

SCIENTIFIC AMERICAN
MIND

BEHAVIOR • BRAIN SCIENCE • INSIGHTS

January/February 2016

Mind.ScientificAmerican.com

Surprising
Truths about
Concussions

page 50

Young and
Transgender

How best
to help
them
thrive

Cultivate
Your
Creativity

User's
Guide to
Sleep
Drugs

THE ARCHIVES

Explore over 170 years of science history. Search any issue from 1845–present.



Enjoy All-Access!

Read any issue, any year, on any device.

Receive 12 new issues (one year) of *Scientific American* in both print and digital.

Plus, get full access to our award winning Archives, where you can explore any issue in our long history, 1845–present. Subscribe now. Go to:

scientificamerican.com/all-access

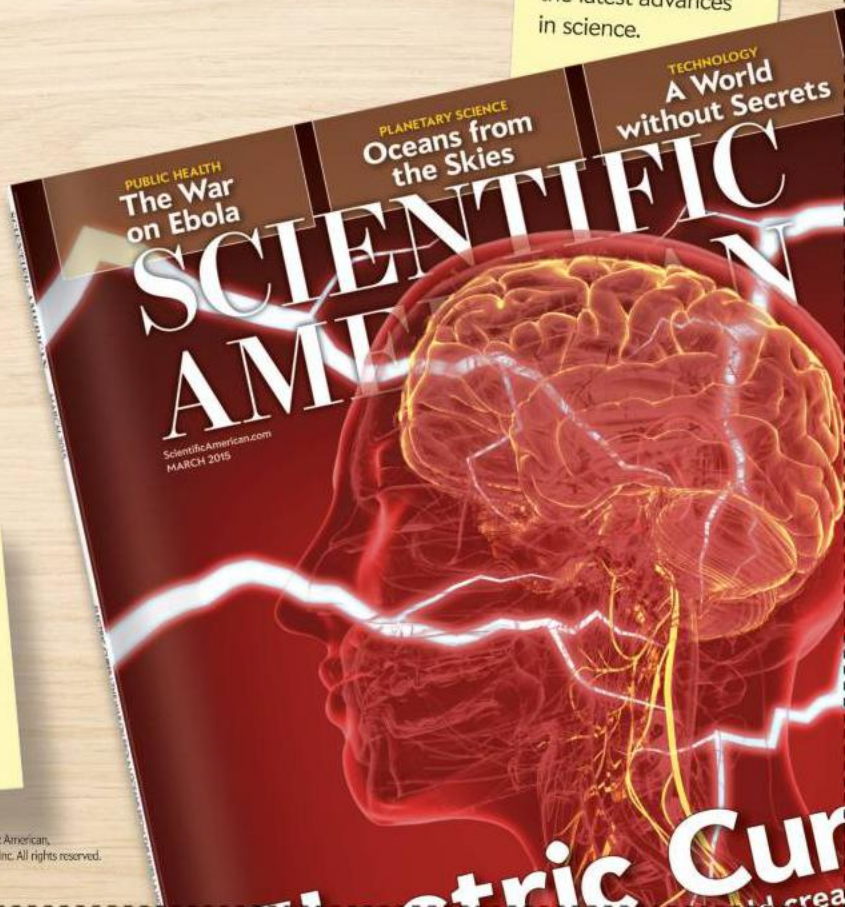
PRINT

12 issues filled with the latest advances in science.



DIGITAL

Online access to your subscription using any computer, tablet or smartphone.



EDITOR IN CHIEF AND SENIOR VICE PRESIDENT:
 Mariette DiChristina

EXECUTIVE EDITOR: Fred Guterl

MANAGING EDITOR: Claudia Wallis

SENIOR EDITOR: Kristin Ozelli

ASSOCIATE EDITOR: Daisy Yuhas

EDITOR AT LARGE: Gary Stix

ART DIRECTOR: Patricia Nemoto

ASSISTANT ART DIRECTOR, IPAD: Bernard Lee

PHOTO RESEARCHER: Liz Tormes

CONTRIBUTING EDITORS:

Gareth Cook, Robert Epstein, Ferris Jabr,
 Emily Laber-Warren, Karen Schrock Simring,
 Victoria Stern, Sandra Upson

COPY DIRECTOR: Maria-Christina Keller

SENIOR COPY EDITOR: Daniel C. Schlenoff

COPY EDITOR: Aaron Shattuck

PREPRESS AND QUALITY MANAGER:
 Silvia De Santis

MANAGING PRODUCTION EDITOR: Richard Hunt

SENIOR PRODUCTION EDITOR: Michelle Wright

SENIOR PRODUCT MANAGER: Angela Cesaro

PRODUCT MANAGER: Cianna Kulik

DIGITAL PRODUCTION MANAGER: Kerrissa Lynch

WEB PRODUCTION ASSOCIATES:

Nick Bisceglia, Ian Kelly

EDITORIAL ADMINISTRATOR: Ericka Skirpan

SENIOR SECRETARY: Maya Harty

SENIOR PRODUCTION MANAGER: Christina Hippeli

ADVERTISING PRODUCTION CONTROLLER:

Carl Cherebin

PRODUCTION CONTROLLER: Brittany DeSalvo

BOARD OF ADVISERS:

HAL ARKOWITZ: Associate Professor of Psychology,
 University of Arizona

STEPHEN J. CECI: Professor of Developmental
 Psychology, Cornell University

R. DOUGLAS FIELDS: Neuroscientist, Bethesda, Md.

SANDRO GALEA: Dean and Professor,
 Boston University School of Public Health

S. ALEXANDER HASLAM:
 Professor of Social and Organizational Psychology,
 University of Queensland

CHRISTOF KOCH: President and Chief Scientific
 Officer, Allen Institute for Brain Science

SCOTT O. LILJENFELD:
 Professor of Psychology, Emory University

STEPHEN L. MACKNIK: Professor of Ophthalmology,
 SUNY Downstate Medical Center

SUSANA MARTINEZ-CONDE: Professor of
 Ophthalmology, SUNY Downstate Medical Center

JOHN H. MORRISON: Dean, Basic Sciences and
 Graduate School of Biomedical Sciences, and
 Professor of Neuroscience, Friedman Brain Institute,
 Icahn School of Medicine at Mount Sinai

VILAYANUR S. RAMACHANDRAN:
 Director, Center for the Brain and Cognition,
 University of California, San Diego, and Adjunct
 Professor, Salk Institute for Biological Studies

DIANE ROGERS-RAMACHANDRAN:
 Research Associate, Center for the Brain and
 Cognition, University of California, San Diego

STEPHEN D. REICHER:
 Professor of Psychology, University of St. Andrews

*Some of the articles in Scientific American Mind
 are adapted from articles originally appearing
 in Gehirn & Geist.*



Matters of Identity

Is it a boy or a girl? When it comes to personal identity, gender is so foundational that it is often the first thing we ask new parents when we learn that a human being has entered the world. But as the behavioral sciences have revealed, gender is not the simple binary matter implied in that age-old question. Nor is it so easy to determine from a child's visible anatomy. For an estimated 0.3 percent of people in the U.S., external appearance feels like a terrible mistake.

In a sensitive and deeply reported cover story that begins on page 26, journalist Francine Russo examines the latest research and an ongoing debate among clinicians about how best to help children and adolescents with gender dysphoria—what experts describe as the “insistent, consistent and persistent” sense that one's sex is not what was written on the birth certificate. Some children make this known almost from the moment they can speak. “Mama, something went wrong when I was in your tummy,” one three-year-old told a mother interviewed by Russo.

Knowing how—and especially when—to intervene for such young people is a fast-shifting frontier of medicine—one with even more ethical and cultural minefields than are faced by transgender adults. “I found it so wrenching for both the kids and their parents,” Russo says of her reporting experience. Fortunately, she notes, “good futures are now possible, especially if they get help early.”

In this first issue of 2016, we continue the proud, 170-year-old *Scientific American* tradition of offering articles written by leading scientists. In an article beginning on page 36, Stanford University psychologist Carol S. Dweck updates her influential research on “growth mind-set”—the belief that your intelligence is not fixed but can be developed through effort. Dweck walks us through a riveting array of recent studies that demonstrate the influence of personal mind-set on student learning, organizational success and even political peacemaking.

Can you be addicted to the Internet? How about sex, eating or video games? Beginning on page 42, Columbia University psychiatrist Carl Erik Fisher sizes up research on “behavioral addictions,” adding insights from his clinical practice.

Who among us doesn't hope to bring creativity to whatever work we do? In an excerpt from their new book *Wired to Create*, University of Pennsylvania psychologist and *Scientific American* blogger Scott Barry Kaufman and journalist Carolyn Gregoire examine research on the traits, brain chemistry and habits of mind that power invention. Turn to page 62 and learn how to cultivate creativity in the new year.

Claudia Wallis
 Managing Editor
 MindEditors@sciam.com

SCIENTIFIC AMERICAN MIND CONTENTS

FEATURES



26 Transgender Kids

Debate is growing among experts about when to intervene and how best to meet their urgent needs.

BY FRANCINE RUSSO



36 The Remarkable Reach of Growth Mind-sets

Believing in people's ability to change can help thwart teen depression, foster workplace creativity and ease political conflict.

BY CAROL S. DWECK



42 Addicted to Food, Games, Gambling, Sex, the Internet ...

Are "behavioral addictions" really mental illnesses or just bad habits? A look at the latest evidence.

BY CARL ERIK FISHER



50 Six Things You Should Know about Concussions

Much of what we've heard is wrong. Here is the latest lowdown on these brain injuries plus new ideas about how to treat them.

BY KAREN SCHROCK SIMRING



58 Breaking the Cycle

Victims of sexual assault in childhood face a higher risk of future abuse, but new insights suggest a way out.

BY SUSHMA SUBRAMANIAN



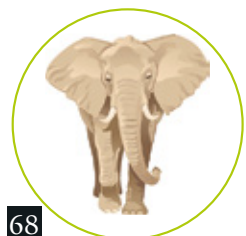
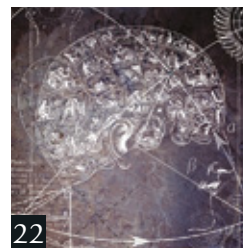
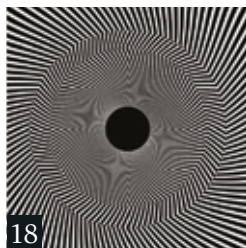
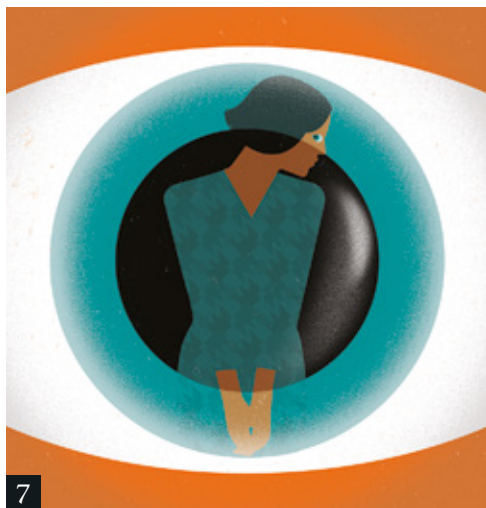
62 How to Cultivate Creativity

Research shows that being open to new experiences spurs innovation in the arts, sciences and life.

BY SCOTT BARRY KAUFMAN AND CAROLYN GREGOIRE

ON OUR COVER The 10-year-old on our cover was one of about two dozen transgender children in the Netherlands photographed by Sarah Wong, beginning in 2003, for her series and book *Inside Out: Portraits of Cross-gender Children*. To see more of Wong's work, which follows these youngsters as they grow, go to www.sarahwong.com/independent.

DEPARTMENTS



1 From the Editor

4 Letters

7 Head Lines

What our eyes communicate.

The skinny on sleeping pills.

Mass shootings are contagious.

How clothes affect our thinking.

Why we claim to know things we don't.

Breakthroughs in multiple sclerosis.

How to be a better runner.

Smell tests may reveal brain damage.

18 Illusions

Changes in our ability to see illusions offer clues to how the brain ages.

BY STEPHEN L. MACKNIK AND SUSANA MARTINEZ-CONDE

20 Perspectives

Don't Touch That Dial

Scientists have linked TV viewing to antisocial behavior and lowered IQ, but a new study raises questions.

BY R. DOUGLAS FIELDS

22 Consciousness Redux

A recent discovery proves embarrassing to any notion of humanity's innate superiority.

BY CHRISTOF KOCH

68 Reviews and Recommendations

The strange new science of the self. Learning to eat. The inner world of animals. Q&A with neuroscientist David Eagleman.

70 Ask the Brains

Can stress be beneficial? Why can I "see" memories?

73 Head Games

Try these Mensa puzzles.

76 Mind in Pictures

Addiction.

BY DWAYNE GODWIN AND JORGE CHAM

Scientific American is a division of Nature America, Inc., an entity of Springer Nature, which owns or has commercial relations with thousands of scientific publications (many of them can be found at www.springernature.com/us). *Scientific American Mind* maintains a strict policy of editorial independence in reporting developments in science to our readers.

Scientific American Mind (ISSN 1555-2284), Volume 27, Number 1, January/February 2016, 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 American 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.

Copyright © 2015 by Scientific American, a division of Nature America, Inc. All rights reserved.



PRESIDENT: Steven Inchcoombe
 EXECUTIVE VICE PRESIDENT: Michael Florek
 EXECUTIVE VICE PRESIDENT GLOBAL ADVERTISING
 AND SPONSORSHIP: Jack Laschever
 VICE PRESIDENT AND ASSOCIATE PUBLISHER, MARKETING
 AND BUSINESS DEVELOPMENT: Michael Voss
 DIRECTOR, INTEGRATED MEDIA SALES: Stan Schmidt
 ASSOCIATE VICE PRESIDENT, BUSINESS DEVELOPMENT:
 Diane McGarvey
 VICE PRESIDENT, GLOBAL MEDIA ALLIANCES:
 Jeremy A. Abbate
 VICE PRESIDENT, CONSUMER MARKETING:
 Christian Dorbandt
 DIRECTOR, INTERNATIONAL DIGITAL DEVELOPMENT:
 Richard Zinken
 ASSOCIATE CONSUMER MARKETING DIRECTOR:
 Catherine Bussey
 SENIOR CONSUMER MARKETING MANAGER: Lou Simone
 CONSUMER MARKETING OPERATIONS MANAGER:
 Kay Floersch
 E-COMMERCE MARKETING MANAGER: Evelyn Veras
 MARKETING DIRECTOR: Diane Schube
 SALES DEVELOPMENT MANAGER: David Tirpack
 PROMOTION ART DIRECTOR: Maria Cruz-Lord
 MARKETING RESEARCH DIRECTOR: Rick Simone
 ONLINE MARKETING PRODUCT MANAGER: Zoya Lysak
 MARKETING AND CUSTOMER SERVICE COORDINATOR:
 Christine Kaelin
 SENIOR COMMUNICATIONS MANAGER: Rachel Scheer
 SENIOR INTEGRATED SALES MANAGERS: Jay Berfas,
 Matt Bondlow, Janet Yano (West Coast)
 SALES REPRESENTATIVE: Chantel Arroyo
 CUSTOM PUBLISHING EDITOR: Lisa Pallatroni
 SENIOR ADMINISTRATOR, EXECUTIVE SERVICES:
 May Jung

HOW TO CONTACT US

FOR ADVERTISING INQUIRIES:

Scientific American Mind
 1 New York Plaza, Suite 4500
 New York, NY 10004-1562
 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
 1 New York Plaza, Suite 4500
 New York, NY 10004-1562
 212-451-8877
 fax: 212-451-8252
reprints@sciam.com

**FOR PERMISSION TO COPY OR
 REUSE MATERIAL FROM SCIAMMIND:**

Permissions Department
 Scientific American Mind
 1 New York Plaza, Suite 4500
 New York, NY 10004-1562
 212-451-8546
www.ScientificAmerican.com/permissions
 Please allow three to six weeks
 for processing.



THE NONDIET PLAN

Regarding Charlotte N. Markey's article "Don't Diet!" I would like to say, simply, "Exactly!"

In December 2012 I weighed 200 pounds and was huffing and puffing when walking my steeply sloped property. My significant other recommended I monitor what I ate, so I set up a spreadsheet and recorded everything, changing nothing intentionally: snacking, eating out whenever I felt the urge, having a big steak now and then. I also weighed myself every day, at the same time every day, right after a shower. By January, I had a pretty good idea of what maintained my weight—except that, oddly, I had lost a few pounds, too. Interesting.

I shifted gears very slightly. My doctor suggested a good breakfast, a hearty lunch, a modest dinner. So I added a few calories to breakfast and lunch and subtracted some from dinner. I continued to lose weight. Very interesting. I then shaved a few calories here and there by adjusting portions and making sure that I was active after breakfast and lunch and that I ate dinner at least three hours before bedtime. More weight loss. It became a kind of game: Where could I adjust portions (and calories), still feel satisfied and continue to lose weight?

To cut to the chase, my doctor, initially pleased with my weight-loss program, was stunned with the results. Not only

had my weight dropped to 160 pounds over a year, my blood pressure had gone from 145 over 80 to 116 over 68.

I continued for a second year, and my weight went down to 150 pounds and then stabilized at 162. There it has stayed for the past 18 months. I no longer use spreadsheets or count calories. To put it simply, I've found that my eating habits have changed. Do I still eat the occasional candy bar? Sure—and without guilt. Do I have a drink now and then? Yep. Do I feel deprived of anything I crave? Nope, because I don't deny myself anything; I just watch my weight. And my blood pressure is to live for.

And my steep property? Weirdly, it seems to have leveled out. I no longer huff or puff. My doc is happy, and so am I.

Paul Jordan-Smith
 Grass Valley, Calif.

Recently I used a popular advertised diet plan to go from obese to a normal body mass index (BMI), and I have stayed within five pounds of that goal for about three months. I'm still learning the habits I'll need to stay there. I can testify that Markey is quite right about obsession and cognitive overload. I can also say that one of the pluses of my approach has been a modest time duration. It's been less than a year since I started, and I can see the end of the tunnel. With gradual habit change, I would probably have lost focus along the way.

Kevin O'Gorman
 via e-mail

MARKEY RESPONDS: O'Gorman raises a valuable point about the process of weight loss: *Wouldn't it be great if weight loss could be faster? Other readers also wrote in about specific diet plans that have worked for them. It is important to remember that different things may work for different people. When scientists report their findings with the aim of informing interventions and treatments, they describe what works for most people most of the time.*

We all (scientists and laypeople alike) would like to identify a diet that results in substantial, quick, sustained weight loss, ideally achieved through the absence of craving of



My Son Has a Disorder That May Not Exist

The symptoms are undeniable, but the research is limited, and so a debate rages over whether to recognize sensory processing disorder

By Melinda Wenner Moyer

My four-year-old experiences a different world than I do.

He sees a world of vibrant colors and textures. The tone of a warning siren from the car is different for him than it is for me. He has the sense of touch that allows him to feel the texture of a blanket or the feel of a pair of shoes. He has the sense of taste that allows him to enjoy the taste of a piece of food. He has the sense of hearing that allows him to hear the sound of a siren or the sound of a siren. He has the sense of smell that allows him to smell the scent of a flower or the scent of a flower. He has the sense of touch that allows him to feel the texture of a blanket or the feel of a pair of shoes. He has the sense of taste that allows him to enjoy the taste of a piece of food. He has the sense of hearing that allows him to hear the sound of a siren or the sound of a siren. He has the sense of smell that allows him to smell the scent of a flower or the scent of a flower.

high-calorie, sugary, nonnutritive foods. But to date, the evidence suggests that no diet meets all these criteria. The best reading of the research available suggests that slow weight loss from changes in habits is most likely to be sustainable for most people. If you find another approach that works for you and is healthy—stick with it! Otherwise, try what science recommends and leave the fads behind.

SENSORY OVERLOAD

I read with great interest the article “My Son Has a Disorder That May Not Exist,” by Melinda Wenner Moyer. I feel as if Moyer has somehow read my medical records, which are replete with statements such as “has hypersensitivity in smell” or “in feet” or “in hearing.” All smells seem strong to me. I can’t stand to wear socks or shoes, and I register even normal touch on my feet as intense pain. I also have incredibly sensitive hearing; for instance, I can pick out a conversation across a crowded room. I have been told since I was a small boy that I “overreact.” Now, at my age of 48, my wife continues to tell me this.

Moyer mentions that adults seem to have fewer sensory issues—or perhaps they simply manage their symptoms better. I believe that in adults these issues are being packaged with other adult afflictions or as a product of aging. I hope that people will see that learning about this disorder in both children and

adults is a worthwhile endeavor and that research funding will increase.

DeWayne Watts
via e-mail

FOLLOWING THE MONEY

This issue of the magazine was illuminating, as usual. The article “Raising Awareness or Drumming Up Sales?” by Melinda Wenner Moyer [Pharma Watch, Head Lines], was particularly informative, though alarming. A relatively new tool for patients that was not mentioned is the Open Payments program. Starting in 2013, the U.S. government has required pharmaceutical and medical device companies to track most payments made to all physicians, including psychiatrists and other specialists.

Consumers can see what payments their providers received by searching the published data. The interface is intuitive and quickly returns results. We are entitled as patients to see this information and to have a dialogue with our providers about such payments.

The data are collected and published by the Centers for Medicare & Medicaid Services. Here is the link: <https://openpaymentsdata.cms.gov/search>.

Cristina Warner
Castro Valley, Calif.

The Pharma Watch article erred in several respects by stating that the Restless

Legs Syndrome (RLS) Foundation is “an organization that is heavily subsidized by GlaxoSmithKline.”

Although the RLS Foundation accepted substantial donations from pharmaceutical companies a decade or so ago, it has not accepted any donations from GlaxoSmithKline since 2012, when the company donated \$20,000, less than 4 percent of our then annual income. The RLS Foundation is funded almost entirely by donations from individuals who are RLS sufferers and their relations. Charity Navigator has given the RLS Foundation its highest rating.

Contrary to the impression the article leaves, RLS is a serious medical condition with several known genetic risk factors. It affects millions of individuals in the U.S. and around the world. PubMed lists more than 3,500 articles discussing its causes and treatment. Your implication that RLS is an invention of a pharmaceutical company is unjustified and unscientific.

Karla M. Dzienkowski
Executive director, Restless Legs Syndrome Foundation
Austin, Tex.

THE EDITORS REPLY: We apologize for the outdated information and any impression that this syndrome is not a real issue for patients. We should have written that the RLS Foundation was subsidized by GlaxoSmithKline in the early 2000s. As such, it fit the trend we hoped to expose: awareness organizations and campaigns are often funded by pharmaceutical companies to coincide with the release of a relevant drug.

ERRATUM

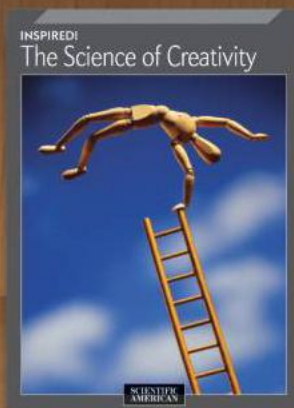
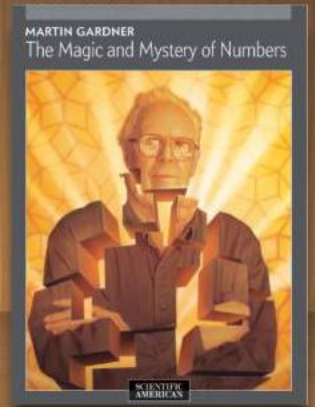
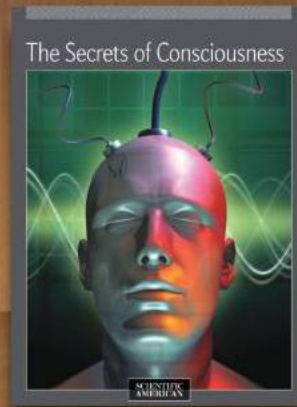
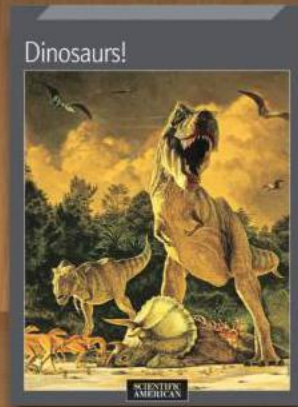
“When Cops Lose Control,” by Rachel Nuwer [November/December 2015], wrongly included Trayvon Martin in a list of people killed by police officers. Martin was shot by George Zimmerman, a neighborhood watchman.

