she would often ask her sister to say the purchases were gifts from her so Debbie would not get in trouble. If the items had not been on sale, Peter would become enraged. Debbie told Eileen that one time Peter ignored his crying children as he snatched the kids' favorite Lunchables off their plates, insisting Debbie return them because they had been too expensive. And, of course, major purchases, such as the house and cars, were made in Peter's name.

They lived on two acres of land in a neighborhood where virtually all residents hired others to maintain very large lawns. Not Peter. He did not want to spend money on a lawn service, so he bought Debbie a tractor. Neighbors watched as Debbie weeded and mowed the vast expanse of grass each week. Sometimes she would ask Eileen's husband to help her move the heavy backyard furniture, which included tables, chairs and a 150-pound trampoline. When asked why she did not hire someone, she would reply with a smile, "I don't mind."

Peter also regulated activities that were essentially free. According to Larry, Peter told Debbie what television shows he considered unsuitable for her or their children, disapproving of those depicting families of lower socioeconomic status because they might lead Debbie and the kids to pick up unseemly habits. For similar reasons, he tried to make sure his kids socialized only with other kids of their same social class or educational pedigree.

Wealth is often seen as a shield against domestic abuse, and an increased risk of intimate partner violence is indeed one of the many perils of poverty. When the World Health Organization surveyed 19,517 women from 10 countries who had partners, they found that high socioeconomic status and educational attainment generally protect women from domestic abuse. In a separate analysis of U.S. couples published in 2002, a team led by epidemiologist Carol B. Cunradi of the Pacific Institute for Research and Evaluation found that, out of all the factors investigated, low annual household income was the strongest predictor of intimate partner violence.

Yet the ranks of victims include people from all walks of life—blue collar, middle class and wealthy—and so do the batterers. I have worked with close to 1,000 victims through nonprofits and in my private practice, in which the vast majority of my clients are well-to-do, educated white women. (In my experience, wealthier victims tend to turn to private therapists; they often question whether social service and domestic violence agencies are for them.) In short, abuse can happen to anyone. No one is protected.

"Why Do You Stay?"

In Cortlandt Manor, the Clancys were seen as a respectable family. No one heard yelling coming from their home. Peter was a quiet, educated man who wore a suit. Other men on the block found him to be reserved but nice, although he did not form close friendships.

Families on their quiet cul-de-sac would gather on Friday nights at Eileen's home for pizza, but the Clancys never joined them. Sometimes Debbie would stop by but quickly leave, saying she had

WHEN SOMEONE NEEDS YOUR HELP

If you know someone in an abusive relationship, you could be that person's lifeline. Here is what to do.

—A.B.

1. Be specific when discussing what signs you have seen or behaviors you have witnessed that raise red flags.
2. Let her know that she is not alone and that professional agencies exist to help women like her.
3. Express your concern for her safety but do not judge her. Listen.
4. Ask how you can help.
5. Stay away from statements suggesting she might be partly to blame. Do not ask, "Why don't you just leave?" or say, "Don't do anything to make him mad."
6. Ask open-ended questions such as "What behaviors does your partner display that show you he does or does not love and care for you?" Such inquiries lead a victim to gain some clarity about the situation.
7. Be supportive but do not pressure the victim. Let her make decisions at her own pace. She should guide the process and decide when to leave because she knows her batterer best.
8. Go to the Web site of the National Coalition Against Domestic Violence and obtain the phone number for the domestic violence coalition in your state and county (www.ncadv.org/resources/StateCoalitionList.php). Alternatively, urge her to contact the National Domestic Violence Hotline at 1-800-799-SAFE, which provides crisis counseling and safety planning, as well as referrals to local hotlines and agencies.
9. Offer to sit with her while she calls a hotline or to accompany her to an initial appointment.
10. Direct her to the tips for safety planning on page 47.

Debbie and Peter on vacation in Florida in 1988.

to get back. They did not socialize as a couple with the neighbors.

Eileen and another neighbor, Fran, eventually befriended Debbie, and they began witnessing some odd behaviors. When the kids clogged a toilet with a toy or sent a baseball through a window, Debbie would call one of these women, panic in her voice, and beg her to send her husband to fix the problem before Peter got home from work. Many evenings Debbie asked Eileen to keep an eye on her children playing outside while she went inside to change her clothes and put on makeup because Peter expected her to "look nice" on his arrival. Debbie often asked Eileen if she could put her trash in Eileen's cans because Peter looked through their garbage in hopes of finding evidence of purchases for which he could scold Debbie.

As word got around about these unusual requests, neighbors speculated about their cause. Many assumed Debbie was simply odd or troubled. Debbie knew she was being discussed, but she was afraid that if anything negative got back to Peter, he would further isolate the family. She also feared the truth would ostracize her and her family even more. Eventually, however, she began to reveal small bits of information. For example, on three or four occasions, she said she had worn long sleeves to cover up bruises on her arms from Peter grabbing her tightly. At first Eileen and Fran thought the stories were embellished. They could not picture Peter being violent in any way.

But Debbie's accounts became increasingly frightening. During one argument, she told both Eileen and Fran, Peter threw her to the floor and repeatedly slammed her head on the hard tile, only stopping when he mistook spilled jelly for blood. They heard Debbie say, "Pete's gonna kill me one day." Eileen and Fran asked, "Why do you stay?"

Many of my clients get this question. Leaving the relationship may seem like the obvious choice—if you are not the one in it. Consider having to leave your partner today. Where would you go? Imagine now that you had no access to your finances and no income of your own. Many victims of intimate partner violence are so financially controlled that the thought of leaving is overwhelming. And consider the impact of tearing your children away from their home, school and community.

Women also typically feel intense pressure to keep a family whole. If a woman cannot manage that, no matter the reason, she may blame herself. As a result, many women decide to keep their family unit together while they try to figure out how to improve things. Especially when emotional abuse has not escalated to physical assault, victims may not see it as abuse; they feel they just need to work harder at their marriage.

Children may also be used as weapons. When they argued, Peter often told Debbie that if she left him, he would take

SIGNS SOMEONE YOU KNOW MAY BE ABUSED

- You often see bruising on her, and when you inquire, she often attributes the wound to walking into something or otherwise accidentally injuring herself.
- She always seems to ask for her partner's permission to do anything.
- You notice that she is frequently "checking in" with her partner and justifying her whereabouts.
- She seems timid or slow to respond to questions in the presence of her partner.
- She is not allowed to socialize with someone of the opposite sex or even be alone with same-sex friends.
- She often justifies a partner's rude or nasty behavior.
- She questions healthy relationship behaviors in others. She may say, "Your spouse doesn't mind that you have a male friend?" or "You're allowed to just make plans without permission from your partner?"
- She talks about her partner's extreme jealousy.
- Her phone rings excessively, and it is always the partner.
- She continually makes excuses to family members and friends for not seeing them.

—*A.B.*

PHOTOGRAPH COURTESY OF DEBORA RIGGS'S FAMILY

the children and she would never see them again. She had no reason to doubt him. He had the power, and he had routinely followed through on his promises.

On top of all those obstacles and pressures, there is one more horrible truth for a woman in Debbie's position: if she leaves, her husband becomes more dangerous than ever. In cases such as this one, violence is the response to a perceived loss of control. "The use of violence may indicate not the experience of control but the experience of loss of control," Kimmel wrote in his 2002 review. He highlighted three antecedents of men's use of violence: "their sexual jealousy, their perception that the women failed to perform a household task such as cleaning or preparing a hot meal, and women's challenging the men's authority on financial matters. All of these are indicators of a breakdown of men's expected dominance and control."

When a woman leaves, the man's control over her drops precipitously—so the risk of violence rises in tandem. According to the WHO, a woman's chances of being murdered by her partner escalate significantly around the time she tries to escape. For good reason, then, many of my clients are more fearful of navigating life without their partner than with him.

Exactly 14 Days

Eileen, Fran, Darlene and Larry were worried about what they were observing. "After years of seeing this, we knew she was abused; we knew she was battered; we knew she was scared, but we did not know what to do," Fran says. "She was so sad and distraught, but she just continually told us he would take her children and she would never see them again."

Despite such concerns, no one dared to say the words "domestic violence." Domestic violence did not happen in their cozy town where the crime rate was so low that they did not even have their own police department. But did Debbie know? So many women, even after they have been physically assaulted, do not believe it is domestic violence. Often they think of their partner as uncaring and selfish, maybe even downright mean. Most people do not consider themselves victims, especially not of someone they have known for most of their lives.

Debbie, Peter and the kids had happy times. Holidays, weekends away and some "good" days were filled with joy for Debbie. But she hid a deep sadness and became increasingly debilitated by frequent and severe migraines, which may have been a somatic response to her emotional pain.

Meanwhile Debbie's assigned chores mounted. She had to maintain not just the inside but also the outside of the home—say, fixing the deck if a step broke. On winter mornings she got up early to clean off and heat Peter's car for him. She cleaned and professionally pressed his laundry with the equipment he purchased for her because he would not pay for dry cleaning. She even drove to the train station he walked in and out of daily to purchase his monthly tickets because he felt he should not be bothered with the task.

Even more disturbingly, she had to sexually please him even if she was sick or just plain exhausted, she told Darlene. It was easier to give in and do it rather than be berated half the night because she would not. The thought of sex made Debbie physically sick.

Debbie even brought Peter to marriage counseling in the hope that someone else would tell him his behavior was not okay. No one informed her that in cases of intimate partner violence, marriage counseling is not recommended. Because of the power imbalance, the abuser would likely punish the victim if she disclosed too much about their marriage. Knowledgeable therapists who see such cases will refuse to offer couples counseling and suggest seeing each partner separately.

Debbie did not contact a domestic violence agency. Women of means often do not think "those" types of services are for them, believing social service agencies are strictly for low-income women who cannot afford private therapists. But in fact, domestic violence agencies provide counseling to anyone being victimized in their relationship, whereas many private therapists lack training in violence between partners. When a private therapist deems what amounts to abuse a "couples issue," for example, the victim may end up in greater danger.

Debbie was trapped in fear. Her migraines worsened. Peter had been badgering her about her expenditures and kept insisting that she show him her

Most people do not consider themselves victims, especially not of someone they have known for most of their lives.

A neighbor recalled seeing Peter's car return to the house later that day, a violation of the order of protection for which he could have been arrested.

receipts and financial books, Darlene recalls. To her sister, Debbie repeated the promise he made to her that she felt he might keep: "If you don't produce them for me when I get home," Peter reportedly said, "you're dead."

After 25 years under Peter's control, Debbie told her mother she wanted a divorce. Her mother had not been completely blind to the abuse but did not know its extent. Debbie planned to apply for the order of protection that she had been told about when she called a local victim service hotline.

At the White Plains courthouse, she filed a petition for a temporary order of protection and described to a judge the emotional, verbal, sexual, financial and physical abuse she had endured. According to the judge's ruling, Peter would have to stay away from their home, except for his court-ordered visitation with the children, whom he would have to pick up and drop off at curbside. He could not contact Debbie in any way. As the order was being served, in late August 2002, Debbie stayed with the kids at Darlene and Larry's home while police officers waited for Peter to gather his belongings from the Clancy residence and leave.

Debbie finally had freedom. Eileen and Fran, as well as Darlene, say they had never seen her so happy. She could come and go as she pleased, not worrying if one of the kids clogged the toilet or broke a pane of glass. Peter went to the Bronx to stay with a family member. Although he called Debbie, begging her to take him back, and contacted both Darlene and Larry, pleading with them to "talk some sense" into Debbie, Debbie did not budge. She smiled, socialized with her neighbors and made her own decisions for exactly 14 days.

Unraveling

Meanwhile Peter had been doggedly digging up information about Debbie: "… he apparently became increasingly obsessed with his wife's activities, but, seemed to primarily focus on gathering information to 'present evidence in order to acquire custody of the children,'" according to a psychiatric evaluation requested by Peter's attorney. Like many abusers, Peter believed he was the victim. Based on comments he received from a friend and a sister, among others, Peter became increasingly concerned that Debbie had been having extramarital affairs. He also believed she was a drug addict and had been hurting the children by exposing them to unhealthy behaviors. (Darlene acknowledges that Debbie did become dependent on prescription painkillers after years of debilitating migraines.) Peter later detailed these transgressions to justify the fatal stabbing to his children in its immediate aftermath.

Meanwhile Peter minimized his own aggression toward his wife. To a worker with child protective services, for example, he admitted to only striking his wife three years ago, according to the psychiatric evaluation. Another time, he recalled kicking Debbie but implied that little harm was done. "She said that I broke her pelvis when I kicked her, but she never went to a doctor," he was quoted as saying in the document.

Having left Peter, Debbie was in great danger. Exactly what measures Debbie took to protect herself and her family—or whether she was even aware of the danger—is unclear. When Debbie obtained her order of protection, an advocate from the court should have alerted her to the heightened threat and discussed a safety plan. Debbie should have told neighbors to call the police if they ever saw Peter around aside from the drop-off and pick-up times for the kids. She should have given the kids passwords that, when spoken, meant: hide in the home or at a neighbor's. She should have been told about safe and confidential shelters. All we know is that she changed the locks to the house.

On September 8, 2002, Peter picked up the kids and dropped them off as instructed. A neighbor recalled seeing Peter's car return to the house later that day, a violation of the order of protection for which he could have been arrested. But a neighbor who has not been informed of the provisions of the order will not know to call the police.

The next day, when word got out about the murder, the town was in shock. Often when someone perceived as normal commits a violent crime, the community concludes that a sane person has somehow "snapped." Instead, as Peter Clancy's story reveals, the truth is more complex. In 2009 criminologists Rebecca E. and Russell P. Dobash, both at the University of Manchester, with their col-

league the late Kate Cavanagh of the University of Stirling in England, found that men who commit these seemingly out-of-the-blue murders are psychologically very similar to perpetrators with prior convictions. Men in both groups display possessiveness, jealousy, and lack of empathy or remorse. According to Bailey, abusive men also often suffer from chronic excessiveness in their behavior, along with extremely poor judgment and impulse control. Thus, even in acts of passion that seem to come from nowhere, a worrisome personal history most likely exists. In Peter's case, of course, many of the signs had been there for a long time.

Dangers of Discretion

In all the years of abuse, the police never visited the Clancy home until the day they served Peter with the order of protection. According to the latest NCVS, only about half of all incidents of partner violence are reported to the police, although data from European countries indicate that reporting is much lower, at 14 percent. My 15 years as a domestic violence counselor, advocate and program director suggest that middle- or upper-class victims may be especially reluctant to share what is happening to them. In affluent neighborhoods, airing "dirty laundry" in public is a powerful deterrent. Unlike in communities where crime is pervasive, the arrival of a police car on a well-heeled block brings residents out to the ends of their driveways to discuss what might have happened.

No matter where they live, however, people have reasons for not wanting to call the police on their partners. Victims want the violence to stop; they generally do not want a partner arrested. Although officers may sometimes simply break up a fight and defuse the situation, an arrest is not an unlikely consequence of summoning them. In New Jersey, the police must issue an arrest if there is any physi-

STEPS TO SAFETY

Leaving an abusive relationship is the most dangerous time for a victim. But all victims, whether living with an abuser or preparing to leave, need a plan to protect themselves and their family. Here are some safety tips I give to the women I counsel. —*A.B.*

IN THE HOME

- If an argument seems unavoidable, try to have it in a room or area with an exit and not in the bathroom, kitchen or anywhere near dangerous instruments or weapons.
- Practice how to get out of your home safely. Identify which windows, elevators or stairs would be best.
- Have a packed bag ready and keep it in a secret but accessible place so you can leave quickly.
- Identify a neighbor you can tell about the violence and ask that person to call the police if a disturbance is heard coming from your home.
- Devise a code word to use with your children, family, friends and neighbors when you need the police.
- Decide and plan where you will go if you leave home (even if you do not think you will need to).