HOW TO CONTACT US FOR GENERAL INQUIRIES OR TO SEND A LETTER TO THE EDITOR:
Scientific American Mind
1 New York Plaza, Suite 4500
New York, NY 10004-1562
212-451-8200
MindLetters@sciam.com

PROMOTION



eBooks
From the Editors of
SCIENTIFIC AMERICAN™



© 2014 Scientific American, Inc.

Start your SCIENTIFIC AMERICAN eLibrary today:
books.scientificamerican.com/sa-ebooks

Head Lines

A USER'S GUIDE TO THE BRAIN



What Our
Eyes Say



SOCIAL INTERACTION: THE EYES HAVE IT

When we lock onto another person's gaze, we are sharing information about our own personality, sizing up their character and signaling our intentions. Our pupils even dilate to unconsciously mimic those of our peers as we converse, revealing trust and affinity. The eyes are truly a window into our social soul.

Eye Contact: How Long Is Too Long?

Research explores the factors that influence our tolerance for long mutual gazes

There's a reason your mother told you to look people in the eye when you talk to them: eye contact conveys important social cues. Yet when someone holds your gaze for more than a few seconds, the experience can take on a different tenor. New work elucidates the factors that affect whether we like or loathe locking eyes for a lengthy period.

Researchers have long known that eye contact is an important social signal. Our recognition of its import may even be hardwired. One study found that five-day-old babies prefer looking at faces that make direct eye contact compared with faces that have an averted gaze. "Eye contact provides some of the strongest information during a social interaction," explains James Wirth, a social psychologist now at Ohio State University at Newark, because it conveys details about emotions and intentions. (Lack of eye contact is one of the early signs of autism in infants and toddlers.) The power of eye contact is so great that, according to a 2010 study

co-authored by Wirth, if someone avoids your gaze for even a short period, you may feel ostracized.

But what determines how we feel about prolonged eye contact? One recent study explored this question. In research presented in May 2015 at the Vision Sciences Society conference, psychologist Alan Johnston and his colleagues at University College London collected information from more than 400 volunteers about their personalities. Then the subjects indicated their comfort level while watching video clips of actors who appeared to be looking directly at them for varying lengths of time.

Johnston and his colleagues found that, on average, the subjects liked the actors to make eye contact with them for 3.2 seconds, but the subjects were comfortable with a longer duration if they felt the actors looked trustworthy as opposed to threatening. "Gaze conveys that you are an object of interest, and interest is linked to intention," Johnston explains—

so if someone appears threatening and holds your gaze, that could indicate that the person has bad intentions. This idea could help explain findings from a controversial study published in 2013, which reported that people are more likely to change their views on a political issue when they are being challenged by people who do not make eye contact with them. If the challengers had made eye contact, they might have seemed more threatening and less trustworthy.

Our reaction to prolonged eye contact may relate to how we perceive ourselves, too. Johnston and his colleagues found that the more cooperative and warm subjects believed themselves to be, the longer they liked eye contact to be held. Johnston speculates that the more socially comfortable a person feels, the more he or she may "enjoy the intimacy of mutual gaze."

—Melinda Wenner Moyer

ILLUSTRATIONS BY NEIL WEBB



Scientists believe the human eye's dark pupil and iris set against a white sclera evolved to aid communication, whereas the overall darkness of many animal eyes evolved for camouflage.

Synchronized Pupils

Humans unconsciously match the pupil size of peers

Pupils are a rich source of social information. Although changes in pupil size are automatic and uncontrollable, they can convey interest, arousal, helpful or harmful intentions, and a variety of emotions. According to a new study published in *Psychological Science*, we even synchronize our pupil size with others—and doing so influences social decisions.

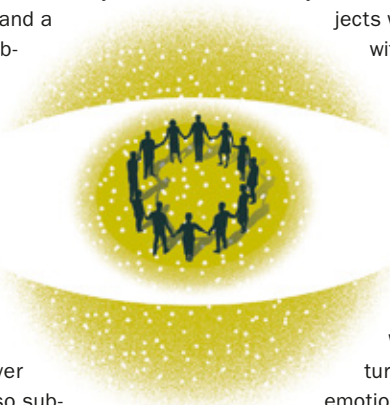
Mariska Kret, a psychologist now at the University of Amsterdam in the Netherlands, and her colleagues recruited 69 Dutch university students to take part in an investment game. Each participant decided whether to transfer zero or five euros to a virtual partner after viewing a video of their eyes for four seconds. The invested money is tripled, and the receiver chooses how much to give back to the donor—so subjects had to make quick decisions about how trustworthy each virtual partner seemed.

Using an eye tracker, the investigators found that the participants'

pupils tended to mimic the changes in the partners' pupils, whether they dilated, constricted or remained static. As expected, subjects were more likely to give more money to partners with dilating pupils, a well-established signal of non-threatening intentions. The more a subject mirrored the dilating pupils of a partner, the more likely he or she was to invest—but only if they were of the same race. The Caucasian participants trusted Caucasian eyes more than Asian eyes—which suggests that group membership is important when interpreting these subtle signals.

Mimicry is common in social interactions. We establish rapport by adopting another's postures, facial expressions and even heartbeat. "In emotion research, there's a lot of focus on facial expressions," Kret says. "Given that we spend so much time looking at each other's eyes, I think we can learn a lot more from the pupils."

—Diana Kwon



Competitors can comfortably maintain eye contact longer than collaborators, perhaps because prolonged eye contact suggests intimidation.

Your Turn to Say Something

We signal our intention to speak or pause for a response by directing our eyes

You may think the fine art of conversation is all about the words you speak. But research suggests your eyes have something to say, too, letting others know when it's their turn to pipe up.

Turn taking in conversation is a topic of high interest to scientists because

it happens so quickly—much faster than our brain is thought to be able to comprehend the words being spoken. Studies stretching back to the 1960s hint that we use eye gaze as a possible turn-taking signal. Yet until recently, such conclusions were usually based on simple, highly controlled interactions or observations of individuals on just one side of a conversation, explains Tom Foulsham, a psychology researcher at the University of Essex in England.

In an effort to track back-and-forth glances over time during more natural conversations, Foulsham and his colleagues at the University of British Columbia attached video eye-tracking devices to 40 individuals, who paired up in groups of two to play 20 Questions or Heads Up!—a Taboo-like word-guessing game.

Although the two games spurred slightly different conversation dynamics, researchers

consistently saw eye-gaze patterns akin to those described previously: individuals typically averted their gaze from the listener while speaking, looking directly at them as they wrapped up their talking turn, according to the report in August in *PLOS ONE*. Listeners, meanwhile, maintained a more constant focus on the speaker but looked away as they shifted into a talking role.

"There's this kind of dance that people do," Foulsham says. "It's not just about looking someone in the eye—it's also about looking away from them."

It remains to be seen how these eye-gaze cues differ depending on the familiarity, rapport or personality traits of conversationalists and the nature of their discussion. Still, such studies may eventually help in everything from improved video conferencing to understanding the communication consequences of altered eye-gaze patterns in individuals on the autism spectrum.

—Andrea Anderson

People spend less time looking directly at people of higher social rank than those of lower social rank, perhaps in deference to their perceived power.





(PHARMA WATCH)

One Pill Makes You Drowsy

New pills offer hope for insomniacs, but inducing healthy sleep is still tricky

Last year a new sleep drug called Belsomra came on the market, featuring a mechanism unlike any other pill: it mimics narcolepsy. That might sound odd, but the potential users are many. More than 8.5 million Americans take prescription sleep aids, and many others use snooze-inducing over-the-counter medications. All these pills, including Belsomra, do one of two things: they enhance the effects of the neurotransmitter GABA, known for qui-

eting brain activity, or they arrest the actions of neurotransmitters that keep the brain aroused. Yet it's not quite as simple as flipping a switch; the drugs have a range of side effects, including daytime drowsiness, hallucinations and sleep-eating. Here's an overview of the sleeping pills currently available in the U.S.—plus a look (*opposite page*) at cognitive-behavior therapy for insomnia, which may be more successful than drugs alone. —*Veronique Greenwood*

Class	Drugs	How They Work	Selected Side Effects	Notes
Benzodiazepines	Lorazepam (Ativan), diazepam (Valium), temazepam (Restoril)	These drugs bind to a type of GABA receptor, increasing its affinity for the neurotransmitter. As long as the drug is bound to the receptor, neural activity is dampened.	Dependency and withdrawal are known problems. These drugs can also make it more difficult to wake up if you stop breathing, making them dangerous for people with respiratory problems. Also, you may feel woozy in the morning, which can contribute to falls and car accidents.	They can cause memory loss. This may be because they bind to GABA receptors on neurons beyond those that are involved in sleep and wakefulness.
Z-drugs	Zolpidem (Ambien), zaleplon (Sonata), eszopiclone (Lunesta), zopiclone (Zimovane)	These bind to a different, less widely distributed part of the same GABA receptor as benzodiazepines.	Less habit-forming and causing less daytime sleepiness. But some people find themselves sleep-driving and sleep-eating.	At least one study found that in chronic insomnia, the z-drug zopiclone was no more effective than placebo. That doesn't mean z-drugs don't help, though: the placebo effect in insomnia treatment is very strong.
Orexin antagonists	Suvorexant (Belsomra)	Brand-new last year, this drug was designed to mimic narcolepsy by blocking the receptors for orexin, a neurotransmitter that promotes wakefulness.	In clinical trials, some people reported odd hallucinations just as sleep came. Vivid dreams were also twice as common as with a placebo.	In clinical trials, there were no reports of another symptom of narcolepsy called cataplexy—the sudden loss of muscle tone at moments of high emotion. But as the drug reaches more people, some doctors are curious about whether cases of cataplexy will crop up.
Melatonin agonists	Ramelteon (Rozerem), tasimelteon, melatonin	Available in supplements, melatonin is a hormone naturally produced in the early evening to signal that night has come. Ramelteon and tasimelteon bind to melatonin receptors, producing a similar effect.	Taken at the wrong time, these drugs can reset your circadian clock and have you awake and asleep at odd hours.	These drugs only slightly shorten the amount of time it takes to fall asleep. More useful for people with irregular work or travel schedules than those with chronic insomnia.
Antihistamines	Doxylamine (Unisom), diphenhydramine (Benadryl)	Cross the blood-brain barrier and block the receptors for histamines and the neurotransmitter acetylcholine, which contributes to alertness.	Sleepiness the next morning is a common problem.	These drugs are often the active ingredients in over-the-counter sleep aids such as Tylenol PM. They can be useful on an occasional basis, but some doctors say that chronic insomniacs can develop a tolerance quickly.

© ISTOCK.COM

Sleep Training for Grown-ups

It requires a lot more work than popping a pill, but cognitive-behavior therapy for insomnia (CBT-I) has been shown to successfully alleviate sleep problems. Aimed at developing healthy habits, CBT-I comes with a lot of homework—between weekly or so visits with a specialist, a patient keeps track of hours spent in bed and hours sleeping and uses the bed only for sleep and sex. The patient must stay up until an established bedtime and get up on awakening, generating a sleep deficit that makes it easier to fall asleep at the right time. Avoiding caffeine and alcohol after 4 P.M. and timing exercise so that it doesn't interfere with drowsiness are also part of the system.

Therapists will work on the cognitive aspects of insomnia, helping people recognize that a sleepless night is not the end of the world and teaching relaxation techniques that can help alleviate worry in the middle of the night. Many studies support the efficacy of this type of CBT. In one study, six months after a six-week CBT-I treatment patients were spending much more of their time in bed asleep than patients who took a z-drug instead.

"Many people, perhaps most people, with insomnia don't have anything wrong with their sleep-promoting mechanisms," says Tom Scammell, a sleep medicine doctor at Beth Israel Deaconess Medical Center in Boston. "They have quite often a problem with their wake-promoting mechanisms." In other words, activities during the day or evening—eating or drinking habits, say, or too much mental stimulation at bedtime—are causing the brain to remain alert. Getting the balance back—learning to put problems aside at the end of the day and give in to sleep—can help bring rest within reach, night after night. —V.G.



Mass Shootings Are Contagious

A contagion model shows violent shooting incidents occur in clusters, not randomly

No one knows why mass murderers commit their appalling deeds. But new evidence reinforces the idea that mass shootings, publicized in the media, may have a contagious effect.

Researchers at Arizona State University analyzed news reports of gun-related incidents from 1997 to 2013. They hypothesized that the rampages did not occur randomly over time but instead were clustered in patterns. The investigators applied a mathematical model and found that shootings that resulted in at least four deaths launched a period of contagion, marked by a heightened likelihood of more bloodshed, lasting an average of 13 days. Roughly 20 to 30 percent of all such violence took place in these windows.

Previous studies have shown that suicide can be similarly contagious. In one recent example, researchers found a correlation between celebrity suicides, like that of Robin Williams, and an increase in suicidal thoughts in an online Reddit suicide watch group for people battling depression.

"People are susceptible to information about these events, but the mechanism is less clear," says Andres Gomez-Lievano, a co-author of the mass-shooting study, published in July in *PLOS ONE*. Where and when the news reports were published could have an effect on incidence, says Dan Romer, director of the Adolescent Communication Institute at the University of Pennsylvania, who was not involved with the study. It is important to note, he says, that "suicides will trigger others, so it makes sense that people who want to commit suicide while killing others could be influenced in the same way." —Kat Long

Psychological Contagions

Many types of thoughts and behaviors can be socially contagious, according to a growing body of work.

- **Mass psychogenic illness.** When we see someone who is physically ill, we can manifest those symptoms simply by observing the person, leading to what looks like an outbreak.
- **Emotions.** Altruism and happiness can spread within social groups. The flip side is true as well: bad moods, sadness, loneliness and depression can also spread in social groups or among individuals.
- **Weight changes and disordered eating.** A 2007 study found that people are more likely to become obese when friends and relatives in their inner circle have gained a lot of weight. Some studies show that weight loss and disordered eating may be contagious, too.

—Victoria Stern

When Picky Eating Becomes a Disorder

A new diagnosis for kids who avoid food but do not have body-image issues

Plenty of children refuse to eat their vegetables, but for some the problem extends far beyond picky eating. In severe cases, abnormal eating patterns can lead to dangerously low body weight or nutrient deficiencies. Such children meet the criteria for a diagnosis made official by the American Psychiatric Association in 2013: avoidant/restrictive food intake disorder (ARFID). Since its addition to the psychiatric manual, the diagnosis has remained largely unused because of a general lack of awareness and understanding on the part of clinicians. Last July, in an effort to bring attention to the oversight, two pediatricians published a review in the *Journal of Adolescent Health* discussing the meager strides made in the two years since the creation of the diagnosis.

In the years leading up to 2013, clinicians were seeing a group of preteen and adolescent patients who shared a number of food-related symptoms, such as extreme pickiness or very low caloric intake, but who were too old to be diagnosed with a feeding disorder of infancy or early childhood. “Clinicians were clearly seeing patients with restrictive eating disorders without body-image or weight concerns,” which are a hallmark of other eating disorders, explains Rollyn Ornstein, an adolescent medicine physician at Penn State Hershey Medical Center,

who was not involved in the new paper. Eating-disorder experts created the diagnosis of ARFID to improve treatment of these patients and facilitate research into their condition.

The group of people who have ARFID differs significantly from those with other eating disorders. More boys are diagnosed, and patients are more likely to suffer from anxiety disorders. They also tend to be diagnosed at younger ages—average age of diagnosis is 11 or 12, compared with 14 or 15 for other eating disorders—although some are adults who have struggled for decades. Symptoms often seem to be related to difficulties in early childhood, such as an incident of choking or vomiting, a poor caretaker-child relationship, or psychosocial problems such as depression or anxiety. This deep history can make ARFID tricky to treat, although one intervention has shown promise: exposure-response prevention, in which patients slowly reintegrate certain foods while learning to avoid their unhealthy reactions.

Despite the clear need for the diagnosis and the two years that have passed since its creation, surveys show that 63 percent of pediatricians have never heard of ARFID, and patients suffer on average 33 months before diagnosis. These statistics are alarming, the authors of the new paper point out, considering that the prevalence of ARFID has been estimated at 3.2 percent in the general population and from 14 to 22.5 percent among children in pediatric treatment programs for any kind of eating disorder.

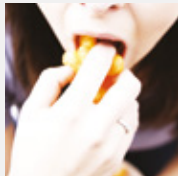
Ongoing studies are aimed at increasing awareness and use of the diagnosis, which will allow for research into a larger sample of patients. “Once we identify and characterize these cases, we can begin to study different types of treatments, long-term outcomes and root causes of the illness,” says Debra Katzman, a pediatrician at the Hospital for Sick Children in Toronto and an author of the recent paper. Getting a correct diagnosis is important for individuals, too—standard interventions for failure to thrive (when a child stops growing) could make ARFID worse, and treatment becomes more difficult the longer ARFID lingers. Experts hope knowledge about the diagnosis will start spreading more quickly—for kids with the disorder, the clock is ticking.

—Jessica Schmerler



Symptom Watch: Chewing and Spitting

This common behavior in eating disorders may be indicative of deeper problems



When you want the taste of food but none of the calories, it might seem like a harmless compromise to chew it up and spit it out, but new findings show otherwise. Chewing and spitting is common among patients receiving inpatient treatment for eating disorders, and previous research has linked the practice with greater illness severity. A study published last year in *Eating*

***Behaviors* confirmed those results and was the first to investigate co-occurring symptoms and personality traits. A third of the 324 inpatients studied reported that they had engaged in chewing and spitting during the eight weeks before admission to the hospital, and 21 percent did so at least once a week. When compared with patients who did not engage in this behavior or did so less than once a week, the higher-frequency group had a more troubling list of symptoms: they restricted food intake more often, exercised more excessively, had increased use of diet pills and laxatives, and had higher levels of depression, neuroticism and body dissatisfaction.**

The findings suggest that chewing and spitting could be a marker of severity for eating disorders. “It may be an ‘add-on’ behavior that is more likely to develop over time as an individual’s illness becomes more severe, and the person’s repertoire of disordered eating behaviors increases,” says Saniha Makhzoumi, now a predoctoral intern in clinical psychology at Lucile Packard Children’s Hospital at Stanford University, who co-authored the study with eating-disorder researchers at the Johns Hopkins University School of Medicine. Despite the greater pathology found among such patients, their short-term response to treatment was similar to that of other patients. The bottom line: watch out for this behavior as an indicator of worsening illness, but remember that treatment can help. —Tori Rodriguez

Dress for Success

What you wear has an effect on your mind-set, performance and even hormone levels

The old advice to dress for the job you want, not the job you have, may have roots in more than simply how others perceive you—many studies show that the clothes you wear can affect your mental and physical performance. Although such findings about so-called encllothed cognition are mostly from small studies in the laboratory that have not yet been replicated or investigated in the real world, a growing body of research suggests that there is something biological happening when we put on a snazzy outfit and feel like a new person.



If you want to be a big-ideas person at work, suit up. A paper in August 2015 in *Social Psychological and Personality Science* asked subjects to change into formal or casual clothing before cognitive tests. Wearing formal business attire increased abstract thinking—an important aspect of creativity and long-term strategizing. The experiments suggest the effect is related to feelings of power. —Matthew Hutson



Informal clothing may hurt in negotiations. In a study reported in December 2014 in the *Journal of Experimental Psychology: General*, male subjects wore their usual duds or were placed in a suit or in sweats. Then they engaged in a game that involved negotiating with a partner. Those who dressed up obtained more profitable deals than the other two groups, and those who dressed down had lower testosterone levels. —M.H.



For better focus, get decked out like a doctor. In research published in July 2012 in the *Journal of Experimental Social Psychology*, subjects made half as many mistakes on an attention-demanding task when wearing a white lab coat. On another attention task, those told their lab coat was a doctor's coat performed better than either those who were

told it was a painter's smock or those who merely saw a doctor's coat on display. —M.H.



Inspired by findings that winning combat fighters in the 2004 Olympics had worn red more often than blue, researchers investigated the physiological effects of wearing these colors. As reported in February 2013 in the *Journal of Sport and Exercise Psychology*, they paired 28 male athletes of similar age and size, who competed against one another once while wearing a red jersey and again while wearing blue. Compared with fighters in blue, those wearing red were able to lift a heavier weight before the match and had higher heart rates during the match—but they were not more likely to be victorious. —Tori Rodriguez



Trying too hard to look sharp can backfire. When women donned expensive sunglasses and were told the specs were counterfeit, as opposed to when they thought they were real, they cheated more often on lab experiments with cash payouts. Fake sunglasses also seemed to make women see others' behavior as suspect. Authors of the study, published in May 2010 in *Psychological Science*, theorize that counterfeit glasses increase unethical behavior by making their wearers feel less authentic. —M.H.



The Red Sneakers Effect

It's not news to anyone that we judge others based on their clothes. In general, studies that investigate these judgments find that people prefer clothing that matches expectations—surgeons in scrubs, little boys in blue—with one notable exception. A series of studies published in an article in June 2014 in the *Journal of Consumer Research* explored observers' reactions to people who broke established norms only slightly. In one scenario, a man at a black-tie affair was viewed as having higher status and competence when wearing a red bow tie. The researchers also found that valuing uniqueness increased audience members' ratings of the status and competence of a professor who wore red Converse sneakers while giving a lecture.

The results suggest that people judge these slight deviations from the norm as positive because they suggest that the individual is powerful enough to risk the social costs of such behaviors. —T.R.

You Don't Know as Much as You Think

“Overclaiming” can result from a heightened sense of expertise



It is only logical to trust our instincts if we think we know a lot about a subject, right? New research suggests the opposite: self-proclaimed experts are more likely to fall victim to a phenomenon known as overclaiming, professing to know things they really do not.

People overclaim for a host of reasons, including a desire to influence others' opinions—when people think they are being judged, they will try to appear smarter. Yet sometimes overclaiming is not deliberate; rather it is an honest overestimation of knowledge.

In a series of experiments published in July in *Psychological Science*, researchers at Cornell University tested people's likelihood to overclaim in a variety of scenarios. In the first two experiments, participants rated how knowledgeable they believed themselves to be about a variety of topics, then rated how well they knew each of 15 terms, three of which were fake. The more knowledgeable people rated themselves to be on a particular topic, the more likely they were to claim knowledge of the fake terms in that field. In a third experi-

ment, additional participants took the same tests, but half were warned that some terms would be fake. The warning reduced overclaiming in general but did not change the positive correlation between self-perceived knowledge and overclaiming.

In a final experiment, the researchers manipulated participants' self-perceived knowledge by giving one group a difficult geography quiz, one group an easy quiz and one group no quiz. Participants who took the easy quiz then rated themselves as knowing more about geography than did participants in the other groups and consequently were more likely to overclaim knowledge of fake terms on a subsequent test.

The results suggest that if you think you know a lot about something, you might want to double-check, lest you fall into the trap of skimming over words and concepts that seem familiar. In addition, the researchers point out that people who believe they know more than they do may be less inclined to pursue further education, or they may give advice about topics they do not fully understand. So the next time you are offered advice from a self-professed expert, you may want to take it with a grain of salt. —Jessica Schermer

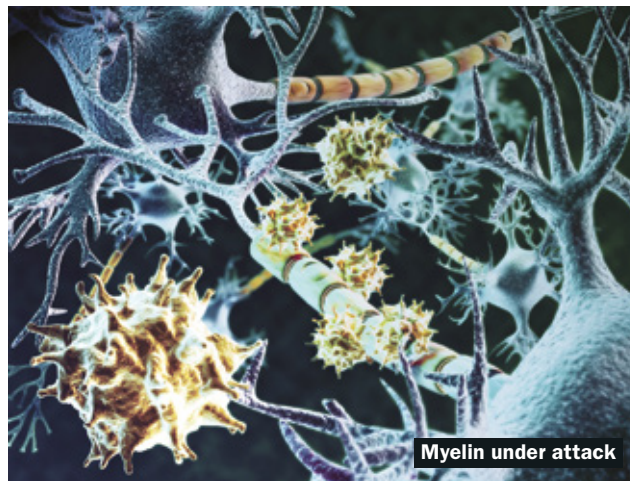
First Drug to Treat Progressive Multiple Sclerosis

Trials are successful in both relapsing and progressive forms of the autoimmune disease

Symptoms come and go in most cases of multiple sclerosis (MS), a chronic disease in which the immune system attacks myelin, the nonconductive sheath that surrounds neurons' axons. Yet 10 to 15 percent of cases are progressive rather than relapsing. This more severe version appears later in life and is marked by steadily worsening symptoms. No treatments are currently available, but that might be about to change.

In September pharmaceutical company Hoffmann–La Roche announced positive results from three large clinical trials of ocrelizumab, an injectable antibody medication that targets B cells, for both relapsing and progressive MS. They found that the drug was more effective at treating relapsing MS than interferon beta-1a (Rebif), a top-performing drug now used to treat the disease. Even more exciting, it slowed the advance of symptoms in patients with progressive MS for the entire 12-week duration of the study. “The drug has dramatic effects on relapsing MS, and we finally have our foot in the door with the progressive form,” says Stephen Hauser, a neurologist at the University of California, San Francisco, who was involved in the trials.

The fact that ocrelizumab works on both types of MS is a tantalizing clue for scientists trying to understand the root causes of the disease and figure out why the inflammation of the relapsing form eventually turns into progressive degeneration in some patients. “These results give evidence that the inflamma-



tory and the degenerative components of MS are related,” Hauser says. “The big question now is, If we begin treatment really early, can we protect relapsing patients from developing the progressive problems later on?”

With these trials, Roche has cleared the last major hurdle in the FDA's drug-testing protocol. The company plans to file for approval to treat both forms of MS in early 2016, which means the drug could be on shelves as soon as 2017. —Diana Kwon



Melatonin's Role in MS

The hormone is linked to seasonal relapses

You may be looking forward to spring, but many people with multiple sclerosis are not—changing seasons

can bring on a relapse. Scientists have attributed the seasonal fluctuations of MS to the rise and fall of vitamin D, which has anti-inflammatory properties and is produced by exposure to sunlight. Some studies, however, find that relapses increase in the spring and summer, when vitamin D levels are expected to be high, pointing to the possibility that other factors are involved. A recent study, published in *Cell*, suggests that melatonin, a hormone that regulates sleep cycles and the internal body clock, also plays a role.

Melatonin levels peak in the body during the darkest months. Mauricio Farez, a neuroscientist at the Raúl Carrea Institute for Neurological Research in Argentina, and his colleagues assessed a group of 139 MS patients in Buenos Aires and found a 32 percent reduction in the number of relapses in the fall and winter, when melatonin is high, compared with summer and spring.

To confirm melatonin's protective effect in the laboratory, the team gave daily injections of the hormone to mice with autoimmune encephalomyelitis, a widely used animal model of MS. It worked—the animals showed reduced clinical symptoms and a restored balance of T cells, white blood cells that contribute to a well-functioning immune system. Melatonin reduced the number of the T cells that promote inflammation while increasing regulatory T cells, defensive bodies that keep the immune system in check. The researchers observed comparable effects of the hormone on human immune cells grown in the lab.

The results show that melatonin regulates

a key immune response, a fact that may be of use in other autoimmune diseases, particularly ones in which seasonal flare-ups occur, such as lupus and rheumatoid arthritis, says study co-author Francisco Quintana, an immunologist at Brigham and Women's Hospital.

“Our data show that melatonin might be one factor explaining the seasonal occurrence of relapses, in addition to infection and vitamin D,” Farez says, “and we need to see how they work together to fully understand their effects.” Farez's group is in the early stages of developing a clinical trial to test melatonin's effects in patients. Until those results come in, the researchers emphasize that no one should take melatonin to mitigate their MS symptoms because it may have unknown and possibly dangerous side effects. —D.K.

Complex Origins

Studies have linked several environmental factors with the origin and progression of multiple sclerosis:

- *Smoking* after being diagnosed with MS may accelerate disease progression, but quitting can slow the degeneration.
- *High salt intake* may exacerbate MS disease activity and the risk of developing new brain lesions, according to a 2014 study.
- *Epstein-Barr virus* may trigger MS and accelerate the progression of the disease, perhaps by activating the immune system.



Cynicism May Cost You

Having a distrustful attitude might limit your earning power

Most of the world's population now lives in cities, which means fewer of us know our neighbors. Should we adapt to modern society by raising our guards and looking over our shoulder? Research says no—we are actually not trusting enough, and it could be costing us money.

A growing body of work has established that in laboratory studies, subjects who are less trusting of their peers make less money in investment and economic scenarios. For instance, participants in one 2009 study underestimated how many partners would return their money in an economics game, so they underinvested and wound up with lower earnings than they could have. A paper, published online in May in the *Journal of Personality and Social Psychology*, now finds some real-world evidence of the financial harm of cynicism.

Analyzing data from national surveys in the U.S. and Germany, psychologists Olga Stavrova and Daniel Ehlebracht of the University of Cologne found that people who reported cynical views of human nature had smaller incomes (by thousands of dollars) two and nine years later, compared with their more optimistic peers. The researchers ruled out several proposed explanations for the link between cynicism and income, including personality, health, education, age, gender and employment status.

Instead they propose that cynicism increases suspicion, which prevents cooperation. If that is true, cynicism should not be harmful in places where a high degree of suspicion is justified. Looking at 41 European countries, the researchers found that in nations with the highest murder rates and least volunteerism, cynicism did not correlate with lower income.

Giving others the benefit of the doubt, then, may not invite deception; it instead seems to pay off—literally, Stavrova says: “So in most places in the U.S. and western Europe, being less cynical might be a better way to go.”
—Matthew Hutson

Why Preteen Friendships Are Fleeting

Middle school friendships end quickly and often, but certain shared traits help them last

Can you remember who your best friend was in seventh grade? If you are having difficulty, it could be because relationships at that age are often short-lived. Half don't last a year. The friendships that do last can be predicted based on demographic and behavioral similarities, according to new research from psychologist Brett Laursen of Florida Atlantic University.

“There is a lot of change during middle school, and that change makes it hard to maintain friendships,” Laursen says. As kids move from one academic track to another, join or leave sports teams, or take up new extracurricular hobbies, the opportunities to interact with friends wax and wane. Middle school is also a time when growing personal autonomy first allows children the chance to pick their friends and invest—or not—in those relationships.



Laursen tracked 573 seventh-grade two-person friendships until they ended or until 12th grade. A few important behavioral traits emerged as predictors of friendships that lasted more than a year: popularity, aggression and academic success. The more similar two friends were in these traits, the longer a relationship lasted. The results mirror a previous study by Laursen in which he found he

could predict which people would become friends based on the similarity of their behavior during seventh grade.

Friends of the opposite sex were least likely to last. “They're completely doomed,” Laursen says, in part because of pressure from other friends. Adolescents tend to sort themselves based on age, race and gender, so being friends with a member of the opposite sex limits the size of one's larger group of “running buddies” and taxes the relationship.

Laursen says this quick turnover in friendships is nothing to be worried about unless a child has trouble making friends. Adults who want to help those children might emphasize that finding peers who are similar in personality and academic interests is key to creating lasting relationships. “But for most kids, the end of a friendship means a new one is starting,” Laursen says.

—Meredith Knight



How to Be a Better

runner

I ran a marathon, once upon a time. (If you could call what I did “running.” It took me nearly five hours—you do the math.) Still, I did it: laced up my New Balances, pounded the pavement through five months of training, and then went ahead and finished the whole 26.2. Some folks, including my podiatrist (bunions), didn’t think I could do it. But as sports psychologists I talked to told me, physical feats are often more about *mind* than matter. Just in time for those New Year’s resolutions, here are five evidence-based tips for upping your running game—or any physical activity you choose.

#1 Set a super clear goal. Edwin Locke and Gary Latham, leaders in goal-setting theory in the 1990s, showed that the more specific your goal, the better you will perform. Hundreds of subsequent studies have confirmed this finding as gospel. So instead of aiming to be a “better runner,” the first thing you are going to want to do is pinpoint a result: add a mile to your longest distance, shave a minute off your most recent race time, or simply get out and do it a certain number of times a week.

#2 Learn to be okay with pain. “Embrace the suck”—a phrase borrowed from soldiers of Operation Iraqi Freedom—has become a useful running mantra of Cindra Kamphoff, director of the Center for Sport and Performance Psychology at Minnesota State University, Mankato, who has completed 11 marathons herself. Running doesn’t always feel good, especially when you’re just starting out—but if you plan for that, you can prepare yourself to withstand it, she says. Jack Lesyk, director of the Ohio Center for Sport Psychology in Beachwood, agrees: “My first run was a quarter of a mile, and when I finished I thought I would have a heart attack. But I was determined to exceed that distance the following day and the day after that.”

#3 Get competitive. Marketing expert Gavin Kilduff of New York University looked at six years of racing data and interviewed runners about their



“rivals”—people of similar age and ability with whom they raced often and felt competitive toward. They found that people ran harder and faster when racing against their rivals. This reminds me of a trick I learned from my dad, one that helped get me through mile 23 when my hips felt as if they were about to burst into flame: Pick out someone a few yards ahead of you and picture yourself throwing a lasso around her waist and reeling her in bit by bit until you catch up and eventually pass her. Then ... it’s on to the next one.

#4 Talk to yourself. Positive self-talk helped Kamphoff win the Omaha marathon in 2012. “I was in a really negative place for much of the race, but for the last four miles I told myself over and over, ‘I’m confident, strong and prepared,’” she says. Those last miles were her fastest of the day, and she also set a personal time record. An oft-cited meta-analysis published in 2011 in *Perspectives on Psychological Science* found that motivational self-talk boosted athletes’ confidence and got them more excited to compete. Lesyk has his own version, one that’s helped him run for 30 years and 14

marathons: “I am runner. I run fast and strong. With each and every step, I become a stronger and stronger person.”

#5 Picture it. The idea of closing your eyes and picturing your way into a win sounds a little woo-woo, but imagery is a long-standing tool in elite athletics. When you vividly imagine yourself doing something before you do it, you’re in essence programming your mind to think you can, Kamphoff says. “There are lots of different ways to do it, but sometimes I’ll have my clients picture a highlight reel of themselves—three to five times when they’ve experienced success in the past—and vividly imagine those things for 10 to 20 seconds at a time. Then do that four or five times,” she says.

The great thing about all these strategies is that they don’t have to apply to just running. One marathon was plenty for me, but I do want to become a better exerciser. After all, Zumba does nothing for your heart if you don’t even make it to the gym. Excuse me while I close my eyes and picture myself ... walking out the door for class. Baby steps! —Sunny Sea Gold

Smell Tests Could One Day Reveal Dementia and Head Trauma

Odor memory is particularly complex, making sniff tests a promising early indicator of damage to the brain

Name that smell—if you can't, it could be an indicator of a problem somewhere in your brain. New research suggests that scratch-and-sniff smell tests could become an easy and cheap way to detect signs of traumatic brain injury and neurodegenerative ailments.

Recent research found that a diminished sense of smell predicted frontal lobe damage in 231 soldiers who had suffered blast-related injuries on the battlefield. In the Department of Defense study led by Michael Xydakis of the Uniformed Services University of the Health Sciences, subjects with low scores on a smell test were three times as likely to show evidence of frontal lobe damage during brain imaging than those whose sense of smell was normal.

When the sense of smell is working properly, it acts as a matchmaker between odorant molecules in the air and memories stored in the brain. Those memories are not housed in a single place, Xydakis says, but extend across many regions. Because different smell signals have to take a variety of paths to reach their destinations, arranging their travel

requires a lot of coordination. “This unique feature makes an individual's ability to describe and verbally name an odor extremely challenging and cognitively demanding,” he says.

A damaged sense of smell, therefore, can indicate that the ability to make those connections has been hampered by disease, a lack of sleep or, as shown in Xydakis's study, injury to the brain. The new results add to a growing understanding of the link between brain damage and an impaired sense of smell. Researchers have been working for years to use olfaction tests to track damage to the brain caused by neurodegenerative ailments such as Parkinson's and Alzheimer's diseases.

Kim Good, an associate professor in the psychiatry department at Dalhousie University in Nova Scotia, is currently recruiting subjects for a cohort study that aims to better understand the link between olfaction and Parkinson's, which could improve early identification and intervention. “Olfactory deficits are as common as tremor in Parkinson's, and they help rule out other competing diagnoses,” Good says.

Smell is also the first sense to be affected by Alzheimer's, with the hallmark protein tangles of the disease appearing early in the olfactory bulb, says psychiatrist Davangere Devanand of Columbia University. Last January he and his colleagues reported the results of a four-year-long cohort study in Manhattan, which found that scores on a multiple-choice scratch-and-sniff test in which participants had to identify 40 scents were good predictors of cognitive decline.

It's not hard to imagine such exams becoming a routine part of primary care for older patients. “The beauty of olfaction,” Good points out, “is that testing is easy and can be done in the family physician's office.”

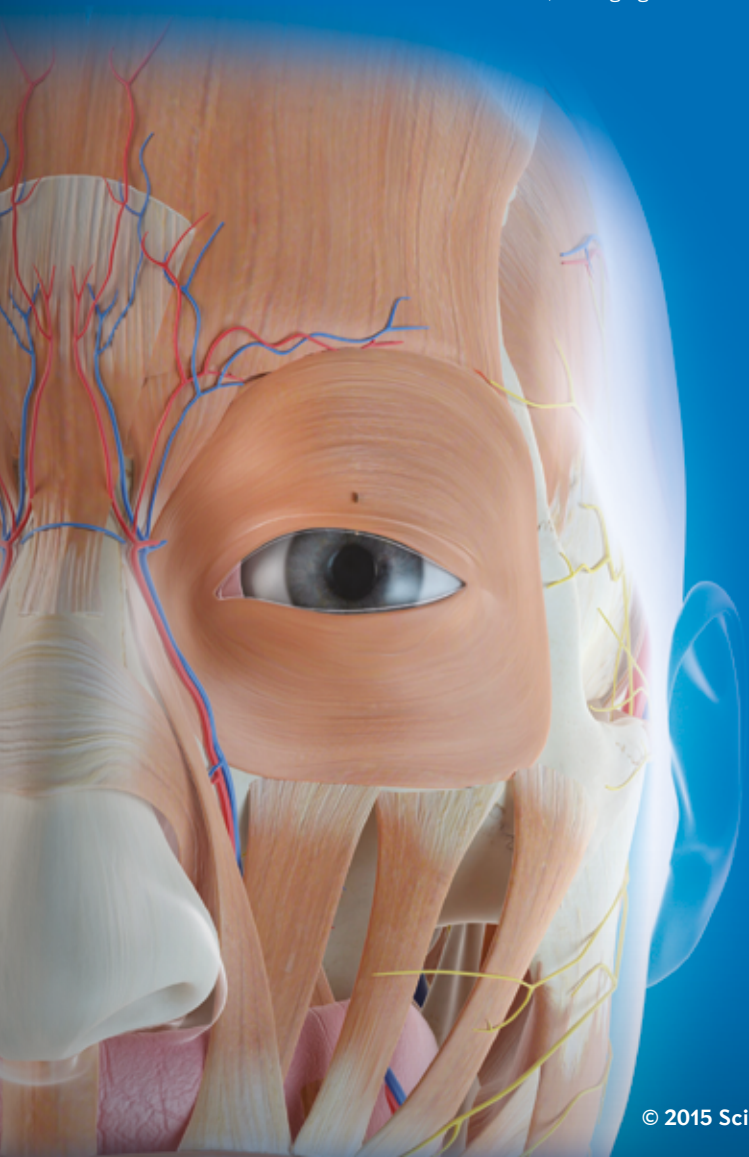
—Ian Chant

Why Smell Is Special

The unique characteristics of our sense of smell make sniff tests ideal for diagnosing brain injury. Here are some of the most interesting scientific findings about this unusual sense:

- The adult brain can generate new neurons in the olfactory bulb, the brain region that processes smells. This area is one of just a few regions that continue to grow new neurons during adulthood.
- Individuals vary in how they perceive odors and whether or not they can detect certain scents, and yet humans seem to universally enjoy the smell of vanilla.
- Anosmia, a condition in which people completely lose their sense of smell, can be debilitating. Sufferers often report feeling disconnected from their surroundings, and many become severely depressed.
- Romantic couples can unconsciously sense their partner's emotional state from their sweat—and the longer they have lived together, the better they are at it.
- Babies locate their mother's nipples in part by learning a smell map of the breasts.

—Victoria Stern

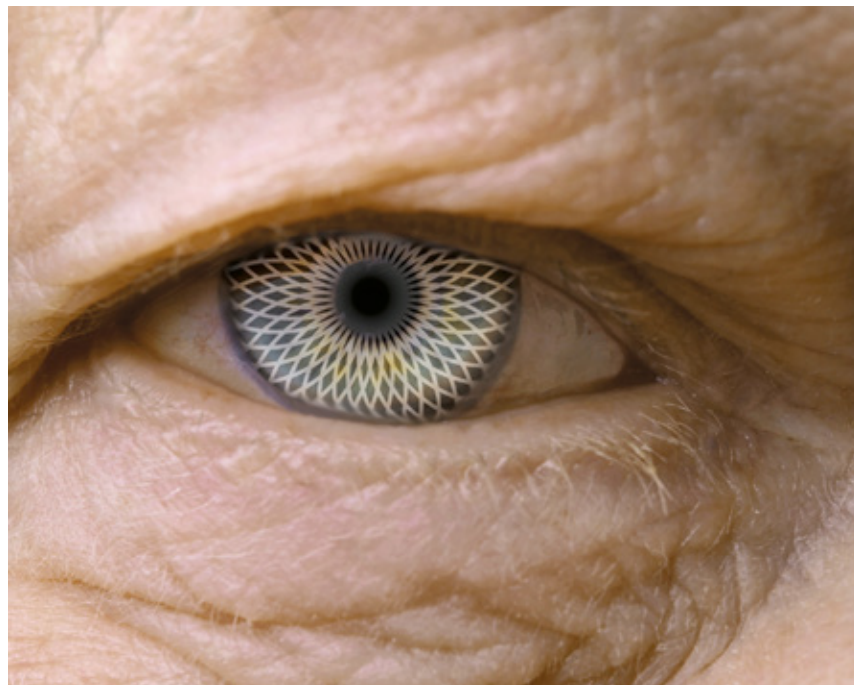


The Age of Illusion

How we perceive illusions offers clues to how the brain changes as we age

Aging causes significant changes in visual perception, even in healthy people with no dementia or eye disease. As a result, many people struggle with simple daily activities as they age—things like driving safely, walking on uneven ground or negotiating stairs. Unfortunately, the mechanisms underlying age-related defects in perception are not well understood. Few studies have investigated the kinds of perceptual changes that occur through adulthood, particularly in older individuals, and even fewer have correlated those changes with brain function and eye movements.

But visual illusions have begun to provide some important insights in this area. Because we know that specific ocular or brain mechanisms mediate cer-



tain illusions, how our perception of them alters with age provides clues to how aging affects related brain cell populations. These shifts also lay plain that the existence of illusions is not just an accident or mistake of evolution. Illusions are part and parcel of our perception, and their degradation with age—which, let's be clear, makes the observer see the world in a more accurate and less illusory fashion—indicates that some aspects of illusory perception may have enhanced survival. Such an advantage becomes less important as brain function decreases in senescence.

Other types of visual impairments can help us understand neurodegeneration in the aging brain. Yet illusions may stand out above other visual biomarkers because older vision scientists—themselves experts in illusory perception—are acutely aware when their own observations do not match those of their younger experimental test subjects. It is one thing to have back pain, or to lose the ability to run an eight-minute mile, or to have trouble memorizing phone numbers. Those problems are all annoying. But when an amazing new illusion

fails to work for your brain—especially when all your younger colleagues are agog—it is downright unnerving. It certainly focuses the mind and makes those neuroscientists wonder if they may be slowly losing theirs.

Lothar Spillmann, currently a visiting professor at the National Taiwan University, is a case in point. Spillmann spent most of his career at the University of Freiburg. Then he turned 65—the German university system's mandatory retirement age—and he had to hit the road to find continued employment abroad. Now 77, he remains a highly productive scientist and serves as an international elder statesman for perceptual science.

As a world leader in his field, Spillmann has discovered a number of important misperceptions, including the Ouchi-Spillmann illusion, which produces a motion effect that we described previously in this column. So you can imagine Spillmann's concern when—the same year he retired in Germany—he discovered he was blind to perhaps the most significant illusion of the past two decades, Akiyoshi Kitaoka's Rotating Snakes [*see top illustration on opposite page*]. **M**



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 are the authors of *Sleights of Mind*, with Sandra Blakeslee (<http://sleightsofmind.com>), winner of a Prisma Prize for best science book of the year.

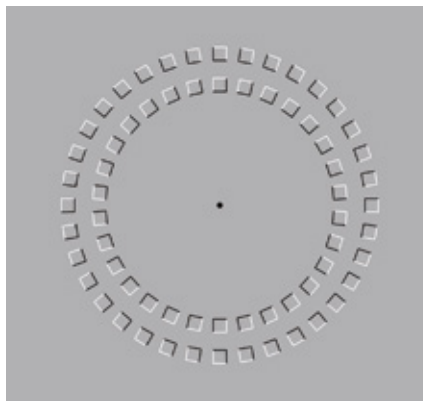
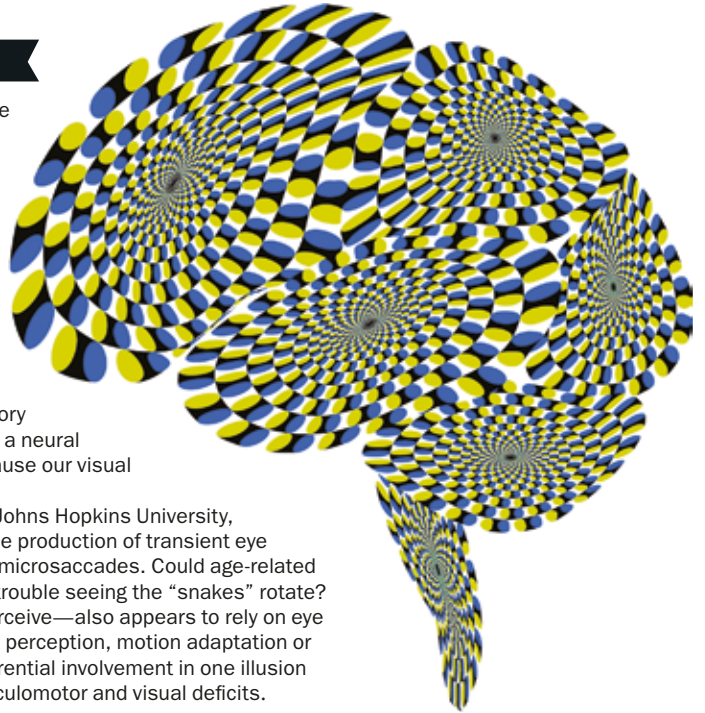


Send suggestions for column topics to MindEditors@sci.am

SNAKES ON A BRAIN

When most people look at Rotating Snakes—rendered here in the shape of a brain by neuroscientist and engineer Jorge Otero-Millan—they perceive illusory motion. Geneticist and painter Alex Fraser and biologist Kimerly J. Wilcox, both then at the University of Cincinnati, first discovered this type of illusory motion in 1979, when they elicited the effect from repetitive spiral arrangements of sawtooth-edged shapes shaded light to dark. Fraser and Wilcox's illusion was not nearly as effective as Rotating Snakes, developed more than 20 years later by Akiyoshi Kitaoka, but it did spawn a number of related illusions. This family of perceptual phenomena is characterized by the periodic placement of colored or grayscale patches of particular brightnesses. In 2005 neuroscientist Bevil R. Conway, then at Harvard Medical School, and his colleagues showed that Kitaoka's illusory layout activates motion-sensitive neurons in the visual cortex, providing a neural basis for why most of us perceive rotation: we see the snakes spin because our visual neurons respond as if we are in the presence of actual motion.

In our own research with Otero-Millan, now a postdoctoral fellow at Johns Hopkins University, we found a direct relation between the perception of this rotation and the production of transient eye movements, including eyelid blinks and tiny involuntary eye jerks called microsaccades. Could age-related eye-motion failures explain why Spillmann and other older people have trouble seeing the “snakes” rotate? Maybe. But the Ouchi-Spillmann illusion—which Spillmann does still perceive—also appears to rely on eye movements. So it may be that certain visual processes, such as motion perception, motion adaptation or brightness perception, which are also susceptible to aging, have a differential involvement in one illusion versus the other. Or the age-related loss may reflect a combination of oculomotor and visual deficits.