PREPARING TO LEAVE

- Determine who will let you stay with them or lend you some money.
- Always try to take your children with you or make arrangements to leave them with someone safe.
- Leave money, clothes, extra keys and copies of important documents with someone you trust.
- Open a savings account in your own name to establish and increase your financial independence.
- Program phone numbers for shelters into your mobile phone.
- Review your safety plan with a domestic violence advocate to devise the safest way to leave your abuser.

AFTER A SEPARATION: ON THE JOB AND IN PUBLIC

- At work, decide whom you will tell about your situation. Include office or building security. Provide a picture of your abuser if possible.
- Arrange to have someone, a receptionist, say, screen your telephone calls at work, if possible.
- Have someone escort you to your car, bus or train. Use a variety of routes to go home, if possible. Think about what you would do if something happened while going home.
- If you have a restraining order (termed an "order of protection" or "protection from abuse" in some states), make sure that all the people in charge of the institutions you and your children frequent have a copy. These may include security at work, your boss, the school principal and the director of a child's day care center.
- Inform your neighbors and landlord that your partner no longer lives with you and that they should call the police if they see your abuser near your home.
- Change or add locks on your doors and windows as soon as possible.

Her story was poignant to me because Debbie seemed like the girl next door. She was the soccer mom, the Cub Scout leader, the school cafeteria volunteer.

cal sign of assault—from a scratch to a broken bone. Even reports of joint pain may be sufficient cause. In addition to an arrest of a spouse, victims fear that social services will remove the children from both parents if police detect abuse. Unfortunately, that worry is not unfounded.

Police may sometimes do too little rather than too much. Officers entering a million-dollar home can be manipulated into thinking that a cry for help was a false alarm or an overreaction. They may thus leave a true victim in peril.

My agency trains police and other possible first responders such as school clinicians, social service workers and health care workers to spot abuse in its various forms—emotional, verbal, sexual, financial and physical—and to differentiate between an occasional fight or hurtful comment and an escalating pattern of cruelty. Properly trained, these individuals can provide support and direct victims to agencies that offer counseling until they are ready to take legal action.

Ideally, a victim who is living in fear but is not in immediate danger will call a counselor at a domestic violence agency. The counselor can help her evaluate the situation and decide on a course of action. If she decides to leave the relationship, a legal advocate will accompany her to the courthouse to get a restraining order, and the counselor can help her devise a safety plan. From there, the agency may secure other needed services such as counseling, career support services, children's counseling, legal help and possibly shelter. In Massachusetts and elsewhere, domestic violence high-risk teams serve as alternatives to shelters, setting up protections for victims in their own communities. These multidisciplinary groups consist of police department representatives, domestic violence counselors, parole officers and others. They assess the risk of each situation and take precautions—such as monitoring a home, confiscating weapons, suspending child visitations and extending sentences—to keep a victim safe. The program has had astounding success in reducing the homicide rate from domestic violence.

Even after more than a decade, Debora Riggs Clancy's family still struggles with the horror of how she was made to live and eventually die. I pieced together her history from legal documents and extensive interviews with members of her family, her neighbors and the attorneys involved with the case. Her story was poignant to me because Debbie seemed like the girl next door. She was the soccer mom, the Cub Scout leader, the school cafeteria volunteer. Her death changed how I looked at my own community. On the day of the funeral, I thought about how she would never celebrate a birthday with her family as I would that very day with mine. I wish often that I could go back in time and talk to Debbie about what had been happening to her. I would have told her that Peter's behavior toward her wasn't her fault and that she had a right to be treated with respect. Most of all, I would like to think I could have helped her get out of the relationship safely.

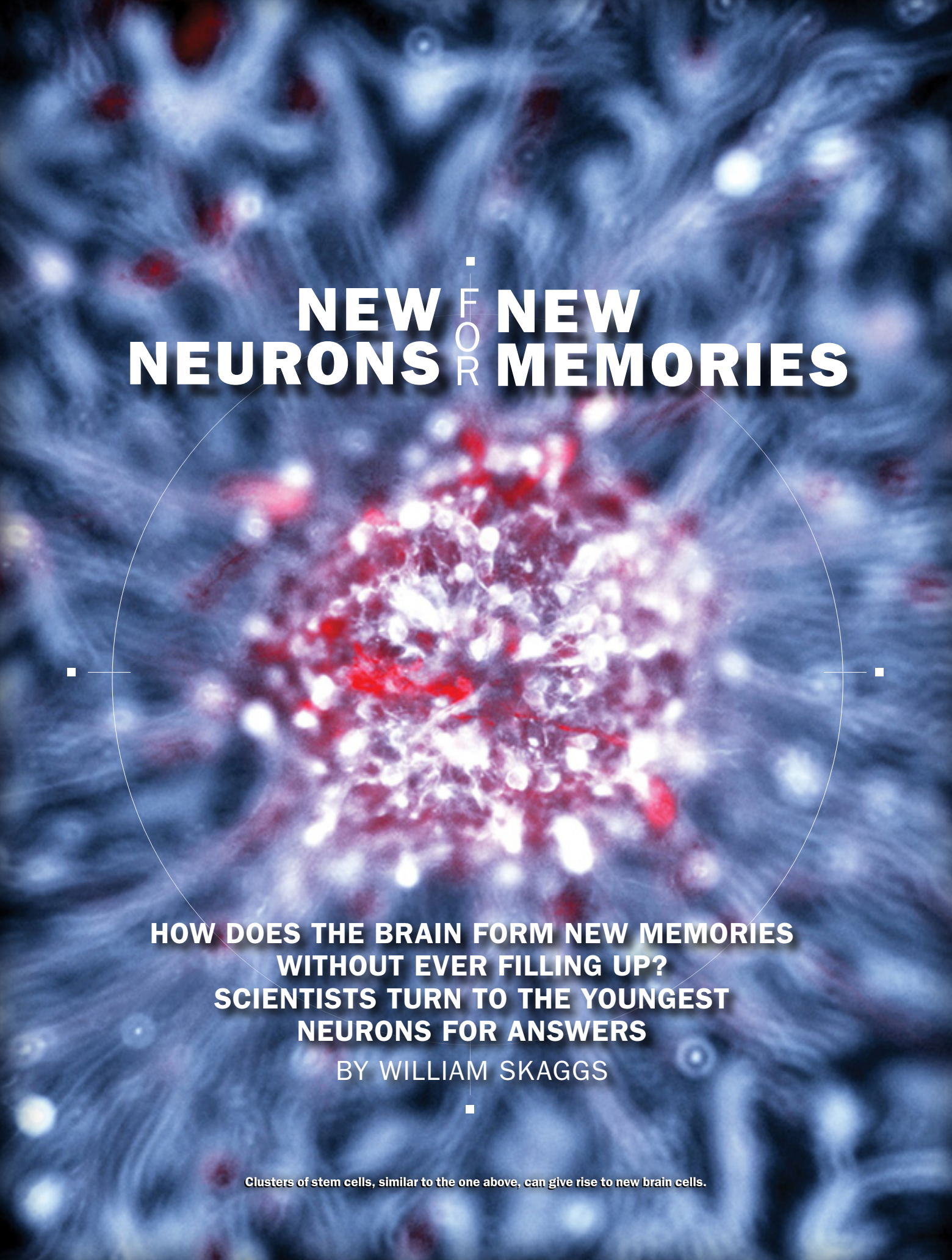
For his part, Peter pled guilty to second-degree murder and is serving a sentence of 20 years to life at Downstate Correctional Facility in Fishkill, N.Y. M

FURTHER READING

- **"Gender Symmetry" in Domestic Violence: A Substantive and Methodological Research Review.** Michael S. Kimmel in *Violence against Women,* Vol. 8, No. 11, pages 1332–1363; November 2002.
- **"Out of the Blue": Men who Murder an Intimate Partner.** R. Emerson Dobash, Russell P. Dobash and Kate Cavanagh in *Feminist Criminology,* Vol. 4, No. 3, pages 194–225; July 2009.
- **What Factors Are Associated with Recent Intimate Partner Violence? Findings from the WHO Multi-country Study on Women's Health and Domestic Violence.** Tanya Abramsky et al. in *BioMedCentral Public Health,* Vol. 11, Article No. 109; February 16, 2011.
- **A Raised Hand: Can a New Approach Curb Domestic Homicide?** Rachel Louise Snyder in *New Yorker,* pages 34–41; July 22, 2013.
- **Nonfatal Domestic Violence, 2003–2012.** Jennifer L. Truman and Rachel E. Morgan. U.S. Department of Justice, Office of Justice Programs, Bureau of Justice Statistics, April 2014.

From Our Archives

- **The Thin Line between Love and Wrath.** Eli J. Finkel and Caitlin W. Duffy; November/December 2013.

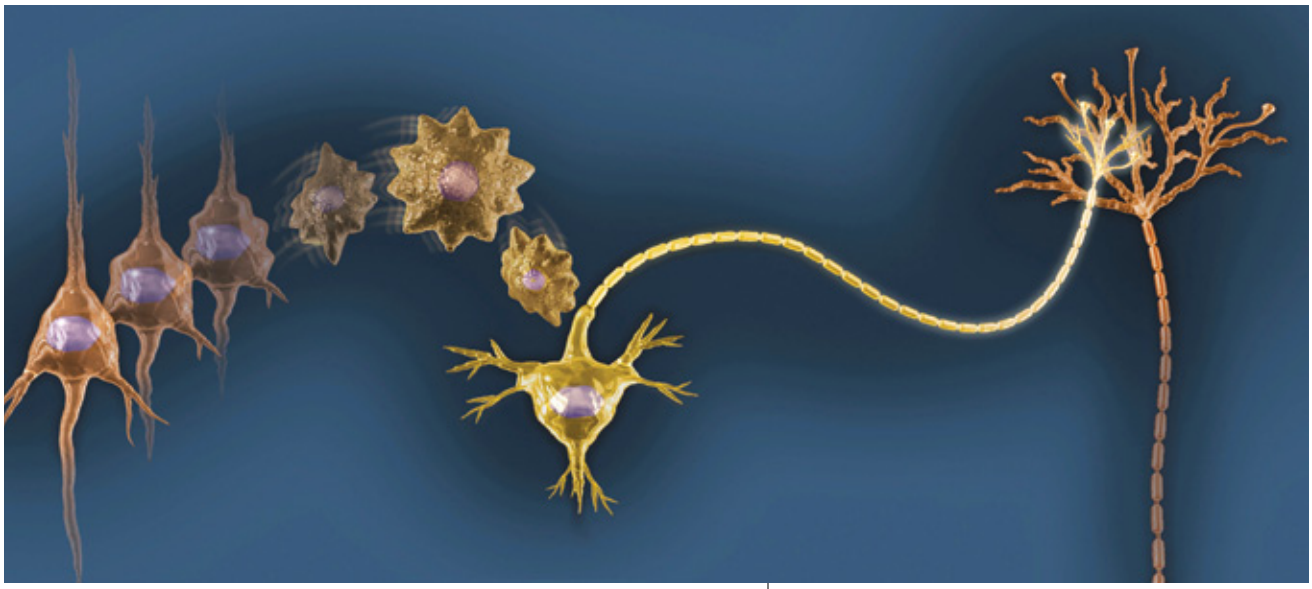


NEW NEURONS FOR NEW MEMORIES

HOW DOES THE BRAIN FORM NEW MEMORIES WITHOUT EVER FILLING UP? SCIENTISTS TURN TO THE YOUNGEST NEURONS FOR ANSWERS

BY WILLIAM SKAGGS

Clusters of stem cells, similar to the one above, can give rise to new brain cells.



The brain's stem cells (*far left*) can develop into neurons (*center*). These new nerve cells extend their connections, reaching out to other neurons in the brain (*right*).

For many years scientists believed that you were born with all the neurons you would ever get. The evidence for this dogma seemed strong: neuroanatomists in the early 20th century had identified immature neurons under the microscope but only in the brains of mammalian embryos and fetuses, never after birth.

We now know that the truth is not quite so simple. By radioactively labeling DNA, researchers gradually began to find exceptions to the rule against new neurons in the adult brain. Today scientists have identified two small regions where neurogenesis, or the birth of new neurons, continues throughout life: the olfactory bulb and the hippocampus. The former area is part of the brain's odor-discrimination system, so neurons there likely participate in this process. But the hippocampus has a much broader function. It gives us memory.

The discovery of nascent neurons in the adult human hippocampus, first reported in 1998, came as a surprise to many in the field. Although sprouting new brain cells may sound useful, the costs are potentially high. After all, space within the skull is finite, and newcomers could disrupt the delicate neural networks that store knowledge.

Neuroscientists now suspect that neurons born in the hippocampus help the brain create and sift through the millions of memories we form over the course of a lifetime. If this is true, neurogenesis might solve a puzzle that has perplexed memory researchers for more than 60 years: how our brain keeps separate memories of similar events. These discoveries may ultimately reveal not only how we recall the episodes of our lives but also how we can preserve our brain's powerful record-keeping faculties despite the inevitable decline of aging.

FAST FACTS

EXPANDING MEMORY'S STORES

1. Neurogenesis, or the growth of new neurons, occurs in two regions of the adult brain: the hippocampus and the olfactory bulb.
2. Researchers suspect that the new brain cells in the hippocampus facilitate the storage and separation of memories.
3. Experimental evidence supports the idea that new neurons aid in creating memories, whereas older neurons help you recall earlier episodes.

Making Memories

In 1949 Canadian psychologist Donald O. Hebb proposed a theory of memory that would come to dominate the field. Hebb suggested that each neuron in the cerebral cortex, the brain's large outer layer essential to thought and intelligence, encodes some feature of the world and becomes active whenever that feature is present. He also noted that every brain cell is connected to many others by links called synapses. His idea was that we encode memories by creating alliances between groups of neurons. When two connected neurons are active at the same time, the synapses holding them together grow stronger. In other words, "cells that fire together wire together."

To understand how this works, imagine how a memory might map onto a set of interconnected neurons. Say you take a trip every summer. On one occasion, you pack your backpack for a journey to the mountains, including your favorite book. The

PRECEDING PAGE: HENNING DALHOFF *Science Source*; THIS PAGE: RICCARDO CASSIANI-INGONI *Science Source*

features of the event—backpack, mountains, book—will each map onto separate neurons in the cortex. As you unpack the book at your alpine campsite one evening, those neurons fire together, bolstering the connections between the three elements and thereby storing the memory.

In reality, the brain uses far more than three neurons and their connections to encode memories, but the principle is the same. If any one of the neurons in the stored memory were to become active later, an electrical impulse would propagate to the other cells in that network. As a result, the neurons representing all three features would fire, encoding the full memory. This process, called pattern completion, is the way that memories are retrieved, according to Hebb's theory. It explains how merely glimpsing the backpack after the trip can conjure up mountain vistas in your mind's eye.