ILLUSIONS ACROSS THE AGES

In a 2009 study, psychologists Jutta Billino, Kai Hamburger and Karl Gegenfurtner of the Justus Liebig University Giessen in Germany tested 139 subjects—old and young—with a battery of illusions involving motion, including Rotating Snakes. They found that older subjects perceived less illusory rotation than younger ones, not only in Rotating Snakes but also in the Rotating-Tilted-Lines illusion, depicted above on the left.

To experience this illusion, move your head forward and backward as you fixate on the central area (or alternatively, hold your head still and move the screen or page you are reading). Most young adults see illusory motion: the ring spins against the central and surrounding regions. But the Pinna illusion, which was the first to create a rotating motion effect (right), works for most observers, regardless of age: as you move your head (or the image) forward and back, you will see the inner and outer rings rotate in opposite directions.

Whatever causes these various percepts to change with age is not simply a failure to perceive illusory movement but reflects ongoing changes in the brain or visual system. We hope these findings will lead to future research and a more nuanced grasp of the mechanisms underlying our perception of real and illusory motion, as well as the specific neurodegenerative effects of aging on different brain circuits.

MORE TO EXPLORE

- **Japanese Optical and Geometrical Art.** Hajime Ouchi. Dover Publications, 1973.
- **Perception of Illusory Movement.** Alex Fraser and Kimerly J. Wilcox in *Nature*, Vol. 281, pages 565–566; October 18, 1979.
- **Neural Basis for a Powerful Static Motion Illusion.** Bevil R. Conway, Akiyoshi Kitaoka, Arash Yazdanbakhsh, Christopher C. Pack and Margaret S. Livingstone in *Journal of Neuroscience*, Vol. 25, No. 23, pages 5651–5656; June 8, 2005.
- **Age Effects on the Perception of Motion Illusions.** Jutta Billino, Kai Hamburger and Karl Gegenfurtner in *Perception*, Vol. 38, No. 4, pages 508–521; 2009.
- **Microsaccades and Blinks Trigger Illusory Rotation in the “Rotating Snakes” Illusion.** Jorge Otero-Millan, Stephen L. Macknik and Susana Martinez-Conde in *Journal of Neuroscience*, Vol. 32, No. 17, pages 6043–6051; April 25, 2012.
- **The Neuroscience of Illusion.** Susana Martinez-Conde and Stephen L. Macknik in *Scientific American*, Special Edition, Vol. 20, No. 13, pages 4–7; Fall 2013.

JORGE OTERO-MILLAN (brain-shaped Rotating Snakes illusion); FROM “A NEW MOTION ILLUSION: THE ROTATING-TILTED-LINES ILLUSION,” BY SIMONE GORI AND KAI HAMBURGER, IN *PERCEPTION*, VOL. 35, NO. 6, JUNE 2006 (Rotating-Tilted-Lines illusion); FROM “A NEW VISUAL ILLUSION OF RELATIVE MOTION,” BY BAINGIO PINNA AND GAVIN J. BRELSTAFF, IN *VISION RESEARCH*, VOL. 40, NO. 16, JULY 1, 2000 (Pinna illusion)

DEVELOPMENT

Don't Touch That Dial

Scientists have linked TV viewing to antisocial behavior, lowered verbal IQ and altered brain structure—but a new study raises questions

By R. Douglas Fields

We all heard the warning as kids: “That TV will rot your brain!” You may even find yourself repeating the threat when you see young eyes glued to the tube instead of exploring the real world. The parental scolding dates back to the black-and-white days of *I Love Lucy*, and today concern is growing amid a flood of video streaming on portable devices. But are young minds really being harmed?

With brain imaging, the effects of regular TV viewing on a child's neural circuits are plain to see. Studies suggest watching television for prolonged periods changes the anatomical structure of a child's brain and lowers verbal abilities. Behaviorally, even more detrimental effects may exist: although a cause-and-effect relation is hard to prove, higher rates of antisocial behavior, obesity and mental health problems correlate with hours in front of the set.

Now a new study hits the pause button on this line of thinking. The researchers conclude that the entire body

R. DOUGLAS FIELDS is a developmental neuroscientist. He serves on *Scientific American Mind*'s board of advisers and is author of *The Other Brain* and *Why We Snap*.



Send suggestions for column topics to MindEditors@sciam.com



of research up to now has overlooked an important confounding variable, heredity, that could call into question the conventional wisdom that TV is bad for the brain. Further study will be needed to evaluate this claim, but the combined evidence suggests we need a more nuanced attitude toward our viewing habits.

Replaying the Evidence

To understand the argument against television, we should rewind to 2013, when a team of researchers at Tohoku University in Japan, led by neuroscientist Hikaru Takeuchi, first published findings from a study in which the brains of 290 children between the ages of five and 18 were imaged. The kids' TV viewing habits, ranging from zero to four hours each day, were also taken into account. Takeuchi and his colleagues found that the more television these kids watched, the bulkier the brain's hypothalamus, septum, sensorimotor area and visual cortex became. These areas are implicated in multiple processes, including emotional responses, arousal, aggression and vision, respective-

ly. In addition, the brain showed thickening in a frontal lobe region, the frontopolar cortex, that is known to lower language-based reasoning ability. Testing confirmed that verbal IQ scores, which measure vocabulary and language skills, fell in proportion to the hours of TV the children watched. The changes in brain tissue occurred regardless of the child's sex or age or his or her family's income.

Some of these brain differences could be benign: an increase in the visual cortex's volume is likely caused by exercising eyesight while watching TV. But thickening in the hypothalamus is characteristic of patients with borderline personality disorder, increased aggressiveness and mood disorders. Perhaps watching TV shows, with their high density of drama, action and comedy, engages circuits of arousal and emotion such that these areas, rather than circuits of intellect, strengthen. This change could lead to psychological and behavioral issues. Previous studies have shown that for each additional hour of television watched in childhood, the odds of developing symptoms of depres-

sion increase by 8 percent and the odds of being convicted of a crime increase by 27 percent. And other findings suggest that for every two hours watched in one's youth, the odds of developing type 2 diabetes increase by 20 percent.

There are many possible explanations for these links. TV viewing is generally sedentary and solitary, denying children many health benefits of physical activity and socialization. The development of verbal proficiency, reasoning and other intellectual abilities could atrophy from passively viewing a screen. "Guardians of children should consider these effects when children view TV for long periods," Takeuchi and his colleagues concluded.

But the correlation between TV viewing and brain and behavioral changes does not necessarily tell us the whole story. The quandary scientists face is determining whether TV viewing causes changes in brain and behavior or whether preexisting personal traits or other conditions underlie binge watching.

Fast-forward to the new study, by criminologists Joseph Schwartz of the University of Nebraska Omaha and Kevin Beaver of Florida State University. Schwartz and Beaver analyzed middle and high school students to look for associations between TV viewing and a range of factors such as race, gender, antisocial behavior and incarceration for violent crimes. Researchers checked back with nearly 15,000 of these children about two years later and again after they had reached adulthood, between the ages of 18 and 26. Much like previous studies, they found that young adults who had watched more television during early adolescence were more likely to engage in antisocial behavior, to be arrested at least once and to be incarcerated as an adult.

The researchers then added one more factor to their analysis. The study included more than 3,000 sibling pairs (that is, half-siblings, full siblings, and identical and nonidentical twins). The correlation between nearly all the negative behavior and time spent watching TV vanished after the researchers statistically accounted

for relatedness. Genetics, they concluded, shapes brain and behavior, which in turn has wide-ranging consequences, including how many hours of TV individual children tend to watch and how their brains respond to it. "For example," Schwartz says, "children with increased predisposition toward aggressive behavior may be more drawn to TV." Similarly, those who are genetically inclined to depression or obesity may be more likely to

comparing adopted and nonadopted children raised in the same home found that genetics was the most important factor in determining how many hours of TV kids watched. But the study also found that the higher a mother's IQ, the fewer hours both her biological and adopted children spent glued to the tube.

Everyone's brain is different, and what you do with your brain—especially at a young age, when it is developing—

GENETICS WAS THE MOST IMPORTANT FACTOR IN DETERMINING THE HOURS OF TV KIDS WATCHED.

spend their free time watching TV in the family room rather than shooting hoops on the basketball court.

Research suggests that heredity accounts for approximately half of the risk of developing antisocial behavior, with the remaining risk explained by environmental influences. In particular, genes that influence neural signaling involving dopamine and serotonin are associated with increased criminality, antisocial behavior and psychological disorders. "[Our findings] suggest that the changes in neurobiological functioning observed by Takeuchi et al. would have occurred regardless of the actual amount of television watched," Schwartz says.

Stay Tuned

It would appear that researchers have been weighing the evidence out of balance by neglecting the important factor of heredity in TV habits. But this chicken-or-egg dilemma resolves as it does with real chickens: this is an interdependent cycle. For instance, a 1990 study

does affect its physical structure and function. If a child has inherited risk factors predisposing him or her to behavioral difficulties, he or she will likely spend more time watching TV, but doing that is not helping the situation. "Watching more TV may trigger various neurobiological changes that ultimately exacerbate any underlying inclinations toward aggressive behavior," Schwartz warns. In such cases, limiting exposure to TV could be helpful. For other children, TV may not have this risk.

Recognizing this fact, parents will want to regulate their children's TV viewing in the context of those children as individuals. Ultimately, Mom is right: the more time spent sitting on the couch, the less time spent in physical activity, reading, and interacting with friends. The lack of physical activity and intellectual pursuits has obvious physical and cognitive consequences. TV may or may not rot the brain, but sitting perched in front of the screen for so long does seem to waste it. **M**

MORE TO EXPLORE

- **Individual Differences in Television Viewing in Early Childhood: Nature as Well as Nurture.** Robert Plomin et al. in *Psychological Science*, Vol. 1, No. 6, pages 371–377; November 1990.
- **Revisiting the Association between Television Viewing in Adolescence and Contact with the Criminal Justice System in Adulthood.** Joseph A. Schwartz and Kevin M. Beaver in *Journal of Interpersonal Violence*. Published online March 27, 2015.
- **The Impact of Television Viewing on Brain Structures: Cross-Sectional and Longitudinal Analyses.** Hikaru Takeuchi et al. in *Cerebral Cortex*, Vol. 25, No. 5, pages 1188–1197; May 2015.

NEUROANATOMY

Does Brain Size Matter?

A recent discovery proves embarrassing to any notion of humanity's innate superiority

While “size does not matter” is a universally preached dictum among the politically correct, everyday experience tells us that this can’t be the whole story—under many conditions, it clearly does. Consider the size of Woody Allen’s second favorite organ, the brain.

Adjectives such as “highbrow” and “lowbrow” have their origin in the belief, much expounded by 19th-century phrenologists, of a close correspondence between a high forehead—that is, a big brain—and intelligence. Is this true? Does a bigger brain make you necessarily smarter or wiser? And is there any simple connection between the size of a nervous system, however measured, and the mental powers of the owner of this nervous system? While the answer to the former question is a conditional “yes, somewhat,” the lack of any accepted answer to the second one reveals our ignorance of how intelligent behavior comes about.

Bigger Is Slightly Better

The human brain continues to grow until it reaches its peak size in the third



BY CHRISTOF KOCH

Christof Koch is president and chief scientific officer of the Allen Institute for Brain Science in Seattle. He serves on *Scientific American Mind*'s board of advisers.



to fourth decade of life. An MRI study of 46 adults of mainly European descent found that the average male had a brain volume of 1,274 cubic centimeters (cm^3) and that the average female brain measured 1,131 cm^3 . Given that a quart of milk equals 946 cm^3 , you could pour a bit more than that into a skull without any of it spilling out. Of course, there is considerable variability in brain volume, ranging from 1,053 to 1,499 cm^3 in men and between 975 and 1,398 cm^3 in women. As the density of brain matter is just a little bit above that of water plus some salts, the average male brain weighs about 1,325 grams, close to the proverbial three pounds often cited in U.S. texts.

Removing brains after their owners died revealed that Russian novelist Ivan Turgenev’s brain broke the two-kilogram barrier, coming in at 2,021 grams,

whereas writer Anatole France’s brain could barely bring half of that weight on the scale at 1,017 grams. (Note that post-mortem measures are not directly comparable to data obtained from living brains.) In other words, gross brain size varies considerably across healthy adults.

What about smarts? We all know from our day-to-day interactions that some people just don’t get it and take a long time to understand a new concept; others have great mental powers, although it is impolite to dwell on such differences too much. Think of Bertie Wooster, an idle but clueless rich man, and Jeeves, his genius valet, in a series of novels by P. G. Wodehouse and their successful British adaptation to the small screen.

Individuals differ in their ability to understand new ideas, to adapt to new environments, to learn from experience,

to think abstractly, to plan and to reason. Psychologists have sought to capture these differences in mental capacities via a number of closely related concepts such as general intelligence (*g*, or general cognitive ability) and fluid and crystalline intelligence. These differences in people's ability to figure things out on the spot and to retain and apply insights that they learned in the past to current circumstances are assessed by psychometric intelligence tests. These observations are reliable, in that different tests strongly correlate with one another. They are also stable across decades. That is, measures such as the intelligence quotient (IQ) can be repeatedly and reliably obtained from the same subjects nearly 70 years later.

Differences in general intelligence, assessed in this way, correlate with success in life, with social mobility and job performance, with health and with life span. In a study of one million Swedish men, an increase in IQ by one standard

In healthy volunteers, total brain volume weakly correlates with intelligence, with a correlation value between 0.3 and 0.4 out of a possible 1.0. In other words, brain size accounts for between 9 and 16 percent of the overall variability in general intelligence. Functional scans, used to look for brain areas linked to particular mental activities, reveal that the parietal, temporal and frontal regions of the cortex, along with the thickness of these regions, correlate with intelligence but, again, only modestly so. Thus, on average, a bigger brain is associated with somewhat higher intelligence. Whether a big brain causes high intelligence or, more likely, whether both are caused by other factors remains unknown.

Recent experiments take into account the particular connections among neurons in certain regions of an individual's brain, much like a neural fingerprint. They do better at predicting fluid intelligence (the capacity to solve problems in novel situations, to find and match pat-

is there a difference in the basic number of switching elements?

It is also well established that the cranial capacity of *Homo neanderthalensis*, the proverbial caveman, was 150 to 200 cm³ bigger than that of modern humans. Yet despite their larger brain, Neandertals became extinct between 35,000 and 40,000 years ago, when *Homo sapiens* shared their European environment. What's the point of having big brains if your small-brained cousins outcompete you?

Brain Size across Species

Our lack of understanding of the multiplicity of causes that contribute to intelligence becomes even more apparent when looking outside the genus *Homo*. Many animals are capable of sophisticated behaviors, including sensory discrimination, learning, decision making, planning and highly adaptive social behaviors.

Consider honeybees. They can recognize faces, communicate the location and quality of food sources to their sisters via the waggle dance, and navigate complex mazes with the help of cues they store in short-term memory. And a scent blown into a hive can trigger a return to the site where the bees previously encountered this odor, a type of associative memory that guides them back and that was made famous by Marcel Proust in his *Remembrance of Things Past (À la Recherche du Temps Perdu)*. The insect does all of this with fewer than one million neurons that weigh around one thousandth of a gram, less than one millionth the size of the human brain. Yet are we really a million times smarter? Certainly not if I look at how well we govern ourselves.

The prevailing rule of thumb holds that the bigger the animal, the bigger its brain. After all, a bigger creature has more skin that has to be innervated and more muscles to control and requires a larger brain to service its body. Thus, it makes sense to control for overall size when studying brain magnitude. By this measure, humans have a relative brain-

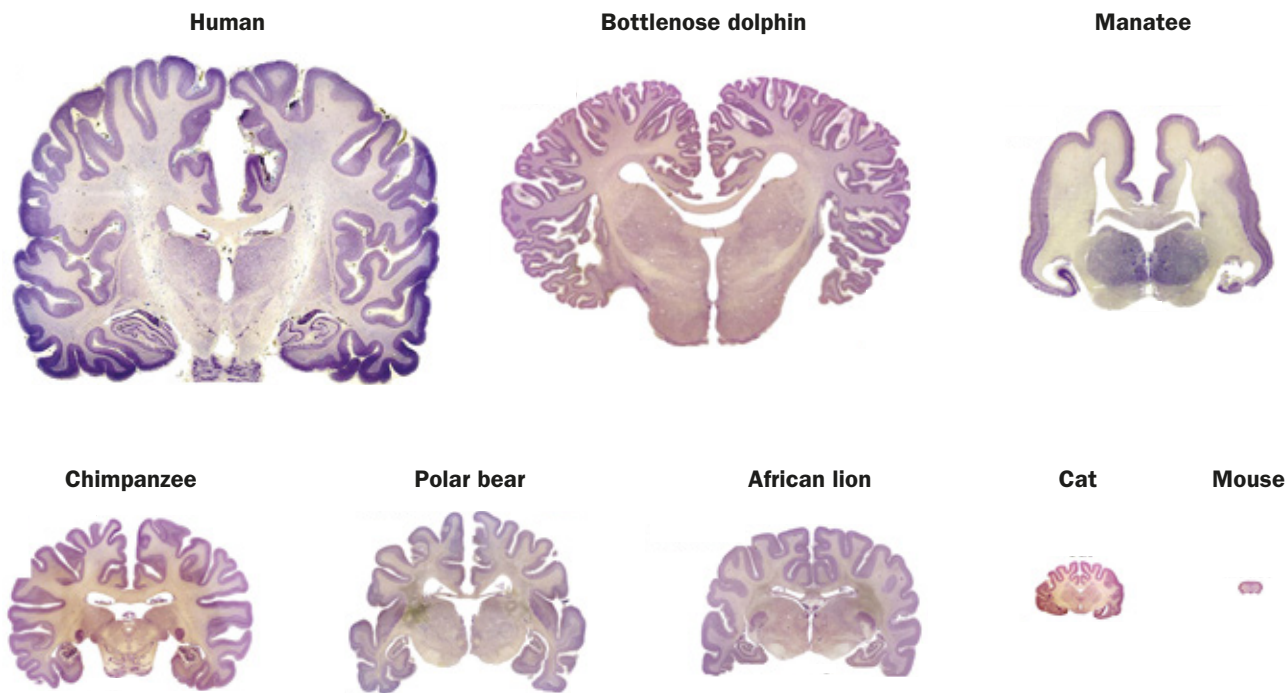
RUSSIAN NOVELIST IVAN TURGENEV'S BRAIN BROKE THE TWO-KILOGRAM BARRIER. WRITER ANATOLE FRANCE'S BRAIN WAS BARELY HALF THAT.

deviation, a measure of variability, was associated with an amazing 32 percent reduction in mortality. Smarter people do better in life. Whereas a high IQ may not predispose people to be happy or to understand the finer points of dating, the highly intelligent are more likely to be found among hedge-fund managers than among supermarket checkout clerks.

What about any numerical relation between brain size and intelligence? Such correlations were difficult to establish in the past when only pathologists had access to skulls and their content. With structural MRI imaging of brain anatomy, such measurements are now routine.

terns, to reason independently of specific domains of knowledge), explaining about 25 percent of the variance in this measure from one person to the next.

Our ignorance when it comes to how intelligence arises from the brain is accentuated by several further observations. As alluded to earlier, the adult male's brain is 150 grams heavier than the female's organ. In the neocortex, the part of the forebrain responsible for perception, memory, language and reasoning, this disparity translates to 23 billion neurons for men versus 19 billion for women. As no difference exists in the average IQ between the two genders, why



From man to mouse: Frontal slices of eight mammalian brains reveal the immense variety in the size of the organ and the patterning of surface convolutions that have evolved over the course of tens of millions of years. The smoothness of the manatee's brain surface contrasts with the cauliflowerlike branching in the bottlenose dolphin. Structural differences extend down to the microscopic scale. Scientists are still laboring to understand what the varying anatomy means for animal intelligence.

to-body mass of about 2 percent. What about the big mammals—elephants, dolphins and whales? Their brains far outweigh those of puny humans, up to 10 kilograms for some whales. Given their body mass, ranging from 7,000 kg (for male African elephants) up to 180,000 kg (for the blue whale), their brain-to-body ratio is under a tenth of a percent. Our brains are far bigger relative to our size than those of these creatures. Smugness is not in store, though. We are outclassed by shrews, molelike mammals, whose brain takes up about 10 percent of their entire body mass. Even some birds beat us on this measure. Hmm.

One small consolation is an invention of neuroanatomists called the encephalization quotient (EQ). It is the ratio of the mass of the brain of the species under investigation relative to a standard brain belonging to the same taxonomic

group. Thus, if we consider all mammals and compare them against the cat as a reference animal (which therefore has an EQ of 1), people come out on top with an EQ of 7.5. Stated differently, the human

Yet it is not quite clear what all this means in terms of the cellular constituents of brains. Neuroscientists always assumed that humans have more nerve cells where it counts, in the neocortex,

A STUDY OF PILOT WHALES PLAYS HAVOC WITH THE NOTION THAT HUMANS HAVE MORE NERVE CELLS WHERE IT COUNTS THAN ANY OTHER SPECIES ON THE PLANET.

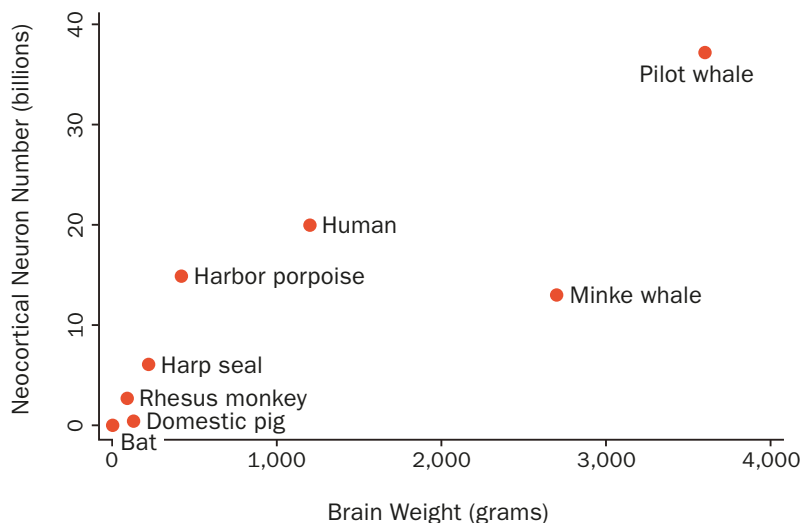
brain is 7.5 times bigger than the brain of a typical mammal weighing as much as we do. Apes and monkeys come in at or below five, as do dolphins and other cetaceans. We finally made it to the top, validating our ineradicable belief in humanity's exceptionalism.

than any other species on the planet, no matter the size of their brain.

A 2014 study of 10 long-finned pilot whales from the Faeroe Islands plays havoc with this hypothesis. Caught as part of a local hunt in the cold waters of the North Atlantic, between Scotland

SOURCE: "THE EVOLUTION OF THE BRAIN: THE HUMAN NATURE OF CORTICAL CIRCUITS, AND INTELLECTUAL CREATIVITY," BY JAVIER DE FELIPE, IN *FRONTIERS IN NEUROANATOMY*, VOL. 5, ARTICLE NO. 29, PUBLISHED ONLINE MAY 16, 2011.

Who Has the Most Brain Cells?



Bested by a dolphin: The long-finned pilot whale appears to have more neurons in the neocortex—an area devoted to higher mental processes—than any other mammal, about twice the number found in the human cortex. This type of dolphin and its massive brain are shown in the two images at the right.

SOURCE: "QUANTITATIVE RELATIONSHIPS IN DELPHINID NEOCORTEX," BY HEIDI S. MORTENSEN ET AL., IN *FRONTIERS IN NEUROANATOMY*, VOL. 8, ARTICLE NO. 132, PUBLISHED ONLINE NOVEMBER 26, 2014 (chart); HEIDI S. MORTENSEN (brain); ØLAVUR FREDRIKSEN (pilot whale)

and Iceland, these graceful mammals—also known as blackfish—are actually dolphins. The number of nerve cells making up their highly convoluted neocortex was estimated in a few sample slices and then extrapolated to the entire structure. The total came to an astonishing 37.2 billion neurons. Astonishing because this implies that the long-finned pilot whale has about twice as many neocortical neurons as humans do!

If what matters for cognitive performance is the number of neocortical neurons, these dolphins should be smarter than all other extant creatures, including us. Whereas the highly playful and social dolphins exhibit a variety of skills, including the ability to recognize themselves in a mirror, they do not possess language or any readily discernible powers of abstraction that stand out from those of other nonhuman animals. So

what gives? Is the complexity of the nerve cells themselves substantially less than cells found in people, or is the way these neurons communicate or learn less sophisticated? We don't know.

People forever ask for *the* single thing that distinguishes humans from all other animals, on the supposition that this one magical property would explain our evolutionary success—the reason we can build vast cities, put people on the moon, write *Anna Karenina* and compose *Eroica*. For a while it was assumed that the secret ingredient in the human brain could be a particular type of neuron, so-called spindle or von Economo neurons, after Baron Constantin von Economo (1876–1931).

But we now know that not only great apes but also whales, dolphins and elephants have these neurons in their frontal cortex. So it's not brain size, relative

brain size or absolute number of neurons that distinguishes us. Perhaps our wiring has become more streamlined, our metabolism more efficient, our synapses more sophisticated.

As Charles Darwin surmised, it is very likely a combination of a great many different factors that jointly, over the gradual course of evolution, made us distinct from other species. We are unique, but so is every other species, each in its own way. **M**

MORE TO EXPLORE

- **The Evolution of the Brain, the Human Nature of Cortical Circuits, and Intellectual Creativity.** Javier DeFelipe in *Frontiers in Neuroanatomy*, Vol. 5, Article No. 29. Published online May 16, 2011.
- **Quantitative Relationships in Delphinid Neocortex.** Heidi S. Mortensen et al. in *Frontiers in Neuroanatomy*, Vol. 8, Article No. 132. Published online November 26, 2014.



As a small child, Skyler rejected girly clothes and insisted on playing with boys. Puberty was a nightmare until he finally came out as the first trans kid in his school. Now 14 years old, he hopes to begin cross-sex medical treatment.



DEBATE IS GROWING
ABOUT HOW TO
MEET THE URGENT
NEEDS OF
**TRANSGENDER
KIDS**

By Francine Russo

PHOTOGRAPHY BY TIMOTHY ARCHIBALD

Skyler was counting down the days. In just a few months, the 14-year-old would attend a life-changing medical appointment. It would be the first step toward resolving body and identity issues that the teenager had been struggling with for years.

Skyler's sex at birth (or, to use trans terminology, his "assigned" gender) was female, yet he did not readily identify as a girl. From the age of four, Skyler hated wearing dresses, which he would rip apart with scissors. "It didn't feel like me," he says. Later he did not understand why he was told not to play football, soccer and kickball with the boys.

His confusion grew painful over time. Skyler's first period, at age 11, was traumatic. Every month he would spend an entire week at home, unable to face school. "I was at war with myself," he says, "and I struggled with depression. I'd pick at my skin and cut myself on my arms and shoulders and legs to distract myself."

By seventh grade he had learned about transgender identities at his public school. There had been a few other transgender children in the district, and he realized he felt trans. He began binding his size-DD breasts, albeit awkwardly and painfully, and investigating blogs, articles and YouTube videos on being transgender. He learned about puberty blockers, which could stop all further sexual development, but given how womanly his body had already become, thought—mistakenly—it might be too late for that option. "I just started to give up," he says. "And that's about the time I came out to my mom."

His mother, Corina, a preschool teacher, had long been concerned about Skyler's gender issues. She was supportive and, with the help of transgender advocate Aidan Key of Gender Odyssey, began seeking experts to help her child. In eighth grade Skyler came out at school, becoming the first openly trans kid there. Although there was some fumbling at first, the teachers began adopting masculine pronouns for him and using his new trans name, Skyler. After a long struggle with the administrators, the school finally created one gender-neutral bathroom for him to use.

Despite these initial hurdles at school, the cutting stopped. He finally felt "more at peace" with himself. But the challenge of a medically assisted biological transition remained. After a long wait, Skyler at last had an appointment set for November. The doctor would examine his physical health and review his gender

history, psychological health, emotional maturity and a host of other details. But what would follow was unclear. In a case like this, a physician might prescribe puberty blockers to stall further development or—as Skyler hoped—cross-sex hormones to begin the development of more masculine attributes. As the days ticked down, his excitement grew: "It's so hard to wait until November. I go to sleep and wake up, and I think, 'Is today November?' But it isn't, and I have to wait, and it's so long!"

It is hard to imagine a more momentous and complex set of decisions than those faced by young trans people like Skyler and the clinicians who seek to help them. As the media has spotlighted trans celebrities such as television personality Caitlyn Jenner and actress Laverne Cox and as society begins to better understand and accept trans people (perhaps even in the U.S. military), demand for medical and psychological support has exploded. But the biggest challenge—medically, psychologically and ethically—is the growing number of children (some as young as seven or eight) seeking treatment despite uncertain medical science. Distressed but supportive parents have been flooding the small number of U.S. clinics that specialize in helping transgender youth. In Los Angeles, for example, the Center for Transyouth Health and Development saw close to 400 patients in 2014 versus 40 in 2008. The center is currently adding three to four new patients a week.

No one can say how many transgender people are out there. A 2011 meta-analysis of population surveys from the University of California, Los Angeles's Williams Institute suggests that 0.3 percent of people in the U.S. feel strongly that they are transgender. One of the studies included in the analysis—from the University of Michigan—found that between 0.1 and 0.5 percent of Americans have taken medical steps to transition. Whether these individuals take those steps or not, they are a vulnerable population. Transgender youth, according to a 2015 Boston-based study of data from electronic health records, face two to three times the risk of their peers for serious psychological issues, such as depression, anxiety disorders, self-harm and suicide. They urgently require attention.

Yet this area of medicine is so new that few clinics have enough qualified and experienced professionals to adequately screen these children and youth. A protocol, developed by Dutch scientists in the early 2000s and adopted by the international Endocrine Society, serves as a guideline for doctors helping young people transition, and researchers have recently confirmed that this approach yields good results for most patients. But clinicians are now debating how closely to follow it. A growing number of trans experts believe the recommendations are too cautious, that screening procedures are too onerous and that young people are forced to wait too long for treatment that could alleviate their misery. Veterans in the

FAST FACTS

BENDING GENDER

- 1 Studies suggest that 0.3 percent of people in the U.S. feel strongly that their biological sex does not correspond to their gender identity.
- 2 Researchers have developed a multipart transition process for young trans people that begins with careful screening, then blockers at the onset of puberty and later cross-sex hormones to allow them to undergo puberty in their affirmed gender, followed by surgery.
- 3 Some parents and clinicians are pushing back against the existing guidelines, seeking a more case-by-case approach.



Skyler struggled with depression and felt “at war with myself,” he says, before undertaking a social transition, which included coming out to classmates and changing his name.

field counter that caution is essential given that treatment is largely irreversible and that gender identity can be fluid in the young, with some patients having second thoughts. A paucity of research

makes it difficult for both sides to resolve the debate and determine what is best for their patients.

Insistent, Consistent and Persistent

As newly alerted parents arrive at clinics with boys who sew and dress in frilly outfits and girls who would not be caught dead doing either, experts have to diagnose whether these children have gender dysphoria. In this condition, people suffer distress because of a mismatch between the gender identity they experience and their biological sex as determined by chromosomes, gonads and genitals. (Until 2012, psychiatrists classified the condition as “gender identity disorder,” a term now viewed as stigmatizing.)

Although adolescents may confuse the two, gender identity is different from sexual orientation. Norman P. Spack, a pediatrician, pediatric endocrinologist and founder of the gender clinic at Boston Children’s Hospital, borrows language from one of his first transgender patients to explain: “Sexual orientation is who you go to bed with. Gender identity is who you go to bed *as*.” In fact, Spack adds, “I could never predict the sexual orientation of my patients.”

Furthermore, gender dysphoria is more than just rejecting the social and cultural roles assigned to a given gender. Many kids push back against these norms—as when a young boy rejects macho roughhousing to playing house or a girl prefers toy soldiers to dolls—without any discomfort regarding sexual or gender identity.

But for some children, there is a nagging, painful conviction that the gender they are forced to present to the world does not reflect their true self. “There’s a small subgroup of trans kids who, as soon as they can talk, are saying, ‘I’m not the gender you think I am,’ ” says psychologist Diane Ehrensaft of the Child and Adolescent Gender Center at the University of California, San Francisco, Benioff Children’s Hospital. Often, Ehrensaft says, these kids do not like their bodies.

Among children under the age of about 12 who cross-identify, in terms of how they dress and behave, only a minority will continue to see themselves as transgender after puberty. A 2008 study by psychologists Madeleine S. C. Wallien and Peggy T. Cohen-Kettenis, both then at VU University Medical Center in Amsterdam, followed 77 children

who had been diagnosed with gender dysphoria between the ages of five and 12. At age 16 or later the researchers found that 43 percent of the teens were no longer gender-dysphoric and that 27 percent remained so (some could not be reached for follow-up). Of those who stopped cross-identifying, all the girls and half of the boys were heterosexual; the other half of the boys were either homosexual or bisexual.

In what has become the mantra of the field for recognizing clear-cut trans children, they are “insistent, consistent and persistent over time” in their identification with the gender opposite to the one that they were assigned. A 2013 study led by Thomas D. Steensma, a psychologist at VU University Medical Center, confirmed that the intensity and persistence of identifying with the opposite, nonassigned gender are powerful indicators in predicting who will remain trans. Working with 79 boys and 48 girls referred for gender dysphoria to VU University Medical Center before age 12, Steensma and his colleagues measured these factors through a questionnaire assessing cross-gender behavior through early childhood. At age 15 or later only 23 of the boys and 24 of the girls had persisted. Those who remained trans were more likely to have been insistent early on, saying, for example, “I am a boy” rather than “I wish I were a boy” or they would grow up to be a daddy, not a mommy. Still, Steensma cautions, it is hard to predict whether any specific child will persist as transgender.

Some children change their mind at critical junctures, such as after undergoing a “social transition” (changing their



Payton McPhee (*above and opposite page*) began questioning his gender at age 11. Three years later he learned about female-to-male transitions and identified as trans male. “I was excited to finally have something to call myself,” he says.

name, pronoun and appearance to live in their affirmed gender) or taking puberty blockers. Some children, Ehrensaft says, gradually realize that they are trans. Still others are more focused on gender expression: wishing to be the other gender and cross-dressing but in a playful, fantasy context, without any distress about their body. Some, she says, are “proto-gay” and likely in adolescence to come out as gay, lesbian or bisexual. Increasingly, many will identify as gender queer, saying, in effect, “I do not identify with either gender; I’m beyond gender” or “I do not fit into your male/female binary.” Such kids,

Ehrensaft says, “are our littlest gender outlaws.”

Teens who identify as trans, says psychologist Laura Edwards-Leeper of Pacific University, may also be reacting to peer influences, family dynamics, or religious or cultural beliefs. In some cultures, for example, she says, individuals face less stigma for being transgender than for being homosexual. So it is complicated.

THE AUTHOR

FRANCINE RUSSO is a veteran journalist, specializing in psychology and behavior. She is also a speaker and author of *They're Your Parents, Too! How Siblings Can Survive Their Parents Aging without Driving Each Other Crazy*.

Setting the Standard

In many respects, the Netherlands serves as an exemplar for supporting trans and gender-questioning people. In October, Loiza Lamers won Holland's Next Top Model, the first transgender winner from any country. One Dutch teenager (who appears on our cover at age 10) began her social transition early in

life and feels that her experiences today are no different than those of her contemporaries. “I’m like any other high school girl,” she says. “I love my dogs, spending lots of time with my girlfriends, going dancing.”

The degree of social acceptance in the Netherlands may reflect the country’s long history working with the trans community. Since 1975 clinicians at VU University Medical Center have counseled 5,000 adults and helped many hundreds of people transition to a different gender. As younger people came forward seeking guidance, Dutch experts established a second clinic for children and adolescents at University Medical Center Utrecht in 1987 that has since joined VU University Medical Center’s clinic, known as the Center of Expertise on Gender Dysphoria. To date, they have counseled 1,000 young people, including some who, like the Dutch teen, have pursued a transition.

The procedure these clinicians developed became a template of sorts for the Endocrine Society’s standards of care, now used around the world. The protocol first requires a series of psychological assessments. Given the potential fluidity of identity in a young person, careful screening is considered essential to identify which children should undertake the process of transitioning. Assuming kids meet the diagnosis of gender dysphoria, clinicians advise parents to wait until after puberty to see whether their child will persist. (Meanwhile many parents, with or without clinicians’ encouragement, may help their children make a social transition before puberty.) At what doctors refer to as Tanner stage 2, when girls have tiny breast buds and boys have slightly enlarged testes, they can receive puberty blockers to prevent further sexual maturation. This stage’s onset is variable but usually occurs between 10 and 12 years of age. At around age 16 those who persistently identify as transgender can receive cross-sex hormones, and at 18 they can elect to have gender-reassignment surgery. Throughout the process, the transitioning person must receive mental health support.

According to the first long-term research findings, young people who receive this kind of care do quite well. A 2014 study by psychiatrist Annelou L. C. de Vries of VU University Medical Center and her colleagues reported good results for 55 young people followed from before puberty suppression until after cross-sex hormonal treatment and surgery. Over this period, their psychological functioning steadily improved—with declining levels of gender dysphoria and anxiety and a greater sense of overall happiness. After treatment, their sense of well-being was similar to that of their peers who were not trans. All these transgender youth had identified as trans in childhood, de Vries says.

These recent positive outcomes are based on strict adherence to the protocols. But increasingly in both the U.S. and the Netherlands, with this research as a baseline, clinicians are making treatment decisions on a case-by-case basis. Guidelines recommend waiting until 18 for body-altering surgery, for instance, but some trans boys are having the most common operation—“top surgery,” or breast removal—as early as 13 because binding breasts can cause pain or physical problems.

Even the Endocrine Society is revising its guidelines to be more flexible, says society committee member Stephen Rosenthal, a pediatric endocrinologist at the U.C.S.F. School of Medicine. Although “around 16” will still be the recommended age for cross-sex hormones, for example, newer standards will recognize “compelling reasons” to start earlier, such as to safeguard a child’s physical or emotional welfare.

Parents are part of the push to address cases more individually. Gender transitions are complex at any age, but for a minor there is the added complication of reliance on adult guardians for consent and support.

Helping Younger Children Thrive

At age three Marlo Mack* reports, her child looked in her eyes and said, “Mama, something went wrong when I was in your tummy that made me come out as a boy instead of a girl. Put me back so I can come out again as a girl.” For nearly a year Mack resisted her child’s entreaties to be a girl. Then she grieved for her lost little boy and loved and accepted her new daughter, a “girl with a penis.”

Their therapist, Mack says, urged her to “take a wait-and-see attitude,” at least until age five, before supporting a social transition. “I tried to do it,” Mack says, “but I felt unsupportive and almost abusive.” Thus, at the age of four and a half, Mack’s child became a girl at home and in the world.



*A nom de plume for her podcast *How to Be a Girl*.

There is no medical treatment for prepubescent transgender children, but a growing community of clinicians is cautiously endorsing social transitions. Mack is one of an increasing number of parents in the U.S. who are helping their preschoolers to live as the gender they feel they are. In the Netherlands before the year 2000, Steensma says, almost none of the children referred to the Amsterdam clinic for gender dysphoria were presenting socially as their affirmed gender. By 2009 that percentage had risen to more than 33 percent, a reflection of similar parental support.

The most important question surrounding a social transition, according to psychiatrist Scott Leibowitz of Ann & Robert H. Lurie Children's Hospital of Chicago, is whether it helps the child thrive. Suppose a boy will not go to school except in a dress? "If a kid does go to school in a dress and does well," Leibowitz says, "I support it."

There is one big caveat for parents: be open to your child changing back. Families who, for example, have grieved their lost daughter and finally, painfully, accepted their new son may find it difficult to tolerate the ambiguity of their loss/gain. With the greatest love and best of intentions, they can trap their child in a mold that no longer fits. Edwards-Leeper recalls one patient who told her, "I can't change my mind. My parents have done so much for me."

In a 2011 review of adolescents at the Amsterdam clinic, Steensma found that children who had transitioned socially were indeed more likely to remain trans than those who had not come out in their community. But he is unsure whether the social transition helped or hindered all of these kids. For instance, Steensma says, two adolescent girls who were no longer trans struggled for some time to change back to their female identity because of "fear of teasing and shame to admit they had been wrong." He wonders whether counseling children on coping with their gender variance until early puberty might be a lesser evil than having them make a complete social transition twice, including a name and pronoun change.

"One True Test of Gender"

Adolescence is a powerful time—physically, psychologically and socially—in determining lasting gender identity, experts say. At this point, young people often decide who they are and are not. Some young people may discover they are or may be trans. In a 2011 qualitative study of 25 teens, Steensma found that along with feelings about the changes in their bodies, the children's responses to a new social environment provided clues to their gender identity. They were now confronting a world in which boys and girls divide and hang out with their same-sex peers. They might have also been experiencing their first sexual and romantic feelings.

Despite pressure from an increasing number of parents to use blockers before Tanner stage 2 and the onset of puberty, the medical community agrees that waiting is essential. "Some parents are so convinced their child is trans," Spack says, "that they don't want their child to have any natural hormones.

These parents bring their kids in as young as age seven or eight. If we did that, we'd take away the one true test of gender: puberty. If the kid accepts the body they get at puberty, how can the parents say, 'My child is in the wrong body?'"

At or after Tanner stage 2, endocrinologists administer puberty suppression through either leuprolide acetate injections on a regular basis or surgical insertion of an implant that slowly releases histrelin. These are drugs that mimic the body's natural signal to stop producing hormones.

Doctors who treat trans kids say that puberty blockers are probably safe. Initially there had been concern about a negative impact on bone density, which normally increases during puberty. Fortunately, studies that followed children who had taken these drugs for "precocious puberty" into adulthood found that they appeared to have relatively normal bone density and no other serious effects—at least for the 30-year follow-up period, says pediatric endocrinologist Daniel Metzger of BC Children's Hospital in Vancouver.

After kids stop taking blockers, the effects disappear within six months, and they resume their natal puberty or take cross-sex hormones and go through puberty as their affirmed gender. Some kids remain on blockers when they take cross-hormones to prevent any unwanted pubertal changes that could happen on small doses of cross-hormones.

The medical purpose is to temporarily halt menstruation and the development of breasts, beards and other sexual characteristics, reducing the need for later surgeries and procedures and enhancing the quality of any gender change. Doctors often determine the length of treatment to prolong growth for trans boys and to curtail height for trans girls.

Psychologically, blockers reduce the distress of adolescents who, like Skyler, might otherwise harm themselves in reaction to pubertal changes. Most of all, puberty suppression gives young adolescents additional time to mature, to determine their true gender identity and to more fully evaluate the irreversible effects of taking the next step: cross-sex hormones.

Despite compelling need, some adolescents cannot get blockers. They may be too far into puberty when they recognize themselves as trans or may not be able to afford the treatment, which is often not covered by insurance. Injections of leuprolide acetate cost \$700 to \$1,500 a month, and histrelin implant surgery totals about \$15,000. Cheaper substitutes such as progesterone have potentially serious side effects, including the risk of blood clots. For these reasons, some doctors may start young teens on more affordable cross-sex hormones instead of blockers.

A Rift in the Field

At each stage of transitioning, parents and clinicians have begun questioning the existing standards, particularly for children who appear to be "clearly" trans and therefore might benefit from a different approach. Some of these transgender youth specialists, such as pediatrician Johanna Olson, director of the Center for Transyouth Health and Development at



Where Does Gender Live in the Brain?

Some children insist, from the moment they can speak, that they are not the gender indicated by their biological sex. So where does this knowledge reside? And is it possible to discern a genetic or anatomical basis for transgender identity? Exploration of these questions is relatively new, but there is a bit of evidence for a genetic basis. Identical twins are somewhat more likely than fraternal twins to both be trans.

Male and female brains are, on average, slightly different in structure, although there is tremendous individual variability. Several studies have looked for signs that transgender people have brains more similar to their experienced gender. Spanish investigators—led by psychobiologist Antonio Guillamon of the National Distance Education University in Madrid and neuropsychologist Carme Junqué Plaja of the University of Barcelona—used MRI to examine the brains of 24 female-to-males and 18 male-to-females—both before and after treatment with cross-sex hormones. Their results, published in 2013, showed that even before treatment the brain structures of the trans people were more similar in some respects to the brains of their experienced gender than those of their natal gender. For example, the female-to-male subjects had relatively thin subcortical areas (these areas tend to be thinner in men than in women). Male-to-female subjects tended to have thinner cortical regions in the right hemisphere, which is characteristic of a female brain. (Such differences became more pronounced after treatment.)

“Trans people have brains that are different from males and females, a unique kind of brain,” Guillamon says. “It is simplistic to say that a female-to-male transgender person is a female trapped in a male body. It’s not because they have a male brain but a transsexual brain.” Of course, behavior

and experience shape brain anatomy, so it is impossible to say if these subtle differences are inborn.

Other investigators have looked at sex differences through brain functioning. In a study published in 2014, psychologist Sarah M. Burke of VU University Medical Center in Amsterdam and biologist Julie Bakker of the Netherlands Institute for Neuroscience used functional MRI to examine how 39 prepubertal and 41 adolescent boys and girls with gender dysphoria responded to androstadienone, an odorous steroid with pheromone-like properties that is known to cause a different response in the hypothalamus of men versus women. They found that the adolescent boys and girls with gender dysphoria responded much like peers of their experienced gender. The results were less clear with the prepubertal children.

This kind of study is important, says Baudewijntje Kreukels, an expert on gender dysphoria at VU University Medical Center, “because sex differences in responding to odors cannot be influenced by training or environment.” The same can be said of another 2014 experiment by Burke and her colleagues. They measured the responses of boys and girls with gender dysphoria to echolike sounds produced by the inner ear in response to a clicking noise. Boys with gender dysphoria responded more like typical females, who have a stronger response to these sounds. But girls with gender dysphoria also responded like typical females.

Overall the weight of these studies and others points strongly toward a biological basis for gender dysphoria. But given the variety of transgender people and the variation in the brains of men and women generally, it will be a long time, if ever, before a doctor can do a brain scan on a child and say, “Yes, this child is trans.” —F.R.

Children’s Hospital Los Angeles, consider themselves as advocates for the children. “We have no specific, lengthy, neuropsychiatric screening protocol,” Olson says of her clinic. She feels that current measures of gender dysphoria are inadequate. “Our model is to listen to the young people. They are like snowflakes. They each need an approach that is individually tailored to their needs.”

Perhaps the most controversial issue in the transitioning process is how long teens should wait before taking cross-sex hormones—for trans females, this means estrogen and antiandrogens; for trans males, testosterone. Among their other results, estrogens produce feminizing effects such as enlarging breasts and distributing fat in a more female pattern. Testosterone halts menstruation, promotes the growth of masculine-type body hair, male muscle mass, voice deepening and other male characteristics.

Depending on when puberty begins, it could easily take half a decade before someone qualifies for this step, according

to the strict protocol. More and more, the “advocate” side of the field has called to stop keeping these children “on the sidelines” while their peers go through puberty. For clear-cut trans kids, therefore, many clinicians are increasingly comfortable giving cross-sex hormones at 14 or even younger.

But veteran practitioners, such as Edwards-Leeper, worry about moving too fast. As at other stages, the concern remains that a young person may not persist in a trans identity yet feel pressured to continue. Some patients, she says, feel as though they are “stuck” in a gender or on a runaway train that is hard to get off.” And unlike earlier stages, the stakes are higher: cross-sex hormones have irreversible effects on physical development.

Added complications arise with adolescents who only at puberty discover they may be trans. Payton McPhee of British Columbia is an example. A tomboy as a child, Payton began questioning his gender at 11 as friends began getting crushes. At 13 he realized he was attracted to girls. He came out as a



For years Lenessa wanted to be a girl and wear “flowy” dresses. Her mother helped her realize she was trans, and gradually other family members came to accept her identity. Her father reports she is flourishing.

lesbian, he says, “but it still didn’t feel right.” At 14 he met his first trans person and looked up “female-to-male” online. He was transfixed. “I was excited to finally have something to call myself,” he says.

With the support of his parents and doctors, Payton began taking birth-control pills to reduce his period to twice a year. By binding his breasts and doing vocal exercises to lower his voice, he says, he can “pass” as a boy. Now 15, he would like testosterone therapy. But his parents and doctors are not yet convinced. “His psychiatrist said that at the very least, Payton is

gender-fluid,” reports his mother, Sarah McPhee, “and most likely transgender.”