Yet this explanation of memory has a problem: What happens when features from different memories overlap? Suppose, for example, that on a second summer vacation you pack the same backpack, but this time with a newspaper for a trip to the beach. For this memory to be stored, neurons relevant to the backpack, beach and newspaper will need to connect. When you recall the episode, the attempt to perform pattern completion will activate the backpack neuron and send a burst of activity through both sets of connections. The memories of the two trips would become conflated. This phenomenon is known as interference. It is an inevitable consequence of Hebb's hypothesis and is not easy to fix.

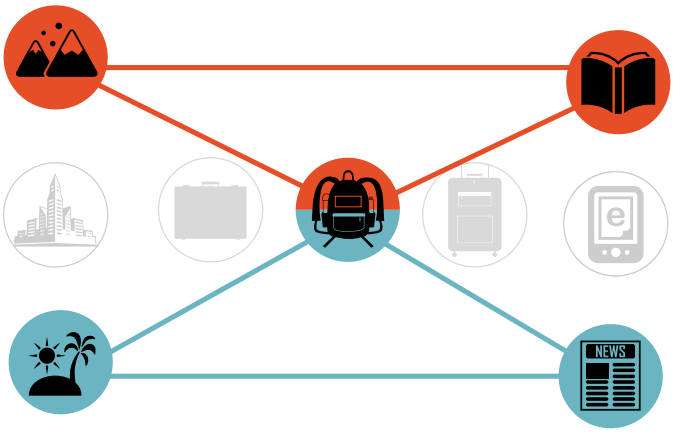
Neuroscientists have spent decades devising ways around the interference problem. One simple solution is to minimize the number of shared features in the memories to be stored. The most straightforward way of doing that is to use features that are very specific. For example, instead of just storing the memory of a book in your backpack, you mentally classify it as a copy of James Joyce's *Ulysses* and the newspaper from the beach trip as the *New York Times*.

Yet this work-around has its drawbacks. The brain learns about the world by detecting patterns: consistent relations among sets of features. For example, you may come to appreciate sunblock after sustaining multiple burns on beach trips in which you neglected to pack

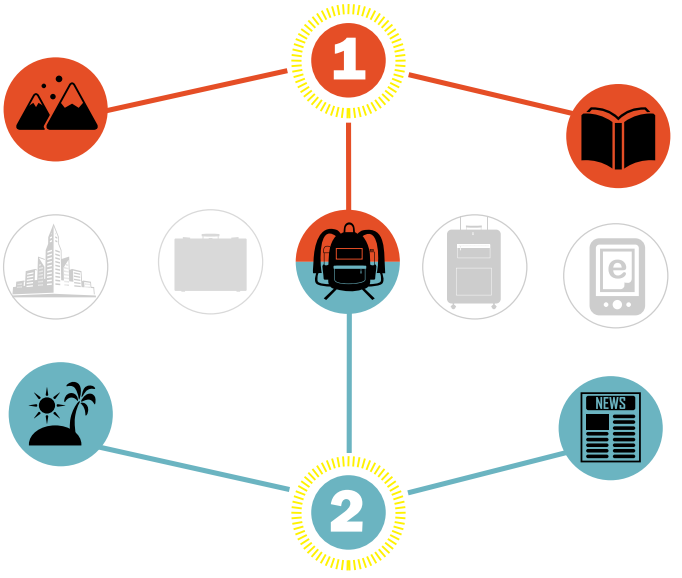
ISTOCKPHOTO

Preventing a Memory Mix-up

In Hebb's model, the cerebral cortex contains neurons that encode different features of the world. By activating relevant features from a stored memory, the brain can recall a specific event. For example, if you packed a book in your backpack on a trip to the mountains, these elements would link to form a memory (*red below*).



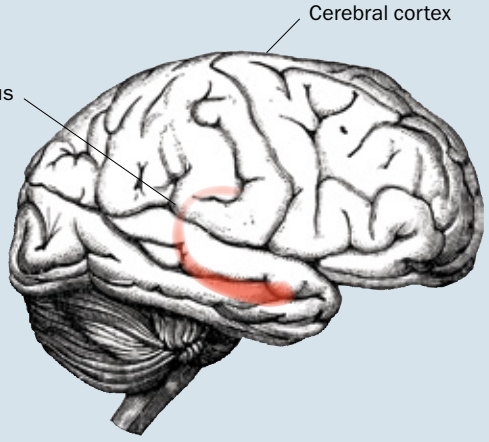
Trouble arises when another memory shares an element—say you bring the same backpack to the beach with a newspaper (*blue above*). Recalling your beach visit would activate the backpack neuron and with it all previous backpack memories.



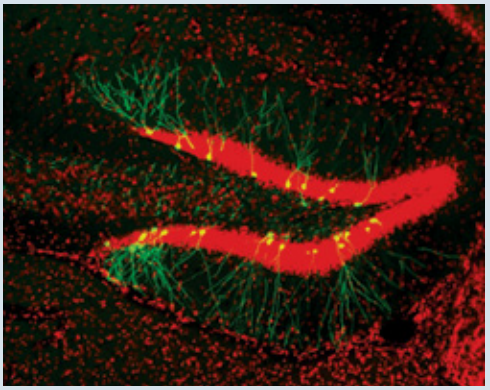
Studies of the brain's hippocampus may have solved this muddle. Certain neurons in this area appear to uniquely tag every memory. These special brain cells also seem to inhibit or compete with one another so that only one memory becomes active at a time.

Building Brain Cells

Researchers now suspect that newborn brain cells help to distinguish between memories whose features are stored in the cerebral cortex. This process could be the long-sought solution to a memory mystery.



The hippocampus is one of only two sites in the adult brain where new neurons grow.



Newborn neurons (*shown in green at left*) appear in the wedge-shaped region of the hippocampus called the dentate gyrus. The bright red area consists of older neurons.

sunblock. If these features are categorized so specifically that they rarely recur, the memories to which they belong will offer no basis for learning. The importance of sunscreen, for instance, applies to every sunny day—regardless of the beach you visit or brand of lotion.

These constraints seem to pit memory and learning against each other. Optimizing the brain for memory requires minimizing overlap, whereas learning depends on easy access to common elements so we can make associations.

THE AUTHOR

WILLIAM SKAGGS is a science writer and neuroscientist whose experimental work has focused on the role of the hippocampus in learning, memory and spatial navigation.

Neurogenesis to the Rescue

Forty years after Hebb proposed his theory, three neuroscientists came up with an alternative approach. James L. McClelland and Randall C. O'Reilly, then at Carnegie Mellon University, and Bruce L. McNaughton, then at the University of Arizona, were pondering the two brain regions involved in memory—the cerebral cortex and the hippocampus—when it dawned on them that the brain might resolve the conflict between learning and memory by separating the two processes. They suggested that to prevent the interference problem, the cerebral cortex would help us forge connections and the hippocampus would focus on filing away distinct memories. They dubbed this hypothesis "complementary learning systems."

Their basic idea hinges on adding another set of neurons to the memory network formed in a Hebb-style trip to the beach. Each of these additional cells tags a small set of memories. Let's say you embark on yet another trip with your trusty backpack. Instead of linking the features of all backpack vacations to one another, the brain allocates a single memory neuron for the latest adventure, and the trip's salient features all link to it. That single memory cell would reside in your hippocampus, whereas the feature-related cells would dwell in the cerebral cortex. Moreover, the cells involved in memory in the hippocampus fire only in discrete groups because they inhibit or compete with one another. In consequence, only one memory can be active at a given time.

When McClelland and his colleagues advanced their theory, evidence for fledgling neurons was still weak, but within a decade this had changed. In 2006 neuroscientists Fred H. Gage of the Salk Institute for Biological Studies, Gerd Kempermann, then at the Max Delbrück Center for Molecular Medicine in Berlin, and others recognized the potential importance of new neurons in the hippocampus. In two separate papers, they proposed that neurogenesis might be the brain's way of continually expanding its stores of memory.

For one thing, they reasoned, the new cells can more easily connect to other neurons than older cells. A second clue is that young neurons have a more uncertain fate than older neurons do. Many of these new cells die in their youth, but their probability of survival improves when an individual is forced to learn unfamiliar tasks—a prime opportunity to form new memories. In fact, as Rutgers University neuroscientist Tracey J. Shors observed in 1999, the rate of neurogenesis can increase during learning exercises. Thus emerged a radical new idea in the science of memory. When the brain needs to create mental records, it might just grow more neurons.

SEBASTIAN JESSBERGER *Brain Research Institute, University of Zurich (dentate gyrus)*; ISTOCKPHOTO (*brain*)

A radical new idea in the science of memory emerged: when the brain needs to create mental records, it might just grow new neurons.

The Brain Cell Bank

To test this idea, scientists set out to obliterate neurogenesis in rodents to see if its absence might reveal its function. They did so in inventive ways—manipulating the genes of mice and rats, exposing them to powerful x-rays and administering cell-destroying drugs. As predicted, studies have found that such meddling impairs the animals' capacity to identify subtle differences between situations. Moreover, boosting neurogenesis appears to help them discriminate more deftly between very similar scenarios.

Neuroscientist Susumu Tonegawa of the Massachusetts Institute of Technology took these findings a step further in 2012. Tonegawa's laboratory developed a genetically modified mouse in which old neurons were rendered inactive while new neurons remained functional. These mice then faced a series of new challenges, such as locating food pellets in a maze. The researchers found that the modified mice were better than the control mice at solving new puzzles but worse than the controls at recalling the solution to a maze from several weeks earlier. In other words, these neurons were temporally tied to specific memories. The new cells offered an advantage in learning and recalling only recent concepts, whereas older cells aided the recollection of earlier episodes.

New brain cells may be equally significant in humans. In 2013 Jonas Frisén of the Karolinska Institute in Stockholm and his colleagues found that the rate of daily neurogenesis in humans—some 1,400 cells a day—is comparable to that of a mouse, which supports the idea that the findings in animal models could apply to people.

If neurogenesis does indeed supply the neurons needed for creating memories, studying the phenomenon could provide new approaches for understanding our powers of recollection. Studies of the maturing brain suggest dysfunction in the dentate gyrus—the part of the hippocampus where neurons are born—is associated with certain forms of cognitive decline. It is also well established that new nerve cells blossom rapidly in our early years but that this rate falls with age—although the exact cause is unclear. Harnessing the power of neurogenesis could therefore benefit burgeoning elderly populations.

For example, we already know of a few ways to boost the growth of new neurons. The techniques are familiar hallmarks of a healthy way of life. Both Gage and Kempermann have found that physical exercise and ongoing learning can increase neurogenesis. More recently, they have confirmed that combining cognitive challenges with physical activity can encourage neuronal growth in older rodent brains. Perhaps a regimen of regular exercise, coupled with learning a new skill, could yield comparable benefits in humans.

In the opposite direction, severe and continued stress, alcohol and some drugs may hinder neurogenesis. Although the precise mechanisms remain a mystery, these findings hint that making healthful choices could prolong and improve your brain's memory-building abilities.

More invasive techniques could also apply. In 2011 a research group led by neuroscientist Paul W. Frankland of the University of Toronto found that deep-brain stimulation could improve neurogenesis and subsequent performance on a spatial memory task. Other methods might one day mimic the conditions of neurogenesis, such as using stem cells to replace hippocampal neurons lost to aging.

Although many details of the brain's vast archival process are still unknown, even a glimpse of these intricate activities can reveal their extraordinary sophistication. In helping you store, save and recall a vast array of experiences, your brain's newest neurons might be the glue that connects your present with your past. M

FURTHER READING

- **Why There Are Complementary Learning Systems in the Hippocampus and Neocortex: Insights from the Successes and Failures of Connectionist Models of Learning and Memory.** James L. McClelland, Bruce L. McNaughton and Randall C. O'Reilly in *Psychological Review,* Vol. 102, No. 3, pages 419–457; July 1995.
- **Hippocampal Neurogenesis and Forgetting.** Paul W. Frankland, Stefan Köhler and Sheena A. Josselyn in *Trends in Neuroscience,* Vol. 36, No. 9, pages 497–503; September 2013.
- **A Possible Negative Influence of Depression on the Ability to Overcome Memory Interference.** Don J. Shelton and C. Brock Kirwan in *Behavioural Brain Research,* Vol. 256, pages 20–26; November 1, 2013.

From Our Archives

- **New Brain Cells Go to Work.** R. Douglas Fields; August/September 2007.
- **Add Neurons, Subtract Anxiety.** Mazen A. Kheirbek and René Hen; *Scientific American,* July 2014.

An Unnerving Enigma

NEW CLUES TO FIBROMYALGIA'S ORIGINS COULD CRACK THE CASE OF CHRONIC PAIN

BY STEPHANI SUTHERLAND

Deborah Reed lived in a tall historic house on a tree-lined street in tony northwest Portland, Ore. In 2003 the author and mother of two boys developed deep muscle pain and profound fatigue, seemingly out of nowhere. "I remember climbing the wood stairs to my bedroom on the third floor," Reed recalls. "It was agonizing." Reed would spend entire days in her bed, getting up only for trips to the bathroom. When the pain was at its worst, she once went 10 days without leaving her bedroom.

Her doctor suspected depression and explained to Reed that pain can accompany that ailment. "But I just knew that's not what this was," she says. "This was something else." In addition to widespread muscle aches, Reed experienced tingling and burning sensations in her hands and feet, headaches, and painful sensitivity to temperature and light touch. Specialists tested Reed for multiple sclerosis, arthritis, cancer, lupus, Lyme disease and a catalogue of autoimmune conditions to no avail. After two years of evaluation, a rheumatologist finally gave Reed a diagnosis: fibromyalgia.

For her, like many others, the diagnosis left many questions unanswered. An estimated five million Americans are believed to have fibromyalgia, the vast majority of them women. Physicians do not call fibromyalgia a disease, however. They diagnose this syndrome when they encounter a collection of pain symptoms for which they have ruled out all other potential causes. Most often these symptoms include deep muscle pain that affects the whole body, a flulike, achy feeling and fatigue.

Physicians first identified this bundle of symptoms more than a century ago, but research languished until 1977, when scientists at the University of Toronto described the tender and aching symptoms more formally, sparking new interest. By 1990 the American College of Rheumatology had settled on the name "fibromyalgia" and developed guidelines for consistent diagnosis.

At that time rheumatologists were hunting for signs of inflammation or injury in the joints and muscles. The pain of fibromyalgia, after all, seemed to stem from these areas. Yet they came up empty time and again, and in the past 10 years scientists have instead focused largely on the brain. Now, however, some researchers are beginning to suspect that they called off the search for bodily harm too soon. New studies from neurologists working around the world suggest that these unexplained aches might arise at least in part from damaged nerves. If physicians can halt the destruction and heal those wounds, they might also stop the pain.

FAST FACTS

SOLVING A PAIN PUZZLE

1. Fibromyalgia is a common chronic pain syndrome characterized by an array of aches and discomforts, particularly in the joints and muscles, with no discernible cause.
2. In the past two decades researchers have studied fibromyalgia's effects on the brain, but this approach has not yielded effective treatment options.
3. Neurologists are now identifying damage in the peripheral nervous system that could help explain the symptoms experienced in fibromyalgia.

A Medical Mystery

For Reed, the diagnosis came as a surprise. "I had never heard of fibromyalgia," she says. She quickly realized she was not alone—even some of her doctors were unfamiliar with the condition or doubted its existence. Despite thousands of studies spanning more than 30 years, fibromyalgia remains remarkably mysterious. The severity of symptoms seems to run the gamut: whereas some people experience only mild discomfort or fatigue, others become incapacitated.