Clinicians are seeing kids like Payton show up in increasing numbers. But whether they should get cross-sex hormones, wait or take small doses for a short time to “explore” their gender is an open question. Some kids may be confused, says Harvard Medical School psychologist and gender expert Amy Tishelman, “and this is a way to glom onto an identity.” These kids may turn out to be trans. Or they may be more gender-fluid and need to experiment.

Dianne Berg, a psychologist and gender expert at the University of Minnesota, has seen some transitioning adolescents who identify as neither stereotypically male nor female and have parents pushing them to fit a more traditional mold. “It is hard for parents to wrap their head around their teen saying, ‘I want to be a man, but I don’t want to be a manly man—I want to be a more feminine kind of man,’” Berg says.

Metzger recalls a female-to-male patient who, at 13, wanted to transition and, at 16, got testosterone. Halfway through treatment, when the patient had a little facial hair and a bit more male bone structure, he asked to go on a lower dose, telling his doctor he was “a femme kind of boy.” Metzger believes he has since had his ovaries removed and has remained on a lower dose of testosterone. “Is that *safe*?” the endocrinologist asks. “No one knows the answers.”

Difficult Trade-offs

One of the thorniest issues about age is whether an 11- or even 14-year-old can understand the implications of a treatment that means he or she can never have biological children. Although it is theoretically possible for adolescents to experience enough natal puberty for boys to preserve sperm and girls to harvest eggs, it is rare for natal males to do this, and clinicians say that natal girls categorically reject it. Thus, in effect, when adolescents agree to cross-sex hormones, they or their parents are consenting to lifelong infertility.

Can a young teen understand this? It depends. As 22-year-old trans male Zachary Kerr of Methuen, Mass., recalls about the decision to take testosterone, “I blocked out everything that wasn’t good because I wanted it. I was 16. I didn’t care.”

Other clinicians say that parents must choose for their children, just as they would if a treatment for cancer resulted in permanent infertility. “For some of these kids,” says Michele Angello, a psychotherapist and gender specialist in Wayne, Pa., “the outcome is grim if we don’t treat.” As it is with so many issues these young people face, families and clinicians must recognize that each case is unique and that there are risks on every side. “There is no one right answer,” Olson says. “Trans kids throughout life have to decide between bad choices.”

More broadly, it is this keen awareness of the challenges that young trans individuals face and the limits of current knowledge that motivate concern on both sides of ongoing debates. Day to day, clinicians are doing their best to navigate between the known and unknown, but answers to at least some key questions may soon be coming. In August 2015 the National Institutes of Health awarded \$5.7 million to four major transgender centers for a five-year study of the physical and psychosocial outcomes of treatment for transgender youth.

Ultimately the best course will be to balance the ability to individualize care with caution. “Those of us doing this the longest,” Edwards-Leeper says, “feel more concern. Because we see how complex these cases are, and we understand brain development and child and adolescent development. Some

newer doctors who just want to advocate for the children can lose sight of the bigger picture.”

And both clinicians and families agree that a larger battle of acceptance and tolerance is still being fought. Despite the outpouring of government research funds, media attention and transgender pride in places such as Los Angeles and Seattle, it is important to remember that through great swaths of this country, trans kids face ignorance, blocked pathways and stigma.

Lenessa,[†] a gentle, soft-spoken 14-year-old trans girl from a small town in Texas, came close to becoming a statistic at age 11. From her youngest childhood, she had wanted to be a girl and wear “flowy” dresses, she says, but she was not allowed. While her two brothers roughhoused outside, she would read and sew indoors. The start of puberty was a shock. “I will never forget how horrible it was,” she says. “It started to become permanent that I was a boy—becoming a man.”

When, with her mother’s help, she realized that she was trans and told her family, her father and grandmother rejected her. “Except my mom,” she says, “everyone I loved seemed not to want to be with me. That’s when I *really* didn’t want to live.” To protect her from her suicidal impulses, her mother took her to a psychiatric hospital. For her father, it was “a wake-up call.” “I wanted a live child,” he says, “not a dead son.”

Even with both parents agreeing, finding a way forward was hard. Neither Lenessa’s school nor her pediatrician had ever heard of being trans. Long searching led them to Ximena Lopez at the gender clinic at Children’s Medical Center Dallas, which is affiliated with the University of Texas Southwestern Medical Center.

Now, at 14, Lenessa is on blockers and, her father says, is flourishing. They have moved to a place where no one knew them before, and the girl who is now Lenessa is about to start high school, wearing the dresses that she loves. She hopes to eventually start hormones and develop a more womanly body. She says she understands the sacrifice she will be making: “It makes me sad when I realize I can’t have my own children. But sometimes in life, when you really want something, you have to accept things you don’t like.” **M**

MORE TO EXPLORE

- **Between Pink and Blue: A Multi-Dimensional Family Approach to Gender Nonconforming Children and Their Families.** Jean Malpas in *Family Process*, Vol. 50, No. 4, pages 453–470; December 2011.
- **Children and Adolescents with Gender Identity Disorder Referred to a Pediatric Medical Center.** Norman P. Spack et al. in *Pediatrics*, Vol. 129, No. 3; March 2012.
- **Factors Associated with Desistence and Persistence of Childhood Gender Dysphoria: A Quantitative Follow-up Study.** Thomas D. Steensma et al. in *Journal of the American Academy of Child & Adolescent Psychiatry*, Vol. 52, No. 6, pages 582–590; June 2013.
- **Gender Identity Development in Adolescence.** Thomas D. Steensma et al. in *Hormones and Behavior*, Vol. 64, No. 2, pages 288–297; July 2013.

From Our Archives

- **The Third Gender.** Jesse Bering; May/June 2010.

[†]Not her real name.



THE REMARKABLE REACH OF GROWTH MIND-SETS

Believing in people's ability to change can help thwart teen depression, spur workplace creativity and ease political conflict

By Carol S. Dweck

ILLUSTRATIONS BY ELLEN WEINSTEIN



Do you think it is possible to increase your intellectual ability? For decades I have studied the power of this belief to become reality and watched as the concept of maintaining a “growth mind-set” has taken root in education and parenting circles. My colleagues and I have now shown repeatedly that students who believe their intelligence can grow learn more, acquire deeper knowledge and do better—especially in hard subjects and in negotiating difficult school transitions—compared with equally able students who believe their intelligence is a fixed trait.

The reason is simple: students with a growth mind-set are not as worried about looking intelligent, and so they take on more challenges, persist longer and are more resilient in the face of setbacks. In contrast, those with a “fixed mind-set” tend to see challenges as risky and effort and setbacks as signs of limited talent.

Newer research is revealing just how potent this effect can be. Consider one example: In 2014 my Stanford University colleagues Susana Claro and Dave Paunesku and I analyzed census data, examination results and answers about mind-set from 147,000 10th graders in Chile. We found that at every level of family income, the kids who favored a growth mind-set—as measured by a questionnaire we developed—enjoyed substantially higher levels of academic achievement than those who espoused a fixed mind-set. In fact, poorer kids with growth mind-sets often performed as well as far more privileged kids with fixed mind-sets.

We are also discovering more about how fixed mind-sets are passed on—often inadvertently and with the best of intentions—by parents, teachers and peers. Fortunately, those attitudes can be reset toward growth. Through in-person workshops and online modules, we have successfully taught thousands of students—from middle school to university—that when they step out of their comfort zone to learn hard, new things, the neurons in their brain form new or stronger con-



nections, boosting their abilities over time. They learn how to apply this idea to their schoolwork and how it has helped others to succeed.

In recent years a growing body of research has further demonstrated that, well beyond the classroom, a growth mind-set can help thwart depression, decrease aggression, strengthen willpower, spur creativity in the workplace and possibly advance conflict resolution among long-standing enemies. It seems incredible (even to us!), so I would like to tell you more about these exciting new lines of work.

Weathering Adolescent Angst

During the past few years, we have come to appreciate that mind-sets can shape not just academic but also social success at school. In particular, we have focused on teenagers, who often feel harshly judged by their peers and may wonder, “Am I a ‘misfit’? And will I always be this way?” Developmental psychologist David Yeager, now at the University of Texas at Austin, and I theorized that teens who see themselves and others as evolving, growing people might be better positioned to deal with these social stresses, whereas those with more fixed mind-sets might harbor more hostile feelings toward peers who exclude them because those peers have made them feel like permanent “losers.”

FAST FACTS

TURNING BELIEFS INTO REALITY

- 1 A growth mind-set—or the idea that you can grow your abilities by believing that you can—yields big benefits beyond the classroom for teens, adults, businesses, even political adversaries.
- 2 Identifying how teachers, parents, bosses and peers communicate mind-set may increase the number of people who benefit from growth mind-set beliefs.
- 3 Parents and teachers who think they hold a growth mind-set still sometimes convey fixed mind-set messages—especially when they express the view that setbacks are detrimental to a child’s learning.

To test this idea, we launched a series of studies in 2011. First we measured adolescents' mind-sets about personality—that is, whether they saw personal qualities as fixed or subject to ongoing development. Then we asked them to report on their social conflicts with peers. We found that when adolescents in a fixed mind-set experienced or recalled exclusion or rejection by their peers, they harbored more shame, hatred and fantasies of violent revenge. This pattern was true regardless of the students' socioeconomic backgrounds.

Next Yeager designed a workshop to teach a growth mind-set about personality. More than 200 ninth and 10th graders in a large, low-income high school near San Francisco participated. Over the course of six sessions, they learned that all people have the potential to grow and change—it is not easy but is always possible. Although the staff of the school warned us that it was too late for these teens to change their behavior (“Go help younger kids,” they said), the impact of the workshop was clear.

Compared with control groups, who received no training or different training, the students who attended the six growth mind-set sessions showed reduced aggression in school, as reported by their teachers, who did not know which training the students had received. One month later Yeager put all the kids in the study into a trying situation—specifically, they were temporarily excluded by peers while playing a computer-based ball-tossing game. The growth mind-set group responded less aggressively and more compassionately than control subjects toward the kids who left them out, even when they were given the opportunity to retaliate.

Yeager and his collaborator, psychology Ph.D. student Adriana Miu of Emory University, went on to examine the role these mind-sets play in adolescent depression, known to increase markedly in the first year of high school. In a 2014 study with 599 students, they found that teaching a growth mind-set about personality at the start of ninth grade could reduce the incidence of serious depression by nearly 40 percent, compared with the results for a control group who received different instruction. In fact, Miu and Yeager largely prevented the typical spike in new cases of depression among high school freshmen.

The social effects of mind-set apply to adults as well as teens. Thinking of ourselves as capable of growth can help us weather difficult periods full of judgments and setbacks. And if we can see our adversaries as capable of growth, we can interact more successfully with them. One of our most ambitious projects to date brought together several U.S. psychologists with Eran Halperin of the Interdisciplinary Center Herzliya in Israel to consider the influence of mind-sets on participants caught up in Middle East conflict. We showed that when Jewish Israelis or Palestinians are led to adopt a growth mind-set about social groups—learning that groups can change and do not have an inherent, immutable nature—they come to view one another less negatively and become more willing to entertain serious compromises for the sake of peace.

In research that we have just completed, Halperin, togeth-

MANAGERS IN FIXED MIND-SET COMPANIES EMPHASIZE TALENT BUT ULTIMATELY SEE LESS POTENTIAL IN THEIR EMPLOYEES.

er with my Stanford colleagues James Gross and Amit Gold-berg, found that these attitude shifts can endure. Six months after a growth mind-set workshop, many of the people who had learned a growth mind-set perspective remained more optimistic than those in a control group about the possibility of forging a better future.

Enabling Growth on the Job

Another growing realization in my field is that mind-set can characterize and drive large, organized groups just as it influences individuals. Starting in 2010, Mary Murphy, now at Indiana University Bloomington, and I began collaborating with researchers at several other institutions to examine the role of mind-sets at a group of Fortune 1000 companies. We asked hundreds of employees from seven of these businesses to complete a questionnaire: Did their company believe in fixed talent, or did it instead believe in the development of employees' abilities? Notably, there was good consensus among workers on whether their company had a growth or fixed mind-set.

We learned that mind-sets made a big difference in terms of employee attitudes and job satisfaction. The people who worked for growth mind-set businesses said they felt far more empowered by their company and committed to it. They said that their organization valued innovation and creativity—much more so than those who worked for fixed mind-set companies—and that it would support them if they took a reasonable risk that did not work out. In contrast, those in fixed mind-set companies reported that fellow employees engage in more devious practices—keeping secrets, hoarding information—all designed to make them look like winners in the talent hierarchy.

Perhaps most revealing, we found that the managers in

THE AUTHOR

CAROL S. DWECK is Lewis and Virginia Eaton Professor of Psychology at Stanford University and author of *Mindset: The New Psychology of Success*.

growth mind-set companies more frequently said that their employees showed the potential to rise and become stars, compared with managers in fixed mind-set companies. I find that ironic because the fixed mind-set companies, for all their emphasis on talent, were, down the road, not seeing as much potential in their workers.

Countering Bias

Just as corporations can embrace distinct mind-sets, so can entire academic fields. In 2015 philosophy professor Sarah-Jane Leslie of Princeton University, psychologist Andrei Cimpian of the University of Illinois at Urbana-Champaign and others uncovered how these mind-sets influence who is thought to excel in certain disciplines. They polled scholars working in 30 different areas and asked them the extent to which success in their field required inherent talent (a fixed mind-set) versus dedication, discipline and hard work (more consistent with a growth mind-set). Two strong correlations emerged: the more a field valued inborn genius, the fewer women and the fewer African-Americans earned Ph.D.s in that subject. This relation held true not just for math and science fields, such as physics and chemistry, but also for certain humanities and social sciences, including economics and philosophy.

Through further questioning, this research team discovered that disciplines that buy into the idea of inherent genius tend to be both less attractive and less welcoming to women. In a wonderful, complementary line of research, Murphy and her colleagues are demonstrating, in an ongoing study involving 264 college students, that when women view their college science in-

structors as believing in fixed, inherent talent, they feel less confident that they belong in science. In other words, they view the professor as believing that only some students have what it takes—and they tend to suspect that as women, they do not fall into that category. Murphy is seeking to identify precisely the kinds of statements and practices through which college science instructors convey these fixed mind-set messages.

These findings are key to understanding the gender, racial and ethnic gaps in important fields. They suggest that we need to pay close attention to the mind-set messages we send students. In doing so, we may begin to find ways to increase the number of women and minorities who enter math, science and economics—disciplines that support an increasing number of vital jobs in our society.

Parenting and Praise

So how are messages about mind-set relayed within families, schools and organizations? Our past research has shown that when adults praise a child's intelligence or talent, it sends a fixed mind-set message, with all its associated liabilities. Children hearing this praise may no longer want to challenge themselves and are discouraged by difficulty, which, in this framework, suggests to them that they might not be so smart after all. But children whose parents and teachers offer what I describe as “process praise”—linking their success to hard work or good strategies—tend to adopt more of a growth mind-set, embrace struggles and thrive in the face of challenge.

Now, you might think that parents and teachers who have growth mind-sets themselves would naturally transmit them

Getting the Message Right for Kids

Many of us declare that we have a growth mind-set, when in fact, we all hold a mixture of fixed and growth mind-sets. For many, a fixed mind-set arises when we contemplate stepping out of our comfort zone or when we face criticism or setbacks. In these cases, does a voice in your head say, “You might not have the ability, and everyone will know it” or “Go for it. Learn. Struggle is part of learning. Ask for input or mentoring”?

Many parents and educators incorrectly believe they are fostering the latter attitude when they exhort children to try hard. Some educators even blame kids who do not comply: “I can't teach this child. He has a fixed mind-set.” But simply urging children to try hard is not enough. It does not teach them how the brain grows through learning or how hard work and new strategies lead to deeper learning. And it does not dispel the fixed mind-set belief that hard work is for people who are not that smart to begin with. Never mind that children of all ages experience the generic call to hard work as nagging—something that adults are very good at doing and that kids are very good at ignoring.

Also in the name of a growth mind-set, some adults blithely assure children that they can do anything if only they work hard enough. But if a child lacks the necessary skills, strategies, support or mentoring, such reassurance is hollow and even misguided. On the flip side, some parents and educators have taken to lavishly praising effort, even when a child has not in fact worked hard or effectively. This tactic, too, sends a discouraging message: “You are not capable of anything better.”

To convey a true growth mind-set, adults must help kids understand what they need to do to develop their abilities and to guide them in that process. We see a “process focus” as appreciating not only children's genuine efforts but also their use of good strategies and their appropriate seeking of input from others as they strive to meet a high standard. We also see a process focus as tying these strategies directly to the child's learning and progress. What about when a child has tried hard but fallen short? The adult can appreciate the effort but point to the next step: “Let's talk about what strategies you've tried and what you can try next.” —C.S.D.



to the children in their care. In that case, we could just teach a growth mind-set to the adults and sit back. But as we and other researchers are now discovering, overt words and deeds speak louder than covert mind-sets—and the two do not always match. Let us look more closely.

In 2013, together with colleagues at Stanford and the University of Chicago, I examined how mothers praise their babies, analyzing videotaped interactions when the tots were one, two and three years old. Five years later, when the children were in second grade, we assessed their mind-set and appetite for challenge. At that point, we also asked the mothers about their mind-set and whether they believed that intelligence and other personal qualities were fixed or traits that could be developed.

We discovered that the mothers' earlier pattern of praise predicted their children's mind-set and desire for challenge in second grade, but the mothers' own reported mind-set did not. Mothers who said they had a growth mind-set but did not praise the process their children engaged in did not tend to raise kids who welcomed challenge or believed in growth. But consistent with our past research, the mothers who gave their children more process praise—focused on actions, persistence or strategies—relative to other forms of praise raised kids with stronger growth mind-sets and more interest in tackling challenges. In a follow-up study, we have just found that this latter group of children continued to progress and showed higher math and verbal achievement two years later, in fourth grade.

Thus, many mothers who believe in a growth mind-set may

not know how to put it into practice [see box on opposite page]. Brand-new research, by Stanford psychology Ph.D. student Kyla Haimovitz and me, continues this story. We are looking at parents' views of failure and their reactions to their children's setbacks. In a series of studies, we have found that parents who believe setbacks are harmful (as opposed to helpful) to a child's learning tend to foster a fixed mind-set in their offspring. When they react to their kids' setbacks with anxiety or concern, the children are led to believe that setbacks reflect badly on their (permanent) ability. Here, too, many parents espoused a growth mind-set, but if they did not translate that into a positive reaction to errors, they passed on a fixed mind-set to their kids.

More new research, this time looking at middle school math teachers, tells the same tale. In her fascinating dissertation research at Stanford, Kathy Liu Sun found that many of the math teachers she surveyed said they embraced a growth mind-set and even used the words "growth mind-set" in their classrooms. If they did not, however, back that up with growth-focused teaching methods—for example, emphasizing an understanding of the underlying concepts, giving feedback to deepen that understanding, and offering students a chance to revise and re-

submit their work to demonstrate their enhanced understanding—their students tended to cling to a fixed mind-set in math. The students did not benefit from the experience of growing their mathematical abilities.

Taken together, these results have inspired us to look even more deeply into the practices—the words and deeds—that convey to children and adults that their talents can be developed. Through research, we are seeking to identify more of these practices and to spell them out clearly so that those who hold a growth mind-set and wish to foster it in others can pass it on effectively. But as we scientists are so fond of saying, more research is needed. Stay tuned. **M**

MORE TO EXPLORE

- **Mindset: The New Psychology of Success.** Carol S. Dweck. Random House, 2006.
- **Promoting the Middle East Peace Process by Changing Beliefs about Group Malleability.** Eran Halperin et al. in *Science*, Vol. 333, pages 1767–1769; September 23, 2011.
- **Parent Praise to 1- to 3-Year-Olds Predicts Children's Motivational Frameworks 5 Years Later.** Elizabeth A. Gunderson et al. in *Child Development*, Vol. 84, No. 5, pages 1526–1541; September/October 2013.
- **Expectations of Brilliance Underlie Gender Distributions across Academic Disciplines.** Sarah-Jane Leslie et al. in *Science*, Vol. 347, pages 262–265; January 16, 2015.

From Our Archives

- **The Secret to Raising Smart Kids.** Carol S. Dweck; December 2007/January 2008.



FOOD

GAMES

ADDICTED
TO:

GAMBLING

SEX

Are “behavioral addictions” really mental illnesses or just bad habits? A look at the latest evidence

By Carl Erik Fisher

INTERNET...

Heo did not seem like the type to become addicted to gambling. He was a literary star who had published his first novel at age 24 to great success. While traveling through Europe, he began visiting elegant casinos, at first dabbling in table games like roulette. With time, though, this pleasant diversion became a compulsion, and he lost nearly all his money in just a few years. He continued to produce critically acclaimed books—at one point churning out a new novel in less than a month to settle urgent debts—but he struggled to stay afloat, and his wife soon had to sell her jewelry. Remarkably, aside from the gambling, his life seemed fine. His writing was respected, and his family life was satisfying. He was simply hooked.

“Theo” is actually Fyodor Dostoyevsky, the prototypical gambling addict. Despite profound insight into the human condition, Dostoyevsky struggled with gambling for many years and was almost financially ruined several times. His semiautobiographical novel *The Gambler*—written to cover his debts, published in 1867—described compulsive gambling so well that 20th-century psychiatrists studied it as a model for the concept of gambling addiction.

Well over a century ago people already realized that an individual could have what is today called a behavioral addiction: an overwhelming, repetitive and harmful pattern of behaviors apart from drug or alcohol abuse. Now, 150 years after Dostoyevsky first walked

into the casinos of Romantic-era Europe, addictions to sex, eating, video games and other behaviors are getting serious recognition in some quarters of medicine and among the public. Casualties of behavioral addictions are appearing in the news: not just gamblers throwing their life savings away but also porn addicts masturbating to iPhones on the freeway and even babies left to die by parents engrossed in video games. Doubters, however, argue that slapping the addiction label on these habits inappropriately excuses bad behavior.

Are these behaviors mental disorders? Many people are striving to limit their screen time or watch their diets, but does that mean that Internet and food addiction epidemics are upon us? Proponents argue, neuroscience evidence in hand, that behavioral addictions are brain disorders, but critics question those interpretations and protest that we are unnecessarily medicalizing everyday suffering.

This leaves psychiatrists like me in a difficult position. In my practice in New York City, I received more inquiries in the past year from people seeking help for Internet addiction than for cocaine and heroin addiction combined. It is hard to deny that for some of them, behavioral addictions are real—these individuals are truly overwhelmed by repetitive, harmful behaviors. Their schooling, marriage or job is in danger because of their uncontrolled actions. They sincerely want to stop, but they feel powerless. A mental disorder is defined simply as a dysfunc-

tional thought process or behavior that causes harm. In my view, some behavioral addictions clearly meet that description—there is a reason we have had this intuition since the time of Dostoyevsky.

Yet many people rush to diagnose themselves with behavioral addictions, not recognizing the underlying depression or anxiety driving their problems. Treatment for them may have different considerations, and research is just starting to offer clues about how to help these different types of addictions. After all, that is the goal of all the questions and debates—how can we best help people who are suffering?

As I set out to understand this phenomenon, I found that even the experts within the field are divided—and that includes those who support the idea of behavioral addiction. But along the way I also caught glimpses of paths toward a resolution.

Disordered Desires

People were making unhealthy choices about sex, eating and money well before Dostoyevsky. Saint Augustine’s *Confessions*, written sometime around the year 400, intricately explores loss of control over sexual impulses. The root of the word “addiction” itself is thought to come from the Latin term for “dedication,” and prior to the 19th century the word was often used to describe behaviors in a positive light, such as being dedicated to public service or “addicted to books.” But a darker view of addiction soon began to emerge.

In the 20th century the temperance movement, the development of psychiatry and the growth of Alcoholics Anonymous all shaped the disease model of addiction: loss of control over drugs and alcohol is a chronic, relapsing, lifelong disorder. As early as 1957, offshoot 12-step programs such as Gamblers Anonymous and Overeaters Anonymous applied the addiction model to problems that did not involve drugs or alcohol.

In 1980 “pathological gambling” was added to the *Diagnostic and Statistical Manual (DSM)*, the American Psychiatric Association’s official categori-

FAST FACTS

OUT OF CONTROL

- 1 Many people struggle with habitual behaviors that cause them distress and disrupt their life, such as too much gambling, eating, sex or Internet use.
- 2 Genetic evidence, brain-imaging studies and pharmaceutical treatments suggest these behavioral addictions are similar to drug and alcohol addictions.
- 3 Despite the recent scientific advances, the notion that there are different subtypes of behavioral addictions remains controversial, leaving open the question of whether there are different root causes of these addictions in different individuals.
- 4 Regardless of other co-occurring mental disorders or suspicions about underlying issues, individual treatment plans that address all psychological problems at once work best.

IMAGING STUDIES SHOW THAT THE BRAIN ACTIVITY OF PROBLEM GAMBLERS LOOKS SIMILAR TO THAT OF DRUG AND ALCOHOL ADDICTS.

zation of mental disorders, as a condition deserving further study. In 1990 Isaac Marks, a psychiatric researcher in London, penned a widely cited editorial in the *British Journal of Addiction* describing “non-chemical” addictions, and since then the idea has received increasing attention from mainstream researchers and clinicians.

In popular culture, behavioral addictions are also getting much more recognition. Movies such as *Shame* and *Don Jon* vividly portray sex and pornography addictions. For better or for worse, sex addiction is the go-to excuse for unfaithful celebrities. Residential rehabilitation centers for Internet addiction are booming in China and even starting to appear in the U.S. Additionally, as developed countries

grapple with obesity, a food-addiction model is increasingly used to explain some people’s uncontrolled eating.

At the same time, however, the academic understanding of addiction is a conceptual minefield. Organized psychiatry has long shied away from even using the word “addiction.” The *DSM* formerly called it “dependence,” a stand-in term that emphasized the idea of addiction as a chronic, relapsing disease that is markedly different from other unhealthy drug and alcohol use.

That distinction, between “true” addiction and other harmful patterns of drug abuse, has been struck from the latest edition, the *DSM-5*, published in 2013. The update radically altered the definition of addiction, collapsing both “dependence” and milder forms of “substance abuse” into one condition, “substance use disorder,” with no clear division between mild and extreme cases. That decision was based on data from more than 200,000 research participants, which showed an even continuum from the worst cases down to less severe substance-use problems.

This changing understanding of addiction makes it even more difficult to know how to define behavioral addictions. Is gambling addiction like drug addiction, or is it something else? The evidence base for most behavioral addictions is far less robust than for substance addictions, but research is beginning to fill in the gaps.

Gambling Gets Its Due

Researchers have increasingly used the tools of neuroscience to argue that behavioral addictions are brain-based disorders. For example, as recently as the early 2000s clinicians were not sure how to categorize pathological gambling. Some thought it looked more like obsessive-compulsive disorder than drug or alcohol addiction. From their perspective, pumping quarters into slot machines or repetitively washing one’s hands appeared almost the same—irrational, compulsive and almost automatic.

Marc N. Potenza, a gambling researcher at Yale University, published an enlightening study in 2003. Using functional MRI, a method for assessing blood flow in the brain, his team measured the cerebral activity of people with gambling problems as they watched provocative videos in the scanner: the thrill of an unexpected windfall, the clatter of new chips, the flutter of cards. The imaging revealed decreased activity in the ventromedial prefrontal cortex (vmPFC), an area in the middle of the frontal lobes associated with regulating impulses. People with OCD show the opposite result: they have increased vmPFC activation during obsessions, indicating excessive thoughts and preoccupations. These and subsequent imaging findings show that the brain activity of problem gamblers looks similar to that of drug and alcohol addicts.

In 2005 a group of researchers in Hamburg, Germany, used fMRI to dis-

GAMBLING

OFFICIAL STATUS: The oldest recognized behavioral addiction, gambling disorder, has been listed under various names since 1980 in the *DSM-III* and the *DSM-IV* and is currently fully accepted in the *DSM-5*.

PREVALENCE: Although more than 85 percent of the U.S. population will try gambling at some point in their lives, experts estimate that around 1 percent or less of all adults will develop this disorder.

DID YOU KNOW?: Several celebrities have been reported to have gambling disorder, including Charlie Sheen, Ben Affleck and Tiger Woods, but such stories may be complicated by other issues, possibly including substance use or mental health problems.



SEX

OFFICIAL STATUS: Hypersexual disorder was proposed for the *DSM-5*, but after criticism it was not even included in the appendix.

PREVALENCE: The numbers depend on the definition used, but larger studies of hypersexual disorder (previously studied as “compulsive sexual behavior”) have found rates around 1.5 to 2 percent of the population, with a significant gender difference (greater than 3 percent for men; 1 percent or less for women).

DID YOU KNOW?: Studying the prevalence rates of hypersexual disorder is difficult; many people are likely to underreport their problems because of stigma. For this reason, cross-cultural studies of addictive sexual behaviors are particularly challenging.



cover further similarities between behavioral and substance addictions. They measured responses in the ventral striatum, a deep-brain structure rich in dopamine and associated with sensitivity to rewards. Drug and alcohol addicts have been shown to have both reduced activity in the ventral striatum and altered dopamine levels. This lowered activity is consistent with the idea of a reward deficiency: people with addictions have blunted responses to rewards, driving them to compensate by seeking even more gratification. Sure enough, the gamblers in this study showed less activity in the ventral striatum.

Such findings supported the formal addition of “gambling disorder” to the *DSM-5*. The only other behavioral addiction to be added was “Internet gaming disorder,” but only in the appendix as a condition for further study. Debates were fierce, however, about behavioral addictions in general, and scientific commonalities between behavioral and substance addictions were the crux of the proponents’ argument.

A Lot Like Drugs

Much scientific research on behavioral addictions has focused on comparing and contrasting them with substance dependence. Aside from bolstering their status as disorders, doing so can offer clues as to whether similar treatments might work, if such interventions should be covered by insurance companies, and

how society should treat people who suffer from these afflictions.

There has been a plethora of fMRI studies since Potenza’s influential gambling studies. His initial findings have been replicated several times, and the brain areas implicated are relatively consistent. Preliminary brain-imaging studies have found some similar results in food, sex and Internet addiction, although the results are not always consistent. Overall the findings are not as well aligned with findings from traditional substance-use disorder research.

Investigation of the neurochemistry of these disorders is also preliminary, but some researchers have found altered neurotransmitter receptor function in people with food and Internet addictions. Studies using positron-emission tomography have shown, for example, lower levels of activity in dopamine-producing regions of the ventral striatum at rest in both obese people and people with Internet addiction. PET studies of compulsive gamblers, however, have shown conflicting results. In food addiction, a growing body of evidence from rodents shows changes in neurotransmitters such as dopamine. So although there are interesting clues from neurochemistry, the jury is still out.

Another clue that behavioral addiction may be quite similar to substance addiction is the fact that some pharmaceutical treatments appear to work for both conditions. For example, naltrex-

one, a drug that blocks opioid receptors in the brain, has successfully treated alcohol and opioid dependence since the 1990s. More recent evidence shows that it can help with gambling addiction, and some smaller trials hint that it might ease sex addiction.

These confluences suggest that behavioral and substance addictions might have the same underlying causes—as does the fact that large population surveys show that the two types of addiction tend to occur together. Such findings are often comforting to people who wonder why they cannot overcome a repetitive behavior—framing it as a “real” addiction can mitigate shame and speed recovery. For me and other clinicians, the similarities between behavioral addictions and drug addictions help us choose and be confident in our therapeutic strategies.

Yet just as with substance addicts, people who show signs of behavioral problems often have other mental disorders that may be complicating the diagnostic picture. To give them the best

THE AUTHOR

CARL ERIK FISHER is assistant professor of clinical psychiatry at Columbia University. He works in the Division of Law, Ethics, and Psychiatry and teaches in the university’s Masters in Bioethics program.

treatment, sometimes it is important to look more closely at what underlies their behaviors.

Why Me?

Patients with behavioral addictions often ask me whether they are fated to be addicts—whether their battles for control are an intrinsic part of their character. We have known for many years that genetic factors explain up to 50 percent of the risk for developing addictions, including problem gambling. Just recently, genetic studies of other behavioral addictions have found similar results. A 2014 study of more than 800 Chinese twins and a 2015 study of more than 5,000 Dutch twins both found that, statistically, genetic factors explained approximately half the risk of compulsive Internet use. The exact genetic contributions, however, are too complicated to make interpretations based on an individual's genetic makeup.

Other factors can be set in motion before a person's birth, as illustrated by rodent research of food addiction. In one 2010 study, mouse mothers on a high-calorie, high-fat diet transmitted an exaggerated preference for fat to their offspring, as compared with control mice on a normal diet. This preference appeared to be passed down through epigenetic alterations that effect the expression of the genes responsible for dopamine-managing proteins in the brain.

Life experience, early exposure and a

ABOUT HALF THE RISK OF DEVELOPING A COMPULSIVE INTERNET HABIT APPEARS TO BE GENETIC, ABOUT THE SAME AS FOR ALCOHOLISM.

host of other environmental factors probably play a role in steering a person toward an addiction—the reality is that only a small percentage of people who engage with potentially addictive substances or behaviors end up hooked, and scientists know very little about why. Unfortunately, brain-imaging studies cannot answer that question. If you could go back in time and put Dostoyevsky in a scanner, he would almost definitely show altered activation in his brain's reward centers, but that would not necessarily tell you that gambling was his fundamental problem. Maybe he was instead driven by existential angst, or the trauma of his Siberian exile, or even his documented case of temporal lobe epilepsy.

Explaining the mechanism is not the same as revealing the cause. From the

fMRI studies of brain activation down to the intricate functions of neurotransmitters, the issue of causality is a big sticking point for the interpretation of this research. The basics are clear: the brain has circuits that respond to the feeling of pleasure and the anticipation of reward. In some vulnerable individuals, these circuits adapt in response to extreme repetitions of pleasurable activities. Yet this process speaks only to *how*, not *why*; what ultimately drives the behavior remains unexplained.

An unexpected illustration of this mystery comes from the treatment of Parkinson's disease. The illness is treated with drugs that act directly on dopamine receptors, and because the drugs disrupt the reward system, some people with Parkinson's develop compulsive behaviors. For some, eating, sex or gambling becomes addictive. Others abuse the drugs themselves, taking more than prescribed and doctor shopping for extra doses. But plenty of people do not develop any compulsive behaviors, even though they experience the same underlying influence—an introduction of powerful dopamine-acting drugs.

Reducing the anatomy of addiction to the "reward system," therefore, is too simple. Yet discussions of the reward system dominate the scientific discourse about addictions, in part because it is challenging to integrate all the other dimensions that matter—social, psychological, even philosophical concerns.

FOOD

OFFICIAL STATUS: Food addiction is not officially recognized, although some eating-disorder experts argue that certain binge-eating cases may be caused by addictions.

PREVALENCE: Using the Yale Food Addiction Scale, a recently created 25-item survey, and studying relatively small populations, researchers have found food-addiction rates of approximately 5 percent.

DID YOU KNOW?: Food addiction appears to show a significant sex difference, with rates of more than 6 percent in women and just 3 percent in men. It is also closely linked to weight status; in obese populations, rates have been found to range from 7 percent to more than 37 percent.



Societal Costs

When hypersexual disorder was proposed as a new diagnosis, critics in the psychiatric community expressed concern about the social and legal ramifications. Would the disorder be misused in court cases involving sex offenders? Would residential treatment centers pop up to unfairly profit from fad diagnoses, or would the disorder be used as an excuse for sexual predation?

Beyond the concrete risks, there is a popular notion that medicalizing behaviors such as compulsive sex and shopping might cast people in an undesired sick role. There is some value, the argument goes, in preserving the opprobrium that society usually levels at philanderers and spendthrifts. Negative public perception might actually help keep some people in check, whereas a new diagnosis might inappropriately absolve them of responsibility.

If more behavioral addictions are classified as mental disorders—as they almost surely will be, with proponents continuing to muster neuroscientific evidence—there will be societal consequences. Insurance coverage, disability determinations, or the public's understanding of “mad versus bad”—the stakes are high. On the other hand, restricting the recognition of behavioral addictions could curtail identification of and treatment for people who are truly in pain. As long as a behavioral addiction is causing significant harm in a person's life, I believe it needs to be recognized.

WHEN HYPERSEXUAL DISORDER WAS PROPOSED, CRITICS WORRIED IT WOULD BECOME AN EXCUSE FOR PREDATORY BEHAVIOR.

This issue of harm, however, is sometimes missed by researchers, which leads to some odd proposals. For example, French researchers recently suggested “tango addiction.” They claimed to have found that one third of recreational dancers had symptoms of craving and that 20 percent had physical withdrawal symptoms related to the (admittedly captivating) Argentine dance. The problem, as even those researchers admit, is they could not find any good evidence of tango causing real problems in people's lives.

The gray area between clear disorders and unhealthy habits is rightfully controversial. Sometimes when people ask if they should call themselves addicts, I have to reply that I don't know. We are in the midst of clarifying and even redefining what addiction means, with our eye constantly on the end

goal—to help the people who are suffering from these plights.

The Way Forward

A paradigm shift is happening in psychiatry, and many researchers now say that *no* mental illness fits into a neat diagnostic category. In fact, the National Institute of Mental Health is completely revamping its research program to focus less on lumping together symptoms and more on exploring the specific genetic and neurobiological elements of mental disorders. In this way, behavioral addictions are a case study in one of the trickiest problems in psychiatry: how to characterize disorders that have no definitive brain scan, no blood test and no gold standard. With time, and with more research into the underlying causes of such behaviors, we may be better able to help those who feel helpless and out of control.

One promising area of research suggests that any given type of behavioral addiction—say, Internet gaming disorder—might not be one neat disorder but rather an assortment of different underlying problems that happen to manifest the same way. This idea of subtypes was first articulated in 2000 by Alex Blaszczynski, a psychology professor who studies gambling at the University of Sydney. He and his colleague Lia Nowler, a professor of social work at Rutgers University, proposed three subgroups of gambling addiction: behaviorally conditioned gamblers who get in the habit of chasing wins and losses, emotionally

ONLINE GAMING

OFFICIAL STATUS: Internet gaming disorder was included in the *DSM-5* as a condition deserving of further study.

PREVALENCE: Classifications of online gaming are extremely variable. Depending on the criteria used and population studied, estimates range from less than 0.1 percent to more than 50 percent of gamers.

DID YOU KNOW?: Treatment clinics for online gaming exist in the U.S. and other countries. The South Korean government was so concerned about online gaming addiction in children that it enacted a curfew, banning youths from playing games online between midnight and 8 A.M.



ALEX STOKES/Alamy

INTERNET

OFFICIAL STATUS: Not recognized in the *DSM-5*. The Internet can be a gateway to potentially addictive material such as porn and games, making “Internet addiction” a confusing and ill-defined diagnosis.

PREVALENCE: Broadly inclusive studies have found large numbers, and findings depend on the culture (for example, 3.7 to 13 percent in the U.S., 10.7 percent in South Korea, but only 1 to 5.2 percent in Norway). More conservative estimates suggest that 1 percent of Internet users have symptoms significant enough to warrant a diagnosis.

DID YOU KNOW?: The governments of South Korea and China are particularly concerned about Internet addiction. A recent documentary, *Web Junkie*, estimates that there are more than 400 Chinese Internet-addiction rehab “boot camps.”



vulnerable gamblers who are responding to anxiety or depression, and antisocial gamblers who are dysfunctionally impulsive across the board.

Nower and Blaszczynski recently studied data from more than 500 problem gamblers, drawn from an addiction study of more than 43,000 people, and found three distinct groups that matched their model: one group with milder symptoms, one with more co-occurring psychiatric disorders, and one with severe impulsivity across many areas of life. Also, in studies of online gaming, investigators have found distinct motivations similar to Blaszczynski and Nower’s model: a preoccupation with mastery (behavioral conditioning), a compensation for real-life problems, or a response to social anxiety (reactions to emotional problems). Although the evidence is still pending, some researchers believe the subgroup model can also be applied to hypersexual behavior.

The point of all these diagnostic refinements, of course, is to help the sufferers of addiction. Unfortunately, studies of treatments tailored to those subtypes have not yet shown any added benefit. Indeed, researchers in the field of substance-use disorder have argued over possible “typologies” of drug and alcohol addiction for decades, and there is still no clear consensus emerging. Perhaps the current models, which are based only on outwardly observable features of addictions, are incomplete. Diagnosis may have to go beyond the psychological

features of addicts and look at their underlying genetics and neurochemistry. For example, in the substance-addiction field, researchers have recently shown that variations in genes for specific neurotransmitter receptors can predict addicts’ responses to medications such as naltrexone. Considering how new this work is, the behavioral-addiction field may need time to catch up.

In the meantime, a flexible and holistic approach to treatment is best. People who consider themselves Internet addicts or sex addicts, whose problems are complicated by social anxiety or depression or other issues, need more attention to the emotional component of their behavior, as opposed to those who fit the traditional model of addiction and feel stuck in an automatic cycle of stimulus and response. Research has shown that when people have both substance-use problems and other emotional issues, we get the best re-

sults by treating all issues simultaneously.

My own approach is to aim for this inclusive mind-set. We have to assume we do not have all the answers. People cannot simply be reduced to their “hijacked” reward systems, and there is no single, unassailably correct diagnosis of or treatment for addiction. Someday a new wave of research findings may help make finer distinctions more precisely. For now, though, we do the best we can by trying to learn as much about our patients as possible.

There are no easy answers. As the examples of Dostoyevsky and Saint Augustine show us, we humans have been endeavoring for ages to understand why we get stuck in patterns of harmful behaviors and why for some the consequences from losing control are truly severe. As we begin to focus on this problem with real scientific rigor, the right question might not be “Is this real?” but rather “How can we help?” **M**

MORE TO EXPLORE

- **Do We All Have Behavioral Addictions?** Allen Frances in *Huffington Post*; March 28, 2012.
- **A Targeted Review of the Neurobiology and Genetics of Behavioural Addictions: An Emerging Area of Research.** Robert F. Leeman and Marc N. Potenza in *Canadian Journal of Psychiatry/Revue Canadienne de Psychiatrie*, Vol. 58, No. 5, pages 260–273; May 2013.
- **Controversies about Hypersexual Disorder and the DSM-5.** Rory C. Reid and Martin P. Kafka in *Current Sexual Health Reports*, Vol. 6, No. 4, pages 259–264; December 2014.
- **Disordered Gambling: The Evolving Concept of Behavioral Addiction.** Luke Clark in *Annals of the New York Academy of Sciences*, Vol. 1327, pages 46–61; 2014.
- **Are We Overpathologizing Everyday Life? A Tenable Blueprint for Behavioral Addiction Research.** Joel Billieux, Adriano Schimmenti, Yasser Khazaal, Pierre Maurage and Alexandre Heeren in *Journal of Behavioral Addictions*, Vol. 4, No. 3, pages 119–123. Published online May 27, 2015.

SIX THINGS YOU SHOULD KNOW ABOUT **CONCUSSIONS**

**MUCH OF WHAT WE'VE HEARD IS WRONG.
HERE IS THE LATEST LOWDOWN ON THESE
BRAIN INJURIES PLUS NEW IDEAS ABOUT
HOW TO TREAT THEM**

BY KAREN SCHROCK SIMRING

ILLUSTRATIONS BY RADIO



O

ne minute I was waving hello to the neighbors during a typical Rollerblading session with my dog, and the next I was flying down a newly paved hill at a runaway speed. Aiming for a soft landing, I steered up a driveway toward a lawn. My feet hit the grass, and I flew about 10 feet through the air before landing and rolling on the ground. I had the wind knocked out of me—a truly painful experience I hadn't had since childhood—but I could tell I hadn't broken any bones. I was just congratulating myself on avoiding a serious injury when I passed out.

I didn't know it at the time, but this incident last fall was my personal introduction to the frightening and sometimes baffling experience of having a concussion. As a science editor, I had handled a number of stories on mild traumatic brain injury (TBI), as concussions are officially known, but I was not prepared for the pain and debilitation that came over the following weeks and months. That is because—for all its prevalence in the news as a danger to massive NFL players and tiny soccer tots alike—concussions remain subject to a remarkable amount of myth, mystery and misinformation. Even among well-meaning doctors. The good news is that concussion research has surged in recent years, thanks to concern from the athletic and military communities—so we are starting to learn more about the underlying causes of its symptoms and how best to treat them. And we are beginning to clear away some of the fog around who is at greatest risk for serious repercussions. Here are six key things you should know about concussions—things I wish I had known when I hit the ground.

1

You don't have to smack your head to get a concussion.



After my skating accident, I went to my local hospital because my abdomen hurt and one of my arms was rapidly swelling into a purple, football-sized balloon. The emergency room staff x-rayed my arm

and did a CT scan of my midsection to rule out internal bleeding. As we were getting ready to go, my husband asked the doctor why he didn't assess me for a head injury. "Because she said she didn't hit her

head," the doctor replied. And that was that. I went home and went to bed.

The next morning the symptoms hit: excruciating headache, nausea, sensitivity to light, confusion. I thought I was having a bizarre and terrible migraine. I went the next day to see an associate of our family doctor, who promptly diagnosed me with a concussion. He reminded me that a sudden deceleration of the type I had undergone—from, say, 20 miles an hour to zero in less than a second—could damage the brain by causing it to slosh around within the skull.

In fact, doctors are seeing more and more concussions that do not involve a direct blow to the head, especially among military personnel exposed to bomb blasts. The shock wave from an explosion can send the brain bouncing perilously within the skull. Thousands of service members report concussions every year. Among U.S. civilians, the Centers for Disease Control and Prevention estimates about 1.36 million concussions a year. But that number is a bit

FAST FACTS

INJURY TO THE BRAIN

- 1 A concussion can occur when the head is jolted, either from a blow or from a sudden stop.
- 2 After a jolt, it is crucial to avoid a second blow and to see a doctor as soon as possible.
- 3 New research shows that resting for more than a couple of days after a concussion may do more harm than good, and targeted treatments may help with some symptoms.
- 4 It remains very difficult to predict which patients will struggle with a lengthy recovery. Mental illness and psychiatric symptoms such as anxiety, both before and after the concussion, seem to be linked with the highest risk.

shaky, in part because greater awareness of concussions has probably led more patients to seek medical attention and more doctors to notice and diagnose mild TBIs in recent years. As a result, the incidence has been rising.

Another reason the true incidence of concussions is not easy to pin down is that the diagnosis itself is based mostly on subjective symptom reporting [see box on page 56] rather than any definitive test. Doctors diagnose a concussion if a person has had a blow or jolt to the head and reports at least a couple of the well-known symptoms, including dizziness, confusion, short-term memory

loss, headache, and sensitivity to light or noise. But these symptoms can also be caused by a number of other factors, and unless there are clear neurological symptoms such as delayed pupil reflexes, which show up in some concussion cases, there is currently no way to know for sure whether symptoms are arising from a brain injury rather than, say, a migraine, the flu or post-traumatic stress disorder (PTSD). Most emergency room doctors will not order scans unless bleeding or more serious injury in the brain is suspected. Unlike these more dangerous complications, injury from a mild TBI is usually too microscopic

for MRI, CT or PET scans to pick up.

There are simple steps to take if you do notice the telltale symptoms of concussion after you bump your head or after you are in any situation in which your head is jolted suddenly—including a fender bender or even a roller-coaster ride. “First, pull yourself out of risk so you don’t hit your head again,” says William P. Meehan III, director of the Micheli Center for Sports Injury Prevention at Boston Children’s Hospital. “Second, see a medical professional to get some guidance. And third, follow that guidance, which should be a few days of rest followed by gradually increasing activity.”

UNLIKE BLEEDING IN THE BRAIN OR OTHER MAJOR TRAUMA, INJURY FROM MOST CONCUSSIONS IS TOO MICROSCOPIC FOR MRI, CT OR PET SCANS TO PICK UP.

2

If you think you might have a concussion, make sure you don’t hit your head again.



When the primary care doctor warned me about this risk, I thanked my lucky stars I had not decided to get back on my skates the day after my ER visit. Experts agree that minimizing the risk of a second concussion is key because getting two in a row can lead to long-term complications or, rarely, death. The mechanism behind this effect is unknown, but cell studies suggest it might have something to do with sodium.

The brain maintains a delicate balance of sodium and potassium ions to facilitate the electrical signals between neurons. When the head is jolted, cells react by suddenly taking up more sodium, which immediately shuts down the

electrical signaling. That is why a concussion can cause a loss of consciousness so much faster than asphyxiation does. “It’s a blackout of the brain’s electrical grid,” explains Douglas H. Smith, director of the Center for Brain Injury and Repair at the University of Pennsylvania.