Not all pains are equal. Typically pain is good because it alerts you that your body has sustained damage, prompting you to defend yourself against further destruction. Pain becomes chronic when a warning signal persists even after the threat is gone. Fibromyalgia is one of many recognized forms of chronic pain. Most types of long-term pain are considered either inflammatory, as in some types of arthritis, or neuropathic, which often involves nerve damage. Part of the mystery of fibromyalgia is that its symptoms come from both categories, a fact that has only served to frustrate researchers, who have failed to find consistent evidence of either inflammation or damage.

Underlying their bafflement is the conundrum of what causes fibromyalgia. One clue is that fibromyalgia appears to be partly heritable. Genes might account for up to half the risk for it. Researchers now agree that some people inherit a predisposition to chronic pain that springs from differences in genes that encode key pain-signaling molecules. Yet the genetic risk factors linked with fibromyalgia are not limited to pain-related circuitry. Some of the same quirks of the genetic code also crop up with depression and anxiety disorders.

The psychological history of fibromyalgia patients further deepens the riddle. For example, it often develops after physical or emotional trauma. Experts now suspect that fibromyalgia occurs when individuals with an inherited risk are exposed to a physiological trigger, whether from illness, injury or a psychological crisis. "One could imagine a combination of genetic predeterminants that could tip people toward pain," says neurologist Claudia Sommer of the University of Würzburg in Germa-

PRECEDING PAGES: INGO BODDENBERG *Corbis (woman)*; ISTOCKPHOTO *(light effects in clouds)*; THIS PAGE: ISTOCKPHOTO

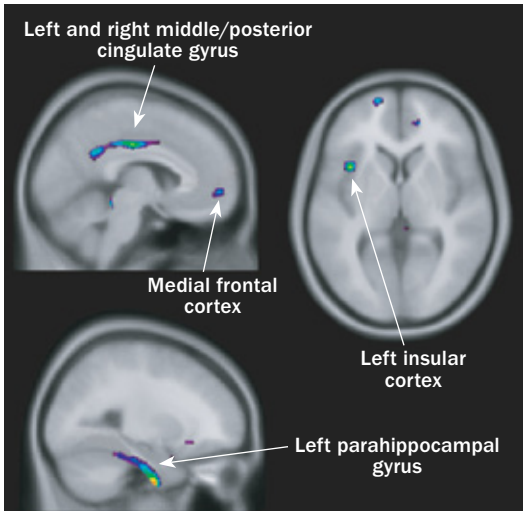
ny. "If you have a happy life, you might tolerate this well, but if catastrophes come along, they could tip you over to chronic pain." Reed, for one, traces her symptoms to a serious head-on car collision she suffered about a year before her troubles developed.

The question of how such varied incidents trigger full-blown fibromyalgia still stumps researchers. Some physicians even suspect the syndrome is actually a collection of separate but similar ailments. Despite these unknowns, the diagnosis brings some comfort to patients like Reed, who found it tremendously helpful to name her pain, discover people with similar symptoms and be taken seriously by her doctor. "To be able to know, okay, I'm not crazy—it was such a relief," she says.

Brain's Pains

To make sense of some of fibromyalgia's brain-based symptoms—such as fatigue, memory problems and sleep disturbance—researchers have used imaging to explore whether fibromyalgia patients process pain differently than healthy people. They have found that people with this syndrome appear to have less brain volume in the cingulate cortex and the medial frontal cortex, areas thought to be critical to our overall experience of pain. Other research points to altered activity in brain areas dedicated to attention and the processing of sensory input, such as sound. Scientists hypothesize that the brain's "volume control" for such sensations may be off-kilter, potentially magnifying pain.

These insights have helped shape the therapeutic approach to treating fibromyalgia, which has focused overwhelmingly on the brain. The only three drugs approved by the U.S. Food and Drug Administration to treat fibromyalgia are an anticonvulsant and two antidepressant medications. These serotonin and norepinephrine reuptake inhibitors, or SNRIs, are thought to dampen pain signals in the brain and spinal cord.



Compared with healthy subjects, patients with fibromyalgia show significantly reduced gray matter in several areas (*marked in colors above*), including the cingulate gyrus within the cingulate cortex.

HANS LAUBEL *Getty Images (air bag)*; FROM "ACCELERATED BRAIN GRAY MATTER LOSS IN FIBROMYALGIA PATIENTS: PREMATURE AGING OF THE BRAIN?", BY ANIL KUCHINAD ET AL., IN *JOURNAL OF NEUROSCIENCE*, VOL. 27, NO. 15; APRIL 11, 2007 (*brain scans*)

Experts now suspect that fibromyalgia occurs when individuals with an inherited risk experience a trigger, such as an illness, injury or psychological crisis.

Yet they fail to restore most fibromyalgia patients to health. Reviews published in 2012 and 2013 concluded that the drugs provide modest pain relief for some patients but do not improve sleep or overall quality of life. Moreover, none of these findings clarified whether fibromyalgia changes the brain or whether some patients' brains are prewired for chronic pain. Although the patterns seen in the brains of fibromyalgia patients were initially hailed as hallmarks of the syndrome, these signatures have turned out to be common across chronic pain conditions. Researchers now suspect that the experience of chronic pain actually reshapes the brain's architecture and activity patterns, just as learning to ride a bike or speak a new language would.

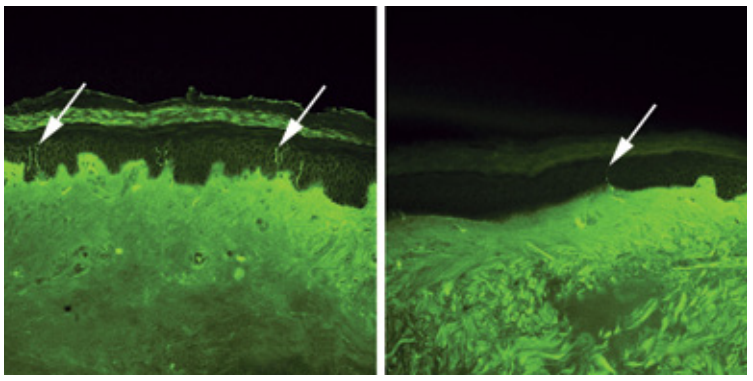
Clues from the Periphery

Meanwhile nerve specialists in Germany, Boston and Spain had noticed a peculiar pattern in patients diagnosed with small-fiber polyneuropathy (SFPN), a pain condition that stems from damage to peripheral nerves. Many SFPN patients had previously received the fibromyalgia label.

One of those neurologists, Anne Louise Oaklander of Massachusetts General Hospital, began seeking collaborators to investigate the link, but she could not find a rheumatologist willing to embark on such a speculative, interdisciplinary project. Finally, Oaklander took matters into her own hands. To search for signs of nerve damage in people with fibromyalgia, her team used several tests, including a skin biopsy, in which a clinician punches out a small sample from the skin of the hand or leg and examines the tiny nerves within the sample under a microscope. "No one had really looked appropriately before at nerves," Oaklander says.

The team's findings, published in 2013, revealed a troubling absence of nerve endings in 41 percent of the 27 fibromyalgia patients studied. This is identical to the damage seen in SFPN, in which injury or disease batters nerves until the endings have withered away. In the same year Sommer found comparable results. The new findings were striking: together they suggested that peripheral neuropathy might contribute to fibromyalgia in some patients.

Given the heterogeneous nature of the syndrome, neither Oaklander nor Sommer would expect every patient to show consistent nerve damage. Instead the findings raise the possibility that neuropathy typifies one variant of fibromyalgia.



Comparing a skin biopsy from a healthy person (*left*) with one from a fibromyalgia patient (*right*) reveals that fibromyalgia patients have fewer nerve endings, indicated by the white arrows above.

Perhaps the battering sustained by surface-level nerves initiates fibromyalgia's symptoms or, as Sommer suspects, indicates more extensive impairment in nerves serving muscles and tendons. In 2014 two additional reports detected peripheral nerve deterioration in fibromyalgia patients, strengthening the consensus that this damage could play an important role.

Biopsy studies confirmed the appearance of neuropathy but did not reveal how the nerves were acting. Neurologist Jordi Serra of MC Mutua and Neuroscience Technologies, both in Spain, tackled this question using a challenging technique called microneurography, whereby a needlelike electrode is inserted into a skin nerve to record its electrical impulses. Comparing the nerve recordings from healthy individuals with patients with either SFPN or fibromyalgia, Serra's team found that in one third of the pain patients, pain-sensing nerves showed spontaneous, abnormal activity not seen in any control subjects.

THE AUTHOR

STEPHANI SUTHERLAND is a neuroscientist, yogi and science writer based in southern California.

The findings, published in 2014 in *Annals of Neurology,* suggest that nerves fire excessively in some SFPN and fibromyalgia patients. "Normally, these nerves are sitting quietly, waiting to detect a burn or pinch, for example," Serra says. But here the pain detectors appear overactive or extra sensitized. It is possible that the same battering that knocked out nerve endings also altered nerve sensitivity. The overactivity, he says, could explain subsequent aches and distress: "Because [these nerves] are hyperexcitable, they discharge spontaneously. These signals go up to the brain, and this is the basis of ongoing pain."

Researchers know that SFPN can be caused by injury, diabetes, genetic mutation or an immune system attack. They therefore hypothesize that similar processes might underlie the nerve loss seen in some fibromyalgia cases. The persistent pain signal would then rewire the nervous system gradually, priming the body for pain. The resemblance to SFPN presents the enticing possibility that by treating the underlying condition, such as an autoimmune disorder, doctors could alleviate or even cure some cases of fibromyalgia.

With the Rain Came Pain

In Portland, where rain drips from the big-leaf maples most months of the year, Reed had noticed that her aches would mostly abate during the warm Oregon summers. But when the temperature dropped below about 55 degrees Fahrenheit and the rain inevitably returned in the fall, so would her discomfort. "That sort of weather change was the most reliable trigger of pain," she remembers.

She and her family would take trips to Mexico every winter to afford her some relief. "As soon as I stepped off the plane into the sun and heat, I could literally feel my body healing. And the opposite happened when I would return to Portland." Eventually Reed moved south to sunny Los Angeles, where she has found her affliction is much more manageable.

Reed's sensitivity to weather and temperature, a feature common to many cases of fibromyalgia, could also relate to nerve anomalies. In 2013 neuroscientist Frank Rice, then at Albany Medical College, and his colleagues described the nerves that end at tiny blood vessels in the hands, called arteriole-venule shunts, in fibromyalgia patients. These shunts, found near the surface of the palms, increase and decrease blood flow to regulate bodily temperature. They also regulate blood flow to deeper tissues, allowing muscles and organs to function during exercise. Rice found that compared with healthy control subjects, people with the syndrome

FROM "OBJECTIVE EVIDENCE THAT SMALL-FIBER POLYNEUROPATHY UNDERLIES SOME ILLNESSES CURRENTLY LABELED AS FIBROMYALGIA," BY ANNE LOUISE OAKLANDER ET AL., IN *PAIN*, VOL. 154, NO. 11; NOVEMBER 2013

Sensitivity to weather and temperature, a feature common to many patients who have fibromyalgia, could relate to nerve anomalies.

had significantly more nerve endings at the shunts dedicated to opening blood vessels.

Rice postulates that the disparity in nerve endings might cause shunts to open and close inappropriately, hindering normal heat exchange. Malfunctioning shunts could rob deep muscles and organs of proper blood flow. Muscles deprived of energizing oxygen-rich blood might also contribute to fibromyalgia's hallmark fatigue. For the moment, Rice concedes that we do not know what role shunts play in fibromyalgia, but the anomaly warrants further investigation.

The evidence from Rice and others strongly suggests that fibromyalgia includes components of physical damage or nerve irregularities in a substantial subset of patients. None of the new studies' authors would challenge the idea that fibromyalgia involves real changes in the central nervous system (CNS). Instead they believe that researchers will have the best shot at understanding the condition overall—and at guiding successful future treatments—by studying both its central and peripheral elements.

Cause or Consequence?

Not all scientists agree on the true meaning of the findings about peripheral nerves. Some, such as rheumatologist Daniel Clauw of the University of Michigan, feel strongly that the newly described nerve abnormalities are merely a by-product of an overactive nervous system. "In pain states, we know there is remodeling of the CNS," Clauw says, alluding to the ways that pain, like learning, causes changes in the brain's architecture. "So why wouldn't that likewise occur in the peripheral nervous system?"

Other physicians and researchers, however, see a ray of hope in the new findings. The most effective management strategy, says Roland Staud, who studies and treats fibromyalgia at the University of Florida, addresses both body and mind. Staud recommends exercise, improved sleep habits and cognitive-behavior therapy, which teaches patients mental strategies to cope with their pain. Reed has developed her own routines, which include a healthy diet, yoga and gentle exercise, such as walking and swimming in her L.A. apartment's outdoor pool. And Reed constantly works to minimize stress—another major pain trigger.

Staud is optimistic that for patients who have detectable damage, healing nerves could alleviate the broader symptoms of fibromyalgia. In other neuropathic pain conditions, researchers have found experimentally that blocking an aberrant nerve's overactive signaling with anesthetics can abate even those symptoms rooted in the CNS. In addition, treating possible sources of nerve injury, such as diabetes or immune disorders, helps SFPN patients. Similar approaches might also work for fibromyalgia patients.

Ultimately, our experience of pain culminates in the brain, but it can originate anywhere, from the skin on a big toe to the cortex. The chance to quiet pain signals at any point along the way could alleviate them, so researchers need to consider all possible targets. "I don't pretend that we have solved the mystery of fibromyalgia," Oaklander says. Cracking that case may require teasing apart the many different kinds of patients gathered under the syndrome's label. Yet the clues emerging from patients' nerves might finally allow researchers to start unraveling fibromyalgia's tangle of symptoms and bring relief to millions of patients. M

FURTHER READING

- **Excessive Peptidergic Sensory Innervation of Cutaneous Arteriole-Venule Shunts (AVS) in the Palmar Glabrous Skin of Fibromyalgia Patients: Implications for Widespread Deep Tissue Pain and Fatigue.** Phillip J. Albrecht et al. in *Pain Medicine,* Vol. 14, No. 6, pages 895–915; June 2013.
- **Small Fibre Pathology in Patients with Fibromyalgia Syndrome.** Nurcan Üçeyler et al. in *Brain,* Vol. 136, No. 6, pages 1857–1867; June 2013.
- **Objective Evidence That Small-Fiber Polyneuropathy Underlies Some Illnesses Currently Labeled as Fibromyalgia.** Anne Louise Oaklander et al. in *Pain,* Vol. 154, No. 11, pages 2310–2316; November 2013.
- **Hyperexcitable C Nociceptors in Fibromyalgia.** Jordi Serra et al. in *Annals of Neurology,* Vol. 75, No. 2, pages 196–208; February 2014.

From Our Archives

- **I Do Not Feel Your Pain.** Ingrid Wickelgren; September/October 2009.
- **The Psychology of Pain.** Howard L. Fields; September/October 2009.
- **Being in the Now.** Amishi P. Jha; March/April 2013.

MAURO GRIGOLLO *iStockphoto*

JURGEN ZIEWE *Corbis*

The New Group Therapy

Your book club, card game or yoga class could be the key to lifting depression

By Tegan Cruwys, S. Alexander Haslam and Genevieve A. Dingle

You can probably remember some morning you struggled to get out of bed. Maybe you kept thinking about the exam you failed, the party you were not invited to or the job you didn't get. If you are clinically depressed, every day is like this—but worse. Nothing you used to enjoy is fun anymore, and you lack the will to do what it takes—to exercise, say, or reach out to a loved one—to pull yourself out of your gloom.

Depression is the leading cause of disability worldwide, according to the World Health Organization. About 20 percent of people worldwide will experience it during their lifetime. This risk is highest for women, young adults and those living in disadvantaged communities or developing countries. If you let down your boss or your child because your misery overwhelms you, depression spreads outward to others and affects society.

Treating depression is tricky. Antidepressant medications have side effects such as drowsiness, sexual dysfunction and weight gain that cause many patients to stop taking them. Nearly one third of patients do not respond to their initial treatment, and of those who do find relief, four out of five will become depressed again later. On average, people relapse about four times across the course of their life.

New strategies for treating the illness are desperately needed, especially in places where medication and psychotherapy may be unaffordable or unavailable. Accumulating evidence now supports a simple, inexpensive approach that may fill a large part of the treatment gap. Our data and those of others show that joining a group, or several groups, can both prevent and cure depression. The type of group is irrelevant as long as it matters to you. It must become an integral part of who you are.

The Ache of Isolation

The American Psychiatric Association recommends two kinds of first-line treatments for most cases of depression: antidepressant medication and

FAST FACTS

ONE OF THE GANG

1. Nearly one third of depressed patients do not respond to their initial treatment, and of those who do, four out of five will become depressed again later.
2. A sense of connection to a group, rather than just contact with individuals, can protect mental health.
3. Joining groups is a cost-effective adjunct to standard depression therapy and may serve as a stand-alone strategy when traditional treatments are unavailable or too expensive.

psychotherapy. Both therapies can work quite effectively, either by changing brain chemistry or by altering one's perspective on life events. Both rest on the assumption that depression is a problem within an individual. Yet evidence suggests that the disorder has potent external triggers. In particular, 60 to 90 percent of people who become depressed have recently suffered some kind of loss—of a job, friendship or romance, for example. In addition, depression preferentially strikes those who live alone. And in recent years researchers have discovered that a sense of social isolation, often arising when you stop participating in activities you used to enjoy, augurs depression within a year. In a study of 229 middle-aged and older adults published in 2010, social neuroscientist John T. Cacioppo of the University of Chicago and his colleagues found that individuals who reported being lonely at some point over a five-year period were far more likely to develop depression symptoms a year later than were those who scored low on a measure of loneliness, independent of age, gender and initial depression severity.

In fact, loneliness often precedes the most devastating consequence of depression—suicide. In a study published in 2012 psychologist Tonelle Handley, then at the University of Newcastle in Australia, and her colleagues investigated various longitudinal predictors of suicidal thoughts—including psychological factors, family, social networks and availability of social support—in 1,356 people living in rural New South Wales. The researchers found that those with the lowest level of social support were the most likely to be thinking about killing themselves one year later.

These skydivers are shielding themselves, and one another, against depression. The protection is not from the thrill of the fall but from the camaraderie of the group.

The Social Cure

The more we learn about depression, the more social isolation seems to be a key factor in its expression. Interactions with others, then, might logically guard against the illness. Such contact works only when a person develops a sense of belonging, however. In another study from 2012 social psychologist Fabio Sani of the University of Dundee in Scotland and his colleagues surveyed 194 adults about how much they saw and spoke to members of their immediate family. They also asked these people how much they thought of their family as an important part of who they are. The amount of contact with family was only weakly related to whether people evinced symptoms of depression, but identifying with their family was highly protective. The same result held for a different type of "family." Among 150 members of an army unit from an Eastern European country, feeling closely associated with their unit seemed to stave off depression far better than simply spending time with other soldiers.

A number of other researchers have replicated this result. Along with University of Queensland psychologists Catherine Haslam and Jolanda Jetten, the three of us analyzed 16 studies, including more than 2,600 participants, to determine whether depression is related to how much a person identifies with a group. The groups ranged from support groups for patients recovering from heart surgery in Norway to students in secondary schools in Australia. As we reported earlier this year, the common finding across all studies was that the more someone identified with a group, the less severe his or her depression symptoms

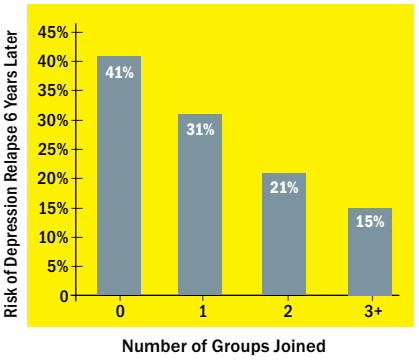
THE AUTHORS

TEGAN CRUWYS is a lecturer and clinical psychologist at the University of Queensland in Australia.

S. ALEXANDER HASLAM is a professor of social psychology at the University of Queensland and serves on the board of advisers for *Scientific American Mind*.

GENEVIEVE A. DINGLE is a lecturer and clinical psychologist at the University of Queensland.

CORBIS



In one study of more than 4,000 individuals, the number of groups a depressed person joined dramatically reduced the chances of a relapse of the disorder within six years.

were. Thus, a sense of connection to a group, rather than just contact with individuals, is what protects mental health.

Groups also can serve as effective treatment for depression. We collaborated with Jetten, Catherine Haslam and psychologist Thomas Morton of the University of Exeter in England in a 2013 study that examined data from more than 4,000 English adults older than 50 that related to their current group memberships and depression symptoms. The surveys were completed several times over eight years. We found that group membership not only enabled nondepressed people to avoid the disorder but also powerfully aided recovery over time for people who had been depressed. Depressed respondents with no group memberships who joined a single group reduced their risk of relapse from 41 to 31 percent; among those who joined three groups, the risk of relapse dropped to 15 percent [*see graph above*].

To be effective as therapy, however, the group you join must be important to you. In a study published this year we, along with Jetten and other colleagues, tested a group-based intervention in individuals at risk for depression as well as those diagnosed with it. We measured depression symptoms in 52 socioeconomically disadvantaged people at high risk for mental illness immediately after they joined a recreational group and three months later. We also asked individuals how much they identified with their group. Though just attending group meetings—to play soccer, make art, sew or do yoga—did not significantly lower depression scores, identifying with the group was associated with a marked decline in symptoms. Similarly, when we studied 92 people diagnosed with depression or anxiety who joined a therapy group in a psychiatric hospital clinic, we found that those who strongly identified with the therapy group were more than twice as likely to recover as those who felt only weakly connected to it.

Equal-Opportunity Remedy

Groups exert these powerful psychological effects because humans are social beings. We have evolved to act as part of a team. Indeed, researchers have found that just thinking about your social groups can make you less likely to get sick after being exposed to a virus, less apt to lash out at those who have wronged you and more tolerant of physical pain. Groups provide a sense of belonging. They also can give life meaning—something that is lost in depression—in part because we are better able to achieve goals when we work with others. Rates of depression and suicide drop markedly in wartime, for example, because people find meaning in working together to defeat an enemy. And of course, other members of your in-group can supply both emotional support and practical assistance in times of need.

Not all groups influence their members in positive ways, though. For instance, studies show that teenagers are much more likely to harm themselves if they hang out with others who self-harm. Two of us (Cruwys and Dingle) have found that breaking away from substance-using social groups is associated with a reduced risk of relapse among those in treatment for drug or alcohol abuse. In a 2010 study of First Nations adults in Canada, psychologist Amy Bombay, then at Carleton University, and her colleagues concluded that adopting a social identity associated with perceived discrimination might make a person *more* vulnerable to depression.

In general, however, social groups are antidotes to unhappiness, and joining them is a cost-effective adjunct to other depression treatments. Engagement with groups might also serve as a stand-alone strategy for those who cannot afford standard therapies or where there is a shortage of mental health professionals. Inexpensive treatments are critical given that the illness disproportionately affects those who are already socially and economically disadvantaged. Receiving therapy in a group can also help people unite to challenge prejudices against mental illness and to work out ways of moving forward together. Groups, then, are not only an effective shield against depression but also a sword that can puncture the stigma that accompanies it. M

SOURCE: "SOCIAL GROUP MEMBERSHIPS PROTECT AGAINST FUTURE DEPRESSION, ALLEVIATE DEPRESSION SYMPTOMS AND PREVENT DEPRESSION RELAPSE," BY TEGAN CRUWYS ET AL., IN *SOCIAL SCIENCE AND MEDICINE*, VOL. 98; DECEMBER 2013

FURTHER READING

- **Mental Health Support Groups, Stigma, and Self-Esteem: Positive and Negative Implications of Group Identification.** Jason W. Crabtree, S. Alexander Haslam, Tom Postmes and Catherine Haslam in *Journal of Social Issues,* Vol. 66, No. 3, pages 553–569; September 2010.
- **The Social Cure: Identity, Health and Well-Being.** Edited by Jolanda Jetten, Catherine Haslam and S. Alexander Haslam. Psychology Press, 2012.
- **Social Group Memberships Protect against Future Depression, Alleviate Depression Symptoms and Prevent Depression Relapse.** Tegan Cruwys, Genevieve A. Dingle, Catherine Haslam, S. Alexander Haslam, Jolanda Jetten and Thomas A. Morton in *Social Science and Medicine,* Vol. 98, pages 179–186; December 2013.
- **Feeling Connected Again: Interventions That Increase Social Identification Reduce Depression Symptoms in Community and Clinical Settings.** Tegan Cruwys, S. Alexander Haslam, Genevieve A. Dingle, Jolanda Jetten, Matthew J. Hornsey, E. M. Desdemona Chong and Tian P. S. Oei in *Journal of Affective Disorders,* Vol. 159, pages 139–146; April 20, 2014.

From Our Archives

- **The Social Cure.** Jolanda Jetten, Catherine Haslam, S. Alexander Haslam and Nyla R. Branscombe; September/October 2009.
- **Different Shades of Blue.** Erica Westly; May/June 2010.

Let's TALK

Listening in on conversations around the world reveals that human dialogue follows some universal rules that enable and enrich our social interactions

By Mark Dingemanse and N. J. Enfield

ILLUSTRATIONS BY JAMES YANG

The Study of animal communication has a long and colorful history. In the 1950s Dutch biologist Niko Tinbergen collected stickleback fish and carefully observed how they interacted. He noticed that the abdomen of male fish would flush bright red during breeding season, as the fish built nests and established their territories. This color served as a warning signal to rivals—so much so that Tinbergen found that territorial males would lunge at any object with a similar hue, including wood blocks he held outside their tank and even a mail van passing by the laboratory window.

Tinbergen's work—which combined the observation of natural behaviors with systematic experimentation—not only earned him a Nobel Prize, but it became a model for the study of animal communication. This classic approach has proved so successful in understanding how animals interact, it seemed only natural to use it for investigating human discourse. Our goal was to discover what people—from a variety of cultures, in the act of everyday conversation—could tell us about the structure of human language.

Quite a lot, it turns out. During the past 10 years our team and others have traveled around the world, learning different languages and listening in on conversations. By analyzing our collective data and returning to the field for further exploration, we have learned that human language has a structure that transcends grammar and goes beyond the words we use and the order in which we deploy our nouns and verbs. This conversational "infrastructure" is the same in all cultures, from the rice fields of Laos to the fjords of Iceland. By teasing apart these commonalities in communication, we are coming closer to understanding the

universal principles that form the foundation for language and, ultimately, the fabric of human societies.

Your Turn

Humans spend more than half their waking hours—and a great deal of their mental resources—interacting with one another. And a good portion of those social encounters involves speech. We use words to cement our relationships, exchange information and build social networks. So to better understand the behavior of our species, it seems, we need to study how people use language.

Language comes into play in all our dealings, but perhaps the most fundamental use of language is conversation. Engaging in verbal back and forth is how we first learn to speak and how we carry out the business of social life in our families and our communities. For these reasons, we focused our efforts on the kind of chitchat that makes up commonplace exchanges.

The study of conversation is, in itself, not new. In the 1970s American sociologist Harvey Sacks of the University of California, Irvine, co-established the discipline of "conversation analysis"—the detailed study of how people use language in day-to-day life. Sacks had been involved with a suicide prevention center in Los Angeles, and it was while working with recorded telephone calls to the center that he became intrigued by the orderly structure of conversation. One thing he noted was that the transitions between one speaker and the other were fairly smooth and well coordinated, so that—for the most part—only one person talked at a time.

How do we manage such fluid give-and-take? Sacks and his colleagues Emanuel Schegloff of the University of California, Los Angeles, and Gail Jefferson, then at U.C. Irvine, pointed out that our understanding of the rules of grammar should allow us to determine when any utterance is finished. For example, "I know the owner" is a complete statement, whereas "I know the" is missing something. Thus, using grammar as a guide, we can predict when our conversation partner's "turn" will come to an end.

In 2006 one of us (Enfield) joined forces with psychologists Holger Mitterer and J. P. de Ruiter, both then at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands, to explore this model further. We recorded spontaneous conversations between friends on a telephone we had set up. We could then manipulate those recordings to determine what cues people use to anticipate when it is their turn to speak. Some of our subjects listened to the original recording. Others heard a robotic-sounding version in which the pitch of each speaker's voice was com-

FAST FACTS

A GLOBAL GABFEST

1. The study of mundane, everyday conversation is providing insights into the higher structure of human communication—a system that exists across languages and cultures.
2. The timing of responses during conversation tends to minimize both silence and overlap. So accustomed are we to anticipating this pattern that a hesitation of even half a second is interpreted as dissent.
3. Humans display a unique ability to interrupt conversation to request clarification. In dozens of languages, this basic act is triggered by a word that sounds like "Huh?"

pletely flattened. Yet others heard a version in which we allowed the voices to rise and fall naturally but used a filter to mask what they were actually saying. What we found was that listeners had no trouble predicting when each "robot" was done talking—yet they performed terribly when they heard the conversational lilt but not the words being spoken. The results indicate that grammar is indispensable for conversational navigation.

Everybody Talks

People are not only good at taking turns while speaking, they are also remarkably quick to jump in once they determine it is their time to speak. In the 2006 study with de Ruiter, we made more than 1,500 measurements of the time it took for one person to begin speaking once the other had finished. We found that most of the transitions occur very close to the point at which there is no silence and no overlap: the average lull in the conversation was around 200 milliseconds—less time than it takes to blink an eye. This turnaround time is so rapid that it suggests people must gear up to speak—mentally planning what they will say next—while their partner is still talking. That way we can initiate our next contribution as soon as our partner yields the floor.

So far the work we have discussed focused on English and Dutch, languages that are fairly closely related. Yet centuries of linguistic research have shown that the languages of the world can vary radically at just about any level, from the sounds they use to the words they have and the manner and order in which words are combined into sentences. Does impeccably timed turn taking occur in all languages? Or are some cultures less hurried in their speech, whereas in others, people trip over one another to make their thoughts known?

The first study to address this question in a systematic way was published in 2009 by Tanya Stivers, then at Max Planck, Enfield and their colleagues. The 10-member team spent years in sites on five different continents, learning the languages, getting to know the local people and their customs, and videotaping daily activities—including the most mundane conversations. Every team member reviewed their recordings and extracted a set of 350 sequences involving a question and response. When the transitions were measured from one speaker to the next, the findings were strikingly similar to the studies of Dutch and English: people, it seems, try to avoid talking over one another or letting too much time lapse between one utterance and the next. Again, the average gap falls around 200 milliseconds.

Making conversation involves more than anticipating when to begin speaking. It is a cooperative venture that requires adherence to the rules of social engagement.

Answer Me

The other thing that is striking about human speech is that people expect answers. Making conversation involves more than just anticipating when to begin speaking. It is a cooperative venture that requires adherence to the rules of social engagement. This kind of verbal accountability does not occur in animal communication. Although creatures sometimes engage in a form of call and response, their vocalizations are not as precisely timed or intimately linked as human dialogue. Many animal calls are purely informational—"I am here" or "Look out: snake!"—and they do not warrant or require a vocal response.

So deeply ingrained is our expectation of a rapid reply that any hitch in the flow of conversation is subject to interpretation. Think of a politician hesitating before replying to a question about the use of illicit drugs. Or how you feel when you ask someone on a date and are met with a silence that feels like it stretches on forever before the person either accepts or declines. In these exchanges, even the slightest pause can feel evasive or seem like a sign of difficulty or doubt.

American linguists Felicia Roberts and Alexander Francis, both at Purdue University, have been examining this phenomenon more closely. In one study, the investigators produced recorded conversations in which one speaker made a request (for example, asking for a ride) and the other answered "sure." They then experimentally manipulated the length of time that passed between the request and the reply and played these recordings for a group of undergraduates. The students were asked to rate how willingly the respondent seemed to agree to the favor. The results were clear: once the lag in response stretched to about 500 milliseconds—just half a second—listeners began to interpret the delay as a reduced willingness to cooperate, even though the speaker's answer was "sure."

That study, published in 2006, was conducted in English. But do people from different cultures across the globe make the same assumptions about the social implications of silence? Roberts

THE AUTHORS

MARK DINGEMANSE and **N. J. ENFIELD** are in the language and cognition department, directed by Stephen C. Levinson, at the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands. The authors have worked together since 2010, when Dingemanse joined Enfield's European Research Council project on Human Sociality and Systems of Language Use.

Human conversation has a rhythm, and deviations from that precisely timed patter are rife with social meaning.

and her colleagues subsequently extended their study to include Italian and Japanese. Across all three languages, they found that the longer the pause in conversation, the lower the perceived willingness to comply or agree.

And that perception may indeed be warranted. In all the languages that Stivers and her colleagues studied, they found that positive responses always came faster than negative ones. Thus, deviations from the average length of time it takes for one person to reply to another may be legitimate indicators of the relative enthusiasm of the speaker. Moreover, the tendency for people to engage in this type of rapid social appraisal is shared across cultures. Thus, it appears that the timing of comments within conversations is part of the structure of our language—not just of one language but of all human communication.

"Say What?"

So human conversation has a rhythm, and deviations from that precisely timed patter are rife with social meaning. Yet not all conversations proceed smoothly, without a glitch. What happens when one speaker does not catch what the other one said? Such failures in communication could lead to serious misunderstandings if it were not for another important feature of human conversation—our natural tendency to ask for clarification. And the simplest tool we have for that purpose is the humble word "Huh?"

You have no doubt uttered this query countless times—and heard it even more. It turns out, the term may well be universal. In a large-scale study of 200 conversations recorded in a dozen different countries, from Ghana and Laos to Italy, Iceland, Russia and Japan, we found that a word that sounds like "Huh?" occurs in every language we examined. And it always serves the same purpose: it temporarily halts the conversation and prompts the speaker to repeat or rephrase what was just said.

"Huh?" may sound like a random grunt, but our study indicates that it qualifies as a word. Children are not born knowing how to say it—they have to learn it as they learn any other word. Also, it is not a simple reflex. Our closest evolutionary relatives—chimps and other apes—do not appear to grunt "Huh?" although they do sneeze and yelp like we do.

The word is subtly different in each language—depending on the local intonations of that tongue. But it is always a single syllable and sounds like a question. And its short vowel sound—"uh" or "eh"—is extremely easy to pronounce: open your mouth and put a question mark at the end of the simplest sound you can squeeze out, and you come up with "Huh?" These qualities serve its function well: the brevity of the word quickly notifies the speaker that there is a problem, and its questioning quality encourages an equally rapid response.

"Huh?" is not the only word we use to "repair" broken links in a conversational thread. Different cultures also have different phrases to call for clarification, and even in English we often ask, "What?", "Sorry?", "Pardon?" or "You mean...?" From the conversations we recorded, speakers called for clarification or explanation an average of once every minute. This frequency—and universali-

Thinking about Talking

Ever been told to "think before you speak"? It is a gentle reminder to say what you mean—and mean what you say. But it also highlights a fundamental property of human communication: language involves both the mental assembly of words and sentences and the sharing of those assemblages with another individual.

Linguists, too, can come at language from either direction. Noam Chomsky of the Massachusetts Institute of Technology, for example, tends to take a thought-based approach. He and his followers are interested in studying our capacity for language generation—how we build words out of sounds and sentences from words.

To the linguists who adopted Chomsky's approach, which dates back to the 1950s, how these grammatical compilations form the basis of conversation seemed beside the point. After all, speech can be sloppy. The well-constructed, pristine thoughts we assemble in our brain run the risk of getting garbled as they make their way through our imperfect vocal systems and then get interpreted by a listener who may or may not have heard exactly what we said.

We elected to take on language from the speech side of the equation: analyzing how words and sentences are used to communicate. Our studies are uncovering the social roots of language and showing how the structure of conversation enables us to share a piece of our mind. Together with the studies that explore how we put together words and sentences, this approach is giving us a better understanding not only of what we say but how and why we say it. *—M.D. and N.J.E.*

ty—indicates that in some ways human social interaction hinges on the verbal devices we use to make sure we understand what is being said. In a sense, then, it is in what we do when things go wrong in conversation that the uniquely social nature of human language becomes clear.

Why We Speak

What do these findings tell us about the function of human language? First, it is clear that conversations have a certain structure. Participants take turns speaking, prepare their thoughts, anticipate when their input is expected, and call for clarification and correction as needed. This intensely cooperative form of interaction is adhered to across a variety of cultures and is unmatched anywhere in the animal kingdom. These mechanisms—including turn taking, timing and repair—form the foundations of our linguistic abilities. They are like the "fundamental forces" that hold together the words and sentences of conversation, providing them with a certain social weight and flavor. And like physicists studying the composition of matter, we look forward to continuing our search for these fundamental particles and interactions that inform human speech.

That people can make use of these common structural elements to construct meaningful conversations reflects something psychologists call our social intelligence: a way of thinking in which we intuit one another's communicative intentions, holding one another accountable for what we say and when and how we say it. This propensity for reading into the minds of fellow individuals reflects the unique sociality of the human species. We use language to build our relationships and to work together—in small groups, in larger institutions and at the level of societies. Without the social glue of conversation, these linkages would not exist, and societies might crumble. Learning more about the natural language of our species—by studying how people from a variety of cultures communicate every day—will continue to reveal fundamental insights into the very essence of what it means to be human. M

FURTHER READING

- **Projecting the End of a Speaker's Turn: A Cognitive Cornerstone of Conversation.** J. P. de Ruiter, Holger Mitterer and N. J. Enfield in *Language,* Vol. 82, No. 3, pages 515–535; September 2006.
- **Universals and Cultural Variation in Turn-Taking in Conversation.** Tanya Stivers et al. in *Proceedings of the National Academy of Sciences USA,* Vol. 106, No. 26, pages 10,587–10,592; June 30, 2009.
- **Judgments Concerning the Valence of Inter-Turn Silence across Speakers of American English, Italian, and Japanese.** Felicia Roberts, Piera Margutti and Shoji Takano in *Discourse Processes,* Vol. 48, No. 5, pages 331–354; 2011.
- **Is "Huh?" a Universal Word? Conversational Infrastructure and the Convergent Evolution of Linguistic Items.** Mark Dingemanse, Francisco Torreira and N. J. Enfield in *PLOS ONE,* Vol. 9, No. 4, Article No. e94620; November 8, 2013. Corrected version published April 2, 2014.

From Our Archives

- **The Curious Behavior of the Stickleback.** N. Tinbergen; *Scientific American,* December 1952.
- **Programmed for Speech.** Sebastian Haesler; June/July 2007.
- **Speaking in Tones.** Diana Deutsch; July/August 2010.

In another language, your own thoughts might be foreign to you

By Catherine L. Caldwell-Harris

ILLUSTRATIONS BY JAMES YANG

In her memoir, Eva Hoffman, a writer and academic, reflects on being a bilingual and bicultural immigrant to North America from Poland. She describes two languages issuing competing commands in her head:

—Should you become a pianist?
the question comes in English.
—*No, you mustn't. You can't.*
—Should you become a pianist?
the question echoes in Polish.
—*Yes, you must. At all costs.*

Typically we regard language as conveying information, not changing it. Yet numerous bilinguals have noted anecdotally that their first language feels more emotional to them. As Hoffman—and a growing body of research—illustrates, the tenor of our thoughts can depend on the tongue in which they are spoken. For example, in psychotherapy with a dual-language therapist, bilinguals sometimes use their mother tongue when they want to feel the full impact of a topic but then switch to another language to achieve emotional distance. Now evidence suggests that this "foreign language effect" even applies to our moral judgments.

The idea that different languages can lead us to distinct conclusions has wide-ranging implications. For couples from different linguistic backgrounds, the effect could sway the emotional give-and-take between two

FAST FACTS
LANGUAGE LESSONS

1. Your thoughts and opinions can differ depending on the language in which you frame them, even when evaluating right and wrong.
2. A nonnative tongue appears to reduce the engagement of the brain's emotional circuitry, leading to a more rational decision-making style.
3. This so-called foreign language effect might arise because foreign languages are used less often in emotionally charged contexts.

lovers. In foreign policy it might nudge certain leaders toward a more rational decision and others toward a more intuitive one. At a more fundamental level, the foreign language effect raises questions about human moral integrity. Your opinions of what is right and what is wrong are not absolute. They can be swayed by seemingly trivial conditions—including the language in which you frame your belief.

At the Whim of Language

The foreign language effect draws some of its influence from the ethos of its culture. For example, when Chinese-English bilinguals were randomly assigned to answer a self-esteem questionnaire in either Chinese or English, those who responded in Chinese received lower self-esteem scores than those who replied in English. Reading self-esteem questions in English cues bicultural respondents to adopt an American self-enhancing bias. Considering the same questions in Chinese might lead respondents to draw on the traditional Chinese virtue of modesty.

Yet culture is not the only reason. Presented with classic scenarios from behavioral economics in which people routinely make slightly irrational choices, bilinguals behave somewhat more logically when evaluating vignettes written in their nonnative language. Speaking a language with imperfect fluency, it seems, reduces the engagement of the brain's emotional circuitry.

New research on the subject, published in 2014, ventures into the realm of morality. Cognitive scientist Albert Costa of Pompeu Fabra University in Barcelona led a team that investigated how language might influence decisions about the "trolley problem," a well-known scenario used by philosophers and psychologists to gauge people's moral reasoning. It goes like this: a trolley is speeding toward five oblivious track workers. You are standing nearby, close to a fork in the tracks. You have time to flip a switch to divert the trolley onto a different track, where only one worker is stationed. Should you flip the switch, thus killing one person and saving the other five lives?

According to a utilitarian view of the situation, saving more workers amounts to the greater good, so it is morally acceptable to kill one to save five. Most people—close to 70 percent, in some studies—consider it permissible to flip the switch. When psychologist Joshua Greene of Harvard University presented this and similar dilemmas to people while they underwent brain scans, he found activation in the executive func-

THE AUTHOR

CATHERINE L. CALDWELL-HARRIS is an associate professor of psychology at Boston University. She has conducted research on a wide variety of topics, including language processing, cross-cultural psychology and individual differences in cognitive styles.

tion areas of the prefrontal cortex, located right behind the forehead, which suggests that people were consciously reasoning through this decision.

A related dilemma requires doing more than flipping a switch—now you must kill someone with your own hands. You are positioned on a footbridge over a train track with the trolley speeding toward five workers. Next to you stands a large man wearing a heavy backpack. If you shove this man off the bridge onto the tracks below, he will die, but he and his heavy backpack will stop the trolley, thus saving the five workers. Respondents usually report aversive feelings such as a sense of horror at the request to push someone to certain death. Typically permissibility ratings for this dilemma are in the range of 12 to 20 percent—far below the 70 percent for the switch scenario. In Greene's neuroimaging study, the footbridge scenario—with its requirement to personally kill someone—elicits strong activity in areas of the brain that mediate emotional responsiveness.

Now imagine evaluating the footbridge dilemma in either your native tongue or a foreign language, in which emotions are expected to be less active. As you might expect, Costa and his colleagues found that only 20 percent of respondents using their native language said that personally spilling blood to save five people was permissible. When evaluating in a foreign language, 33 percent of respondents considered bloodshed permissible. The effect held across several language pairings, including Spanish/English (recruited from the U.S.), Korean/English (Korea), English/French (France), and Spanish/Hebrew and English/Hebrew (both in Israel).

To rule out any effects from the cultural norms linked with a language, the researchers next compared responses to the footbridge and flip-switch dilemmas from native Spanish speakers who had learned English and native English speakers who had picked up Spanish. No matter the language, more respondents favored the utilitarian option in the foreign tongue (44 percent) than in the native language (18 percent, on average). No such difference was found for the switch-flipping scenario. This finding suggests that the foreign language effect is specific to moral dilemmas with a strong emotional component.

Your opinions of right and wrong are not absolute. Seemingly trivial conditions can sway them, such as the language in which you frame your belief.

Tribal Thinking

Although Costa and his colleagues sampled from a variety of native and foreign language pairings—an admirable accomplishment—a different cultural phenomenon might also explain the results. Using a native language could induce the feeling of reasoning about your own people—your so-called in-group. Conversely, a foreign language could signal that the scenario is more relevant to strangers and outsiders. Indeed, studies have shown that assigning specific ethnicities to the victims in the trolley problem can change the pattern of responses in complex ways.

The research also raises a question: What about reasoning in a second language that is not foreign? People who reside for years in another country may ultimately feel as proficient and emotionally engaged when speaking its language as when using the language of their homeland. Or consider the children of immigrants who grow up to become "balanced" bilinguals. They commonly identify more strongly with the language of their parents but achieve similarly high proficiency in both that language and the language of the dominant culture. Would these individuals also think in a more utilitarian way when using their second language?

Although these groups have not yet been studied in moral-reasoning dilemmas, my bet is no. I make this prediction based on my own research on the emotional charge of different languages. In one study of Spanish/English bilinguals, for example, I recorded the electrical conductance of their skin while they listened to emotional phrases in their first or second language. Even a slight change in sweat levels can indicate that feelings are stirring, so we used this technique to measure our participants' reactions.

People without extensive immersion in their second language had lower skin conductance in the foreign language. The skin readouts of balanced bilinguals, however, were about the same. Thus, my conclusion is that a language elicits strong feelings when it is used routinely in emotional contexts—as in conversations between a parent and child or two old friends.

Whether or not you are multilingual, these findings reinforce what psychologists have said for decades: we humans are chameleons. We can be different people in different situations, bristling when an intimate partner criticizes us but apologetic when a co-worker does so. Some philosophers claim that belief in a unitary self is an illusion, albeit a helpful one. So, *praemonitus praemunitus!* Or put in another language: by understanding the many forces shaping our thoughts and behavior, you are forewarned and forearmed. M

FURTHER READING

- **The Foreign-Language Effect.** Boaz Keysar, Sayuri L. Hayakawa and Sun Gyu An in *Psychological Science,* Vol. 23, No. 6, pages 661–668; June 2012.
- **Your Morals Depend on Language.** Albert Costa et al. in *PLOS ONE,* Vol. 9, No. 4, Article No. e94842; April 23, 2014.

From Our Archives

- **The Bilingual Advantage.** Erica Westly; July/August 2011.
- **How to Teach Old Ears New Tricks.** Gabriel Wyner; Perspectives, July/August 2014.

EMOTIONAL CONTROL

Is Mindfulness Good Medicine?

Mindfulness meditation can help alleviate depression and possibly anxiety

In a typical mindfulness meditation session, a person sits on the floor, eyes closed, back straight and legs crossed, his body positioned to facilitate his inner experiences. For 10 to 15 minutes, he observes his thoughts as if he were an outsider looking in. He pays particular attention to his breathing, and when his mind wanders to other thoughts, he brings his attention back to his breath. As he practices, his mind empties of thoughts, and he becomes calmer and more peaceful.

Meditation has long been used for spiritual growth. More recently, in psychotherapy, researchers and practitioners have demonstrated interest in a type of Buddhist meditation designed to foster mindfulness, a state of being engaged in the moment without judgment. Mindfulness meditation has shown promise in treating disorders ranging from pain to psoriasis [see "Being in the Now," by Amishi P. Jha; Scientific American Mind, March/April 2013]. But when it comes to treating diagnosed mental disorders, the evidence that mindfulness helps is decidedly mixed, with the strongest data pointing toward its ability to reduce clinical depression and prevent relapses. In this column, we will discuss these findings and some of the controversies regarding applications of mindfulness.

Openness and Acceptance

People have practiced meditation throughout history. It has evolved into many forms and is found in virtually every major religion. In 2004 psychologist Scott Bishop, then at the University of Toronto, and his associates defined mindfulness as maintaining attention on present experiences and adopting an attitude toward them characterized by curiosity, openness and acceptance.

Psychotherapy researchers have developed and evaluated variations of mindfulness for therapeutic purposes. For example, mindfulness-based stress reduction acts, as the name suggests, to reduce psychological stress. Mindfulness-based cognitive therapy, on the other hand, integrates mindfulness with methods designed to change the dysfunctional thoughts that may contribute to problematic emotions and behaviors. Both are usually delivered through eight weekly classes and an all-day workshop.

As a remedy for depression and anxiety, mindfulness meditation may help patients let go of negative thoughts instead of obsessing over them. Training people to experience the present, rather than reviewing the past or contemplating the future, may help keep the mind out of a depressive or anxious loop.

Indeed, some support exists for the efficacy of such training in ameliorating symptoms of depression and possibly anxiety. In a 2010 meta-analysis (quantitative review), psychologist Stefan Hofmann of Boston University and his

BY HAL ARKOWITZ AND SCOTT O. LILIENFELD

Hal Arkowitz and Scott O. Lilienfeld serve on the board of advisers for *Scientific American Mind*. Arkowitz is an associate professor of psychology at the University of Arizona, and Lilienfeld is a psychology professor at Emory University.

Send suggestions for column topics to ***editors@SciAmMind.com***

NAFTALI BEDER (*illustration*); SEAN McCABE (*Arkowitz and Lilienfeld*)

colleagues examined studies that tested both forms of mindfulness meditation as a remedy for anxiety disorders and depression. They found that the meditation sessions led to significant improvements in both conditions immediately after therapy, as well as approximately three months later. Given the relatively small number of well-designed studies available at that time, however, the authors were appropriately cautious in their conclusions.

Still, a 2013 meta-analysis partly backs up the 2010 assessment. In that review, psychologist Bassam Khoury, then at the University of Montreal, and his colleagues found that both types of mindfulness-based therapies were effective for depression and anxiety disorders, though not more so than cognitive therapy without mindfulness.

Mindfulness has fared less well as a therapy for anxiety disorders in some studies. In another meta-analysis published this year, psychologist Clara Strauss of the University of Sussex in England and her associates found that mindfulness treatments were effective for depression but not for anxiety disorders. The results for anxiety may differ across investigations for various reasons, but one possibility points to differences in patient populations. For instance, some studies include individuals afflicted with anxiety disorders who also have significant health problems such as cancer, whereas others do not. How well mindfulness works may depend somewhat on the source of a patient's anxiety.

Averting Relapse

The clearest mental health benefit for mindfulness may be in reducing relapse rates for a subset of individuals with depression. Preventing relapse is a crucial challenge for therapists because relapse rates for clinical depression are extremely high. Up to 60 percent of those who have had one depressive episode will have one or more additional ones; for those who have already relapsed once, 60 to 90 percent will have further episodes; and for those who have experienced three or more depressive episodes, 95 percent will relapse.

Mindfulness seems to be particularly potent as a preventive in patients who have relapsed three or more times. In a pioneering study of mindfulness-based cognitive therapy for depression recurrence, published in 2000, psychologist John Teasdale, then at the Medical Research Council (MRC) in Cambridge, England, and his colleagues compared individuals receiving treatment as usual, such as visits to family doctors, psychiatrists and therapists, with those who also received mindfulness-based cognitive therapy. Subjects were followed for more than a year. Among those who had experienced three or more episodes of depression, mindfulness therapy significantly reduced relapse rates compared with the usual treatment. No difference between the groups emerged, however, for people who had experienced two or fewer depressive episodes. These surprising results have been replicated in several studies.

Although no one knows precisely why the benefits of mindfulness would be greater for the sample of three or more, a 2004 replication by Teasdale and psychologist S. Helen Ma, then also at the MRC, provides some leads. The researchers found, as Teasdale had previously, that in individuals who had experienced two or fewer depressive episodes, adverse life events, such as a death in the family or a relationship breakup, were a common trigger for relapse but that such external occurrences were less often associated with relapse in those who became depressed more than twice. The researchers speculated that by the time a person has had three or more depressive episodes, a significant negative event is not necessary for relapse. Instead a strong association has been formed in the mind between more ordinary negative moods and depressive thoughts. When a person who has recovered from depression experiences a mild negative mood, that mood may activate thoughts such as "Here it comes again," triggering a full-blown depressive episode. In those cases, mindfulness might help break the cycle by enabling individuals to be less affected by fleeting unhappy thoughts so that they do not lead to emotional turmoil.

> MINDFULNESS MIGHT ENABLE PEOPLE TO BE LESS AFFECTED BY UNHAPPY THOUGHTS SO **THEY DO NOT LEAD TO EMOTIONAL TURMOIL.**

Through such mechanisms, mindfulness-based cognitive therapy and mindfulness-based stress reduction hold promise as remedies for depression and possibly anxiety. What is more, mindfulness-based cognitive therapy offers clear advantages for preventing relapse in patients who have had more than two episodes of depression. (Its ability to avert relapse for anxiety disorders is unknown.) No one fully understands how, or to what extent, mindfulness-based treatments contribute to recovery in these illnesses. Nevertheless, such treatments constitute an exciting new direction in psychotherapy. M

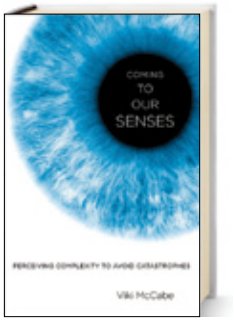
FURTHER READING

- **The Mindful Way through Depression: Freeing Yourself from Chronic Unhappiness.** Mark Williams, John Teasdale, Zindel Segal and Jon Kabat-Zinn. Guilford Press, 2007.
- **The Effect of Mindfulness-Based Therapy on Anxiety and Depression: A Meta-analytic Review.** Stefan G. Hofmann et al. in *Journal of Consulting and Clinical Psychology,* Vol. 78, No. 2, pages 169–183; April 2010.

A THEORY ABOUT THEORIES

Coming to Our Senses: Perceiving Complexity to Avoid Catastrophes

by Viki McCabe. Oxford University Press, 2014 ($29.95)



Sometimes our theories about the world take on a life of their own. We take them so seriously that we ignore the properties of our environment that generated those theories in the first place.

A cognitive psychologist and visiting scholar at the University of California, Los Angeles, McCabe believes this tendency often gets out of hand, contributing to many of modern society's tragedies and ills: the Great Recession of 2008, for example, driven by a focus on derivatives rather than by the actual value of commodities, or the death of more than 1,000 people in Hurricane Katrina, caused by faulty theories about the effectiveness of levees instead of observations about how complex natural drainage systems work.

McCabe's take on this phenomenon is unique and fresh. Drawing on both scientific research and news stories, she demonstrates three things: first, that our mental life is often out of touch with the physical reality around us; second, that we sometimes make better judgments about the complexities in our environment when we rely on intuitions—hunches informed by unconscious perceptions—instead of analytical thinking; and third, that people are complex, dynamic systems nested in a world of complex, dynamic systems.

The book is excellent at reminding us of the importance of complex systems in virtually every aspect of our lives. Even when our intentions are good, McCabe notes, a simple intervention—removing the wolves from Yellowstone National Park to make cattle safer—can destroy an entire ecosystem, resulting in dead trees, erosion and flooding.

At times, though, McCabe goes too far in her defense of intuition. When she tells us, for example, the story of a woman who had a bad feeling about an old man and young girl in a convenience store, she speculates that the woman's unease was an unconscious reaction to the irregular "yoked movements" of the pair. Sure enough, the man turned out to be a kidnapper and pedophile, but this is not evidence for the power of intuition; it is just an anecdote. Extensive research on intuition yields a complex picture. Generally speaking, analytical thinking seems to be every bit as valuable as intuition. Each may serve us well, depending on the circumstances.

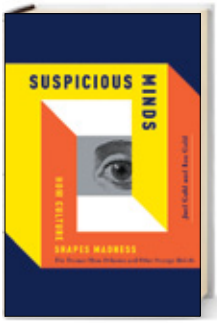
As a researcher, I also found myself bothered at times by what seemed to be an emotional undertone in the book. McCabe often conveys the impression that our failure to pay closer attention to the complex systems of nature is *unjust*—that our reliance on theory causes millions of people to suffer and even threatens the very existence of the human race. Yet our cogitations also help many people to survive and prosper.

Although McCabe has produced a fascinating book, she misses a fundamental point: namely that theories, including her own, become *part* of complex systems; they are not separate from them. In a sense, theories are just more data, helping us make the best decisions we can. —*Robert Epstein*

THE MADDENING CROWD

Suspicious Minds: How Culture Shapes Madness

by Joel Gold and Ian Gold. Simon & Schuster, 2014 ($26)



In 2003 "Albert" came to Bellevue Hospital's psychiatric emergency room. A 26-year-old assembly worker, he was convinced that his life was the focal point of a television show. He entered Bellevue after a fracas at the United Nations, where he had gone to demand asylum from his televised life.

For psychiatrist Joel Gold, Albert was the first in a series of patients convinced they lived their entire existence on TV, circumstances that proved eerily similar to those depicted in the 1998 film *The Truman Show*. These patients prompted Joel Gold and his brother, philosopher Ian Gold, to investigate how culture influences the content of delusional thinking. *Suspicious Minds* is the result of that research, which led them to lay out a theory for understanding psychosis through a social lens.

The Golds begin by reviewing the history and theories of madness, dwelling in particular on hints of interpersonal deficits in people with delusions. For example, individuals with psychoses struggle to understand other people's mental states. Schizophrenia, too, seems to have a social component: immigrants who face discrimination and urbanites in very populous cities face heightened risk of the disorder.

Drawing on such evidence, the Golds hypothesize that everyone employs a "suspicion system" to read and respond to social situations, but some individuals experience delusions when their personal threat detector breaks down. For some, this system may be faulty from birth or broken through severe social strain. Individuals with amygdala deficits may struggle to decode facial expressions such as fear or anger. Delusions then occur when a person tries to make sense of inappropriately perceived social threats; for example, a delusion of grandeur is a way for someone who feels lost in a crowd to puff up his or her status.

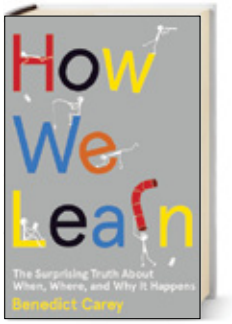
The authors stud their carefully compiled evidence with historical and current case studies. These are the most poignant passages in the book, including an overstressed 24-year-old medical student who abandons her studies to try to raise the dead at Ground Zero and a devoted husband whose 30-year marriage collapses when a series of strokes leaves him obsessively jealous. The Golds suggest that the content of these delusions reflects the reigning zeitgeist—whereas a schizophrenic Englishman in the 19th century feared French spies and pneumatic machinery, a contemporary patient fears the NSA and iPads.

The importance placed on time-sensitive cultural influence may be the weakest argument presented here, eclipsed by the more intriguing ideas about suspicion and immediate social context. Altogether, though, the authors offer a fascinating and intimate portrait of psychosis. Rather than reducing mental illness to mutations and misfiring neurotransmitters, *Suspicious Minds* reminds readers that otherwise healthy people can experience delusional impulses driven by insecurity or stress. In the Golds' conception of psychosis, the line between mental health and illness is very fine indeed. —*Daisy Yuhas*

FORGET TO REMEMBER

How We Learn: The Surprising Truth about When, Where, and Why It Happens

by Benedict Carey. Random House, 2014 ($27)



How We Learn is Carey's gift to guilt-ridden slackers everywhere. In the book, the award-winning *New York Times* science journalist dismantles the "proper" study habits drilled into students from primary school—minimize distractions, adopt a study ritual, find a quiet space—and replaces them with something that could be called responsible loafing.

Slacking is built into our nature—and for good reason. Carey takes the reader through study after study, uncovering the benefits of napping, daydreaming, background noise, forgetting and walking away: precisely the habits that are usually assumed to be impediments to learning, not its drivers.

To build his case, Carey first introduces the reader to the neurological underpinnings of learning and memory—describing how the cellular network that holds a memory expands and grows stronger every time that memory is recalled and how forgetting is actually a useful mechanism by which our brain prunes out irrelevant information.

With that foundation, he moves on to memory-enhancing techniques and problem-solving skills, pulling together research on how the brain works into quick tips people can use to learn better and more efficiently. Instead of always studying in the same spot, for example, Carey recommends changing locations, which maximizes the number of associations tied to a certain memory and makes it easier to access come test time. He quashes concern over the distracting influence of social media, explaining how a short Facebook break can actually help you solve a stubborn problem by clearing your head and letting you return to the task with fresh eyes. In the final section, he also covers tricks you can use to boost learning subconsciously—revealing, for instance, how important sleep is to the process (hint: very).

Thanks to Carey's knack for storytelling, the book is as entertaining as it is functional. He amusingly recounts the sometimes kooky experiments that pioneering learning and memory researchers devised to explore how the mind works in an era devoid of modern brain-imaging technology, often using themselves or their families as test subjects. In a particularly famous experiment, German psychologist Karl Duncker made up puzzles using common household objects—including a matchbox, candles and thumbtacks—to tease out the circumstances that give rise to insight.

Unsurprisingly, Carey incorporates the learning strategies he describes into the book, which can be tedious—such as when he reviews concepts he just covered or doles out homework assignments. Even so, after reading, I felt I had absorbed and retained more information in this book than others of similar heft, so perhaps he is on to something.

Of course, Carey does not suggest blowing off work entirely—effort is always required for success. But what he offers is a way to make it as painless, efficient and gratifying as possible. In the end, *How We Learn* is more than a new approach to learning; it is a guide to making the most out of life. Who wouldn't be interested in that? —*Roni Jacobson*

ISTOCKPHOTO

ON OUR SHELF

High Price: A Neuroscientist's Journey of Self-Discovery That Challenges Everything You Know about Drugs and Society

by Carl Hart. HarperCollins, 2013

In an absorbing memoir, Hart describes his improbable journey from a childhood of poverty and violence in Miami to Columbia University, where he became the school's first African-American science professor to earn tenure. Combining his experience in the 'hood with his training in neuroscience, Hart realized that drugs are far less responsible for humanity's ills than we have all been led to believe. —*Ingrid Wickelgren, senior editor*

Cerebrum 2013: Emerging Ideas in Brain Science

edited by Bill Glovin. Dana Press, 2014

Every year the Dana Foundation, a charitable organization that supports brain research, assembles an anthology from its online journal Cerebrum to highlight accomplishments in brain science as well as ongoing mysteries. In the latest compendium, experts reveal how a high-fat diet could help treat epilepsy and how the antics of a small, speckled freshwater fish launched the study of risky behavior. I've enjoyed each article in the collection so far; the science is accessible without sparing the details that make for fascinating stories. —*Daisy Yuhas, associate editor*

The Humor Code: A Global Search for What Makes Things Funny

by Peter McGraw and Joel Warner. Simon & Schuster, 2014

This engaging read follows psychologist McGraw and journalist Warner as they travel the globe to uncover why we laugh. We see McGraw fail miserably at stand-up in Colorado, examine the ingredients that make a *New Yorker* cartoon funny and travel to Tanzania to explore the 1962 laughter epidemic, in which a laugh spread across an entire community. As the book's forays into science and culture illustrate, the nature of laughter is far more complex than most of us realize. —*Victoria Stern, contributing editor*

Grain Brain: The Surprising Truth about Wheat, Carbs, and Sugar—Your Brain's Silent Killers

by David Perlmutter. Little, Brown, 2013

With evidence mounting that grains cause a host of health problems, I was eager to find out what current research says about a high-carbohydrate diet's effect on the brain. Unfortunately, physician Perlmutter drastically overstates his claims. Some studies indeed hint that grains might worsen or even cause ailments such as Alzheimer's disease, but much more work is needed before any conclusions can be drawn as definitively as they are in *Grain Brain.* —*Karen Schrock Simring, contributing editor*

Are people inclined to act cooperatively or selfishly? Is such behavior genetic?

—**Matthew Robison,** New Hampshire

Ariel Knafo, associate professor of psychology at the Hebrew University of Jerusalem, responds:

The jury is still out on whether we are fundamentally generous or greedy and whether these tendencies are shaped by our genes or environment.

Some evidence points to humans being innately cooperative. Studies show that in the first year of life, infants exhibit empathy toward others in distress. At later stages in life we routinely work together to reach goals and help out in times of need.

Yet instances of selfish behavior also abound in society. One recent study used a version of the classic Prisoner's Dilemma, which can test people's willingness to set aside selfish interests to reach a greater good. After modeling different strategies and outcomes, the researchers found that being selfish was more advantageous than cooperating. The benefit may be short-lived, however. Another study showed that players who cooperated did better in the long run.

It seems that human nature supports both prosocial and selfish traits. Genetic studies have made some progress toward identifying their biological roots. By comparing identical twins, who share nearly 100 percent of their genes, and fraternal twins, who share about half, researchers have found overwhelming evidence for genetic effects on behaviors such as sharing and empathy. In these twin studies, identical and fraternal twins are placed in hypothetical scenarios and asked, for example, to split a sum of money with a peer. Such studies often also rely on careful psychological assessments and DNA analysis.

Other work highlights specific genes as key players. My colleagues and I recently identified a gene linked to altruistic behavior and found that a particular variant of it was associated with more selfish behavior in preschoolers.

As for how we might have acquired a genetic blueprint for collaboration, evolutionary scientists offer several explanations. Cooperative behavior may have evolved first among relatives to promote the continuation of their genetic line. As communities diversified, such mutual support could have broadened to include individuals not linked by blood. Another possibility is that humans cooperate to gain some advantage, such as a boost in reputation. Finally, a hotly debated idea is that evolutionary processes take place at the group level. Groups of highly cooperative individuals have higher chances of survival because they can work together to reach goals that are unattainable to less cooperative groups.

Yet almost no behavior is entirely genetic, even among identical twins. Culture, school and parenting are important determinants of cooperation. Thus, the degree to which we act cooperatively or selfishly is unique to each individual and hinges on a variety of genetic and environmental influences.

Can adults improve their emotional intelligence with training?

—**Emily Lenneville,** Baltimore

John D. Mayer, professor of psychology at the University of New Hampshire, replies:

A cautious answer is that psychologists still are not sure whether adults can enhance their emotional intelligence. Current research suggests, however, that people can almost surely increase their emotional competence.

To explain the distinction, I first need to define these terms. Emotional intelligence is the ability to reason about emotions and emotional information, which includes recognizing, understanding and managing feelings in ourselves. Psychologists view intelligence as mental capacities. Demonstrating an increase in a person's potential to learn something is very difficult, which is why we do not know whether emotional intelligence can improve.

In contrast, emotional competence—a person's emotional functioning or ability to learn about emotions—is relatively straightforward to measure. The largest review of curricula in social and emotional learning, which aggregated studies with thousands of participants, indicated that the programs improve students' social interactions, well-being and sometimes even academic achievement. The few studies that have focused exclusively on adult learning appear to follow the same pattern, so there is good reason to believe that emotional knowledge and functioning can be enhanced in adulthood.

Finally, I would ask: Is it worth improving our emotional functioning? Some pundits overestimate the importance of emotional intelligence—saying, for example, that emotional intelligence explains more than 85 percent of outstanding performance in top leaders and that emotional intelligence—not IQ—predicts exemplary performance. My colleagues and I have never found such claims to be true. Rather we have uncovered more modest benefits, namely that greater emotional intelligence can improve relationships and happiness over time.

Individuals can find success in many ways and may not feel the need to improve emotional intelligence. But those who do want to learn about their emotions may be pleased with the rewards. M

JAMIE CARROLL /*Stockphoto*

1 FILL IN THE BLANKS

Each of the following words contains the letters SEP. There may be other appearances of each letter in the word, but each letter is shown only once. Using the definitions, fill in the words.

Architectural term for a church section: _ _ _ _ S E P _
A dangerous occupation working on high locations: S _ E _ P _ _ _ _ _ _
To pull apart: S E P _ _ _ _ _

2 WORD MORPH

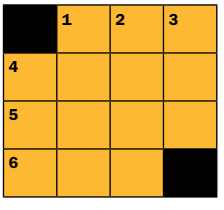
Go from DIRT to ROAD in only seven steps, changing one letter at a time and making a common English word each time. (Example: CAP to HAT in two steps: CAP, CAT, HAT.)

D I R T
_ _ _ _
_ _ _ _
_ _ _ _
_ _ _ _
_ _ _ _
_ _ _ _
R O A D

3 MINI CROSSWORD

Across
1 Sum
4 Disfiguring mark
5 Host
6 Go

Down
1 Land measure
2 Moist
3 Not moist
4 Tree fluid



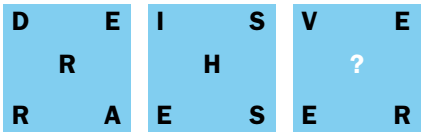
4 WHAT A LARK

Each definition below applies to a word that begins with the four-letter name of a bird. Find all three words.

King topper _ _ _ _ _ (5 letters)
Very chic _ _ _ _ _ _ (6 letters)
Plumber's tool _ _ _ _ _ _ (6 letters)

5 HIDDEN MESSAGE

From the squares below, starting with the right-hand square, spell out a three-word sentence and determine the missing letter.



6 MAGIC SQUARE

Complete the word square below by inserting the nine letters into the grid, one per square, to create the same words reading across and down.

C C E E E E M N R

C	O	A	T
O			
A			
T			

7 ANAGRAM

Find two six-letter words that are anagrams of each other to complete the sentence below.

To understand a _ _ _ _ _ _ system in mathematics, it helps to be _ _ _ _ _ _.

8 POETIC DEFINITION

Choose the correct letter from each clue in the rhyme below, then read the letters in order. They will spell out the answer to the riddle.

My first is in three and also in tray.
My second in burn but not in bray.
My third in lamp and also loop.
My fourth in pile but not in coop.
My last in part and also pink.
My whole a flower you will think.

_ _ _ _ _

9 CITY STUMPER

Fill in the blanks to get the names of four North American cities.

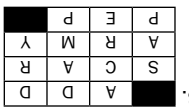
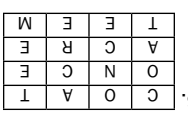
_ _ L _ A _ K _ _
_ Y _ _ C _ S _
_ _ F _ A L O
M _ _ T _ E _ _

10 END GAME

In each row, think of the five-letter answer to the clue on the left, then change its last letter to make the five-letter answer to the clue on the right.

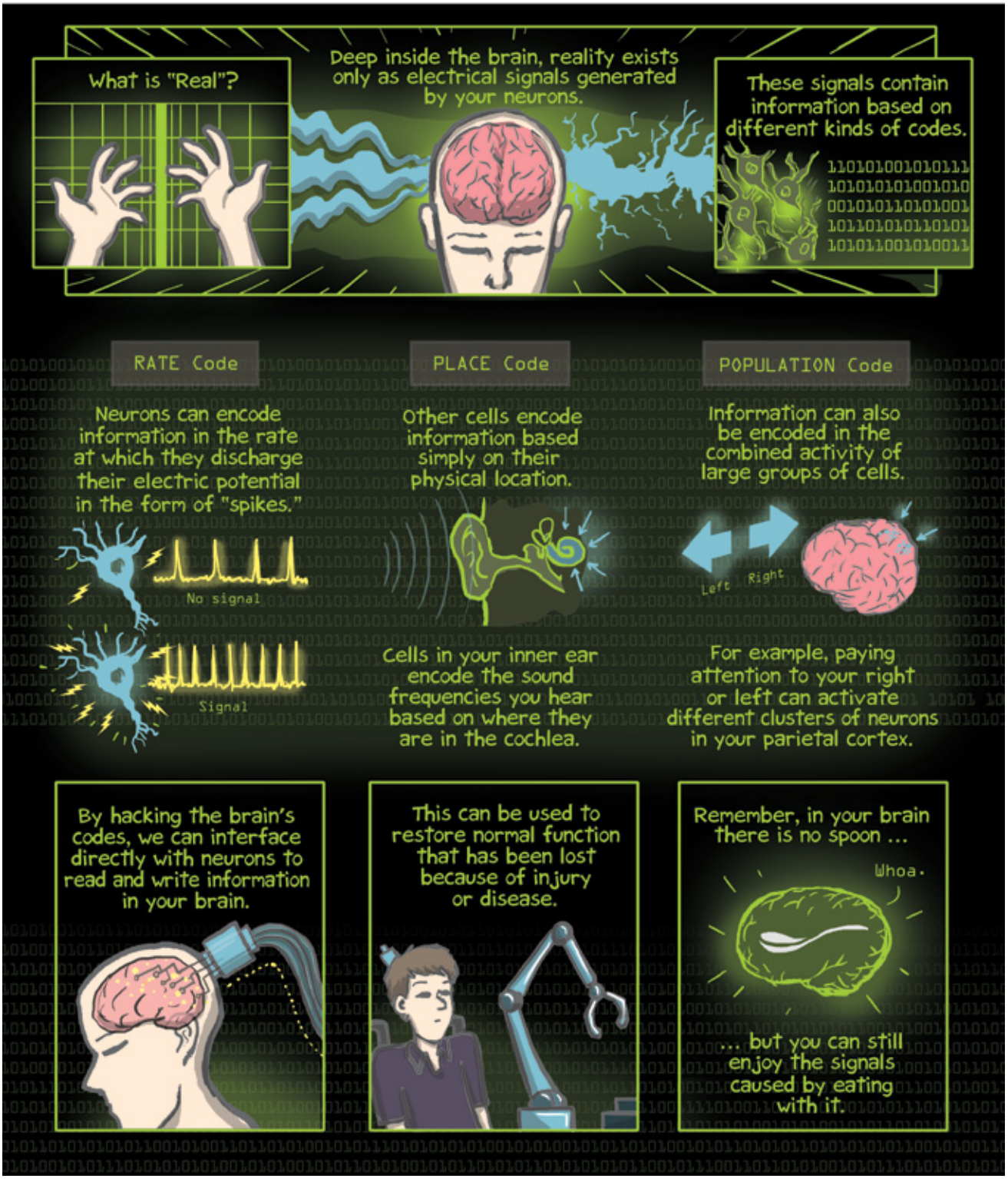
Transparent _ _ _ _ _ / _ _ _ _ _ Spotless
Last Supper cup _ _ _ _ _ / _ _ _ _ _ Elevator filler
Brief affair _ _ _ _ _ / _ _ _ _ _ Fire-starting aid

Answers

1. TRANSEPT, STEEPLEJACK, SEPARATE.
2. One possible solution: DIRT, DINT, DENT, LENT, LEND, LEAD, LOAD, ROAD.
3. 
4. CROWN, SWANKY, WRENCH.
5. REVERSE IS HARDER. (The missing letter is R.)
6. 
7. BINARY, BRAINY.
8. TULIP.
9. MILWAUKEE, SYRACUSE, BUFFALO, MONTREAL.
10. CLEAR, CLEAN; GRAIL, GRAIN; FLING, FLINT

The Mind Code

BY DWAYNE GODWIN & JORGE CHAM



Dwayne Godwin is a neuroscientist at the Wake Forest University School of Medicine.
Jorge Cham draws the comic strip *Piled Higher and Deeper* at www.phdcomics.com.

Think Clearly.

Your brain. It makes up only 2% of your body weight, yet it consumes roughly 20% of your body's energy when at rest. That means the human brain needs a whole lot of nutrition to stay alert and focused throughout the day. Citicoline is nature's way of keeping the brain's energy-producing centers firing. Clinically tested for efficacy, Cognizin® delivers a patented form of Citicoline that supplies your brain with the energy it needs to stay sharp.* Cognizin is also pure, vegetarian and allergen-free. So look for Cognizin brand Citicoline on the ingredient panel of your favorite supplements to help keep your mental edge.*

Cognizin®

For the evolution of your mind®

To learn more about Cognizin®
visit **www.cognizin.com**

Follow Cognizin®

***These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease.**

Look for Cognizin® Citicoline in these fine brands.

Ecological Formulas · Emerald Laboratories · Farmacist Healing · Gungho · Healthy Origins · HempNatura · Jarrow Formulas · Balance Your Life JoMar Labs · LifeExtension · NSI Nutraceutical Sciences Institute · nawgan · Pathway To Healing · Cerebral Success SmartX · SomaLife · Swanson Health Products · TianChi

Get All-Access to THE ARCHIVES

EVERY ISSUE. EVERY YEAR. 1845–PRESENT.

All-Access Subscriptions Now Available!

PRINT
12 issues featuring the latest developments in science, medicine and technology.

+

ARCHIVES
Search over 4,960 issues and 133,700 articles to find the information you need. 1845–present.

+

DIGITAL
Instant access to current issues and the archive using any computer, tablet or smartphone.*

www.scientificamerican.com/all-access

SCIENTIFIC AMERICAN™

*Internet connection required.