Experimental evidence is starting to suggest that one way brain cells react to this blackout is to quickly add more sodium channels along their membranes to help restore the balance. “That might be a great way to get the lights back on, but it also might come at a huge cost if you get hit again,” Smith says. With all that additional access to sodium now available, getting hit again “is like pour-

ing saltwater over live circuits,” he says.

Many decades of studies in youngsters and adults confirm that suffering a second concussion while still experiencing symptoms from the first puts a person at a hugely increased risk for long-term symptoms lasting months or even years. In some rare cases, it can even lead to permanent brain damage or death. Second impact syndrome, as this most severe reaction is known, is diagnosed when a second concussion in the minutes, days or weeks following the first causes sudden and often fatal brain swelling. The exact mechanism behind this catastrophic cascade is unclear, but confirmed cases of second impact syndrome are fatal more than 50 percent of the time.

Most reported cases of the syndrome have been in children, prompting the strict guidelines regarding student athletes returning to play after sustaining a concussion. Prevalence is hard to measure because of the rarity of cases and the fact that the bleeding may be misdiagnosed as a direct result of the blunt trauma, but studies estimate that second impact syndrome kills about three to four people a year in the U.S.

a second concussion. Athletes are often so eager to get back on the field, Thomas says, that “they underreport and lie about symptoms.” Unfortunately, a recommendation intended to protect these overeager athletes got misapplied to the general public. “Athletes tend to recover much more quickly, so the timeline the experts had in mind was a couple of days,” says concussion researcher Noah Silverberg, a visiting assistant professor of medicine at Harvard Medical School. But people like me are often told to rest until their symptoms go away—which can be weeks or even months. “I think that’s not what the original recommendation meant,” Silverman says.

Prolonged rest may not merely be boring, it flies in the face of what we know about healing an injured brain. “If

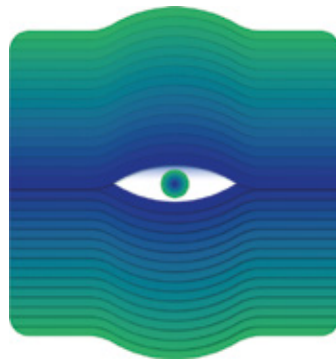
someone has a stroke and then sits around and doesn’t do anything, the person will never get better,” Thomas observes. He recently led one of the first randomized controlled clinical trials of varying rest periods in 88 concussed patients aged 11 to 22. He and his colleagues found that those who were put on strict rest—no school, no exercise, no screen time—for five days postinjury reported more symptoms at 10 days out than those who rested for only two days, according to results from the trial published in February 2015 in *Pediatrics*. The handful of other studies that have attempted to look at the effect of different activity levels postconcussion tend to line up with Thomas’s findings—a day or two of rest following the injury is helpful but more than that is probably not.

Concussion experts believe there are several potential explanations for why more rest is not better. Sitting around thinking about symptoms can make them seem worse, for one. Moreover, when people are told they are too ill to do anything, they sometimes take on a sick role psychologically. It is even possible that resting too much causes a deconditioning of sorts in the brain, so that very little mental effort then triggers symptoms. “We need to take guidance from the physical therapy world: push up to the pain but not through it,” Thomas says. In other words, after the initial day or two of rest, a concussed person should try to go about daily life until symptoms show up and then stop, rest and repeat. Think of it as getting your brain back in shape.

PATIENTS WHO RESTED FOR FIVE DAYS HAD MORE ISSUES THAN THOSE WHO RESUMED ACTIVITY AFTER TWO DAYS.

5

Rest is not the only treatment available.



After enduring my interminable rest period, I tried to get back to work and discovered, much to my dismay, that reading anything on paper or a computer screen immediately triggered an excruciating headache and nausea. My physician had advised me to see a neurologist if I was still having symptoms after all that rest, so I did. The neurologist assessed my symptoms, offered some sympathy and prescribed sumatriptan, a migraine drug that has been shown to help ease postconcussion headaches and perhaps even speed up recovery. And that was it. I saw her every couple weeks; she

verified that my symptoms were improving slowly and re-upped my prescription when necessary. Three months passed before I could tolerate a full day’s work.

When I told this story to the various concussion experts I interviewed for this story, the universal reaction was disappointment but not surprise. “What you’re describing is so common, so frustrating for patients and family,” Smith says. “You’re shown out of the ER and left in the wind.” People with chronic symptoms end up diagnosing themselves, he says, and unfortunately many are never referred to a concussion specialist or clin-

ic. Concussion clinics are becoming more common, especially in major metro areas and regions with large hospitals, and they usually bring together a team of practitioners that includes neurologists, psychiatrists, sports medicine or physiology specialists, and physical and occupational therapists. They offer a variety of physical and psychological treatments, many of which seem to successfully treat certain symptoms. Headache, memory and cognition issues, vestibular problems and visual symptoms—if only I had known!—are all treatable to some degree. Scientific data about the efficacy of these programs are scarce, however, because figuring out which concussion patients to enroll in trials—which ones will have a complicated recovery—is currently almost impossible, Smith says. Yet by borrowing treatments from other fields and specialties, concussion specialists are able to ease many symptoms.

The bottom line: “You *can* do something to speed up your recovery, especially if you’re having a difficult time,” Silverberg says.

6

It's impossible to predict which symptoms a person will have and how long recovery will take—but that may change soon.



Up until a few years ago, doctors believed that being knocked unconscious indicated a more severe concussion than simply getting dazed. That idea is out-

dated. The majority of research findings have now shown that passing out has no relation to the severity of postconcussion symptoms or to recovery time. In

fact, *nothing* about the incident seems to have any consistent predictive power—the type of accident, the location of the blow on the skull, the symptoms immediately following the event.

Recent research from Smith's team and others has finally homed in on an explanation for why some concussions are so much harder to recover from than others. These concussions, in addition to causing a sodium flood, do permanent damage to the brain's axons, the long tendrils that neurons use to communicate with one another and with different regions throughout the brain. In these more serious injuries, the sudden rotational acceleration caused by a blow or jolt to the head causes some axons to break. "Axons are like Silly Putty,"

Do I Have a Concussion?



If you have banged your head, been in a car accident or taken a spill, your doctor will probably assess you for a concussion. The diagnosis is not an exact science; a neurological examination might reveal issues with balance, reaction time or pupil dilation—but many concussions come without these obvious problems, or else these symptoms may have passed by the time of evaluation. For that reason, scientists are working feverishly to develop easy tests that can be conducted on the sidelines of a sports field to reliably identify a concussion no matter what symptoms are present. Many of these tests have shown promise in early trials, especially in cases in which a healthy comparison measurement is on file, making it easy for parents and coaches to quickly assess whether there has been a change in a player's visual reaction time, counting or addition speed, or even ability to discriminate smells on a scratch-and-sniff card.

For those of us without reaction-time test results on file,

however, doctors must rely heavily on the symptoms we report. One day blood tests or brain scans may be available, but right now the only common tool other than the neurological exam is a symptom inventory, such as the one below, developed by neuropsychologist Keith Cicerone. When doctors administer such surveys, they ask patients not only to indicate whether they have a given symptom but also to rate its severity (for example, on a 1 to 5 scale) and report how many days out of the past week it has occurred. Doctors mainly use such lists to track symptom burden over time.

If mood, anxiety or sleep-related symptoms appear in the days or weeks after a brain injury, they can be a warning sign that a patient might be experiencing post-traumatic stress disorder or postconcussive syndrome, which occurs when concussion symptoms linger for many months or even years. These inventories can also be helpful in the initial diagnosis—especially the first five symptoms, which are some of the classic signs of concussion. —K.S.S.

- ◆ Feeling dizzy
- ◆ Loss of balance
- ◆ Poor coordination, clumsy
- ◆ Headache
- ◆ Nausea
- ◆ Vision problems (blurring, trouble seeing)
- ◆ Sensitivity to light
- ◆ Hearing difficulty
- ◆ Sensitivity to noise
- ◆ Numbness or tingling on parts of body
- ◆ Change in taste or smell
- ◆ Loss of appetite or increased appetite
- ◆ Poor concentration, easily distracted
- ◆ Forgetfulness, not being able to remember things
- ◆ Difficulty making decisions
- ◆ Slowed thinking, difficulty getting organized, not being able to finish tasks
- ◆ Fatigue, loss of energy, easily tired
- ◆ Difficulty falling or staying asleep
- ◆ Feeling anxious or tense
- ◆ Feeling depressed or sad
- ◆ Irritability, easily annoyed
- ◆ Feeling easily overwhelmed by things

RECOVERY CAN BE QUICK OR PAINFULLY SLOW. AN EMERGING INDICATOR OF LINGERING PROBLEMS: DEPRESSION OR OTHER MENTAL HEALTH ISSUES.

Smith says. “If you make a cylinder of Silly Putty and stretch it slowly, it will stretch forever. But if you take the same cylinder and stretch it rapidly, it snaps. That’s what happens to axons under sudden rotational acceleration.”

When the axons break, they release a cascade of proteins and chemicals, some of which can trigger additional damage in nearby cells. Although the broken axons never grow back, the brain is adept at finding work-arounds and creating more connections—which is why even people with axon damage recover eventually.

One type of brain scan, called diffusion tensor imaging (DTI), is designed to specifically investigate the connections between cells—the axon tracts. As such, it has shown promise in small studies for identifying the extent of damage in a concussed patient’s brain. Another promising diagnostic test looks for axon proteins in the blood, which can indicate the level of damage. Smith is hopeful that one or more of these techniques will be ready for use in larger studies fairly soon. “We’re on the verge of developing much better diagnostics,” he says. “Then we can have highly powered studies, so we can look at drug therapies or other types of rehab strategies.”

A rash of brand-new studies are suggesting that certain red flags in the patient’s medical history—migraine and motion sickness, for example—might be indicators that recovery will be arduous. But the most robustly supported risk factor is the presence of psychiatric symptoms, manifesting either before or after the concussion. Two studies in 2015, one that looked at 72 soldiers with blast-related injuries and the other that followed 77 civilians with sport- or accident-related injuries, both found that the presence of depression, post-traumatic anxiety and other mental symptoms predicted a prolonged recovery

from concussion. A major review of the literature by Silverberg and his colleagues, published in April 2015 in the *Journal of Neurotrauma*, concurred: the factors that most robustly predicted a slow recovery were a history of mental health issues and postinjury anxiety.

“When a patient comes into a clinic, there are lots of questions asked about the nature of the injury, the mechanics, how and where you hit your head. As far as we know, none of that matters,” Silverberg says. “Clinicians should actually inquire about how concerned patients are about the fact that they’ve had a concussion and whether they’ve struggled with mental illness in the past.” As he points out, these data are cheap and easy to collect (unlike brain scans) and could be far more helpful in flagging people at risk for complications. Doctors should also try to be encouraging about patients’ potential for recovery, he says—yet another reason why telling patients they must lie in a dark room for two weeks is counterproductive.

The last thing to note about concussion symptoms is that they can vary widely from one person to the next and even for the individual patient. During my recovery I found that one minute I could be conversing normally, even energetically,

and the next I would suddenly feel sluggish, confused and nauseated. I heard many stories from the doctors and patients I interviewed about people being very suspicious or dismissive of patients’ postconcussion struggles: bosses handing out pink slips, professors giving Fs, friends and family making accusations of malingering. People recovering from a concussion look totally normal, after all, and their symptoms are usually noticeable only to themselves.

“These are subtle deficits,” cautions Daniel Corwin, a concussion researcher and physician at Children’s Hospital of Philadelphia. “We don’t have objective tests, so we have to take the patient’s report of symptoms at face value.” Corwin and other experts hope that recent media attention to concussions will lead schools, workplaces and the general public to recognize how difficult recovery can be. “It’s tough,” he says. “And it’s a great point for those in the community to consider.”

As for me, I have felt blissfully myself for several months now—except for a newfound nervousness about slipping on ice, falling off my bike or otherwise knocking my noggin. I hope I never have to go through the ordeal of a concussion again—but if I do, at least I now know more about how to help my brain heal. **M**

MORE TO EXPLORE

- **Identification of Children at Very Low Risk of Clinically-Important Brain Injuries after Head Trauma: A Prospective Cohort Study.** Nathan Kuppermann et al. in *Lancet*, Vol. 374, pages 1160–1170; October 3–9, 2009.
- **Biomarkers of Mild Traumatic Brain Injury in Cerebrospinal Fluid and Blood.** Henrik Zetterberg, Douglas H. Smith and Kaj Blennow in *Nature Reviews Neurology*, Vol. 9, pages 201–210; April 2013.
- **Benefits of Strict Rest after Acute Concussion: A Randomized Controlled Trial.** Danny George Thomas et al. in *Pediatrics*, Vol. 135, No. 2; February 2015.
- **Systematic Review of Multivariable Prognostic Models for Mild Traumatic Brain Injury.** Noah D. Silverberg et al. in *Journal of Neurotrauma*, Vol. 32, No. 8, pages 517–526; April 7, 2015.

From Our Archives

- **Impact on the Brain.** Richard J. Roberts; December 2008/January 2009.
- **Fatal Strikes.** Jacqueline C. Tanaka and Gregg B. Wells; January/February 2014.
- **Concussion Coach.** Karen Schrock Simring; Reviews and Recommendations, March/April 2015.



Victims of sexual assault in childhood face a higher risk of future abuse. Research is suggesting ways of

Breaking the Cycle

By Sushma Subramanian

The first time it happened, Christine* was only seven years old. Her mother's live-in boyfriend sexually assaulted her, beginning an abusive relationship that lasted more than two years. When a friend of the family figured out what was going on, the friend informed Christine's mom, who refused to believe it, despite her daughter's confirmation. Soon afterward, a social services worker confronted the family, and Christine's abuser fled.

Christine never saw the man again, but it was not the end of her experience with sexual trauma. She lived in a neighborhood with a high crime rate. She was a latchkey kid, who was often unsupervised and left to fend for herself. Sexual abuse seemed to follow her.

In high school, she was gang-raped at a party. Years later, after she joined the military, she met a man whom she thought she could trust. They dated for a short period, but just when she decided to end the relationship, he forced himself on her.

Now, at 38, Christine is finally in a solid, healthy relationship. But she still has her struggles. Although she has seen counselors on and off over the years, she continues to have nightmares related to her attacks and has difficulty trusting people.

Christine is one of 84 women involved in a long-term study of the impact of childhood sexual abuse, led by University of Southern California psychologist Penelope Trickett. The research began in 1987, when Trickett began interviewing a group of girls in the Washington, D.C., metro area who had recently been reported to child protective services as victims of sexual assault. The children and teens, ages six to 16, came from working- to middle-class families (in general, middle- and upper-class families are less likely to be reported to protective services).

Over the years Trickett has uncovered a disturbing pattern. Although individual cases vary, people who have been victims of assault at least once in their youth are at greater risk than the general population for later assault. In other words, despite having survived traumatic experiences already, these individuals are more prone to fall prey yet again.

To date, numerous papers from other research groups have confirmed this pattern, suggesting that sexual trauma in childhood or adolescence increases the odds of another attack or abusive relationship in adult women by somewhere between two and 13.7. (Whether the pattern holds true for men is unclear because of a dearth of studies.)

The finding is not simply an artifact of an individual's socioeconomic class or environment. Trickett and her collaborators have found that female peers from the same communities who did not suffer this trauma did not have the pattern of repeat victimization. In addition, Trickett and her collaborator Jennie Noll, a psychologist now at Pennsylvania State University, have found that women

who have experienced childhood sexual abuse are more likely than such peers to be in violent relationships, to show a higher rate of obesity and to suffer financially.

These findings add urgency to efforts to pinpoint why so many victims of childhood sexual abuse are trapped in a cycle of victimization and to explore why some are able to overcome their trauma. Increasingly, researchers are turning to a psychological phenomenon known as emotional dysregulation, or an inability to manage emotional responses, as a possible explanation for the risk these former victims carry. If these scientists are correct, then identifying victims of childhood sexual abuse early and providing them with targeted treatments might set them on a safer, more promising path into adulthood.

Missing the Signs

A variety of complex factors may leave victims of sexual assault at greater risk for repeat attacks. For one, early sexual experiences can lay a blueprint for behaviors and expectations in adult relationships. As a result, chronic or repeated abuse may lead to unhealthy beliefs about how to create a relationship. “One core belief might be that I can’t trust the people who are supposed to support me,” says David DiLillo, a University of Nebraska–Lincoln psychologist. “Another schema might be that I have to provide sex on demand, that I’m not an active participant in decision making about the sexual activities that I engage in.” In consequence, former victims may not recognize an aggressor’s inappropriate conduct until it is too late.

In addition, much of the literature shows that women who experience early sexual trauma suffer from symptoms of post-traumatic stress disorder (PTSD) and may attempt to “escape” their pain by using sex or substances. These behaviors can, in turn, put people at greater risk.

In certain cases, past trauma can even desensitize individuals to possible danger. In 2013 University of Denver psychologists Ryan B. Matlow and Anne P. DePrince found that outcomes can differ depending on whether someone has been abused repeatedly by the same perpetrator, what they call chronic victimization, or attacked multiple times by different people, known as revictimization. In a sample of 236 women of different backgrounds, the researchers found that each pattern of abuse was associated with different symptoms of PTSD.

Using a series of psychological tests, the researchers discovered that women who had been chronically victimized did their utmost to dodge discussion or thoughts related to the trauma. This pattern of active avoidance might reflect the fact that they depended on the perpetrator in some way, making it necessary to distance

themselves from negative events to maintain the relationship.

In contrast, women who were victimized by a variety of assailants often struggled to recall important details of their trauma. These passive avoiders tended to feel emotionally numb and estranged from other people. Their responses might, in a sense, shield them from the intensity of their painful memories, but they also left the women less equipped to detect the warning signs of a future attack.

Physiological changes typical of PTSD may underlie this de-

Learning to manage emotions and deal assertively with conflicts could end the pattern of repeat victimization.



sensitization. Prolonged exposure to stress and stress-related hormones (primarily cortisol) can lead to dysregulation of the body’s stress-response system, called the hypothalamic-pituitary-adrenal axis. Even 10 to 12 years after experiencing childhood trauma, the women in Noll and Trickett’s longitudinal study showed signs, in blood tests, of poor regulation of this system, leaving them less equipped to identify and respond to risky situations. Furthermore, research has shown that chronic exposure to high levels of cortisol caused by stress can leave young people vulnerable to other health problems, including obesity and brain changes that affect memory and cognition.

Emotional Disconnect

The confluence of factors that contribute to revictimization paints a bleak picture. Yet researchers also see cases where young people appear to break the cycle and find healthy relationships—even after severe childhood abuse. By studying these cases, psychologists can start to spot the distinctions that might make all the difference in determining how to intervene.

One factor that seems to influence the long-term impact of childhood sexual abuse, Noll says, is “how someone understands the trauma, how much she felt fear or blames herself.” For example, one woman in the study had sex with her stepfather to keep her younger sisters from getting beatings. It happened multiple times. But today she is adjusted and lives a normal life. “Why is it that she’s okay?” Noll asks. “Maybe she knew it wasn’t her fault. Maybe she felt like she was protecting her siblings.”

As one might expect, Noll and Trickett have found that women who escape a dangerous or unstable environment generally fare better in future relationships than those individuals who are trapped throughout childhood. This finding under-

THE AUTHOR

SUSHMA SUBRAMANIAN is a freelance science writer and an assistant professor of journalism at the University of Mary Washington.

scores the importance of teaching young people to report inappropriate or violent behavior, enabling an adult to intervene.

Another approach comes from a growing community of psychologists who suspect that learning to recognize and express emotions could help many at-risk individuals escape the pattern of repeat victimization. DiLillo and his colleagues have noted that many victims of sexual trauma in childhood show signs of emotional dysregulation. This condition can manifest in several ways, such as displaying emotions that are too intense or aggressive for a particular situation, difficulty calming down when upset or avoidance when dealing with a negative situation. Previous research has also indicated that some victims show signs of borderline personality disorder, a condition marked by instability in their moods, behavior and relationships—all consequences of emotional dysregulation.

Emotional dysregulation can arise as part of a person's temperament, but it often occurs in childhood, when kids do not learn how to master challenging emotional situations. Kim Gratz, a psychologist at the University of Mississippi Medical Center who collaborates with DiLillo, explains that serious trauma at a young age can produce intense emotions that are incredibly hard to regulate, particularly as children are still developing the skills to manage them. And some family environments pour fuel on the fire, Gratz observes: "Maybe their elders are invalidating their emotions, telling them they shouldn't feel what they feel or punishing them when they express negative emotions."

DiLillo and Gratz are studying a group of 488 women ages 18 to 25—some of whom experienced sexual trauma and some of whom did not—to test their theory that emotional dysregulation plays a pivotal role in revictimization. The studies are ongoing, but the team has started to publish results that suggest that former victims do, in fact, have more trouble managing their emotions. A 2015 paper based on findings from 106 of these women who experienced PTSD symptoms following sexual victimization found that those with the most intense emotional dysregulation were more likely to make use of cocaine, alcohol, opiates and other substances. The researchers have preliminary data suggesting that these women are also more likely to turn to sex to cope with their negative emotions. Taken together, the findings indicate that helping patients manage emotions more effectively could be a useful strategy in preventing these women from turning to risky sex or substances, which in turn could protect them from the cycle of victimization.

Managing Emotions

One thing is clear, DiLillo says, just raising awareness of risk is not enough—at least not for those who are most vulnerable. Approaching "college women and talking to them about the risks of sexual assault is less effective than one would hope," he says. "Knowledge of risk rarely changes behaviors. You have to have a little more of an intensive individualized intervention."

Perhaps the most promising treatment is dialectical-behavior therapy (DBT), an established approach to addressing emotional dysregulation. Marsha M. Linehan, a University of

Washington psychologist, developed DBT in the 1970s to treat patients with borderline personality disorder. The approach builds on the principles of cognitive-behavior therapy, which focuses on teaching patients to restructure unhelpful thoughts and behaviors. DBT develops skills in four areas: stress tolerance, mindfulness, regulation of emotions and interpersonal communication.

Patients are given strategies for asking for what they need in various relationships, knowing when to stand up for themselves and dealing assertively with conflicts. "On the one hand, we can teach these patients how and why they feel the emotions they feel, and on the other, we can train them in how to moderate arousal," Gratz says. "If emotional dysregulation is the central cause for revictimization, we're hoping that treating it will help them through the course of their lives."

Few large-scale studies have looked expressly at the effectiveness of DBT for women with a history of chronic sexual victimization. A small study published in 2002 by psychiatrist Marylene Cloitre, now at the National Center for PTSD, is relevant. Cloitre recruited 58 women with PTSD related to childhood abuse and enrolled half in a 12-week program that incorporated many components of DBT; the others were added to a waiting list that offered minimal treatment. Compared with the waiting-list group, women who received therapy showed great improvements in mood-regulation skills—as measured by scores on a series of psychological tests—even months after the treatment was complete.

Since then, several small studies have been conducted to test the effectiveness of DBT in treating PTSD from childhood sexual trauma. But thus far none has definitively shown that such treatments can prevent revictimization in patients with a history of previous sexual assault. Even if the approach is validated, it will be an enormous challenge to provide access to DBT, a costly therapy that is often not covered by health insurance.

Research on sexual revictimization is only in its infancy, but early findings may help counteract some of the harmful stigma and self-loathing associated with this behavior pattern. As researchers develop a fuller picture of sexual trauma's complex effects on body and mind, society can learn to stop blaming these victims and start understanding them. **M**

MORE TO EXPLORE

- **Treating Survivors of Childhood Abuse: Psychotherapy for the Interrupted Life.** Marylene Cloitre, Lisa R. Cohen and Karestan C. Koenen. Guilford Press, 2006.
- **Sexual Revictimization: Research Brief.** National Sexual Violence Resource Center, 2012. www.nsvrc.org/sites/default/files/publications_NSVRC_ResearchBrief_Sexual-Revictimization.pdf
- Pandora's Project offers support and resources for survivors of rape and sexual abuse: www.pandys.org/articles/revictimization.html

From Our Archives

- **Abuse and Attachment.** Erica Westly; *Head Lines*, March/April 2010.
- **Love and Death.** Allison Bressler; *September/October* 2014.

How to Cultivate Creativity

Research shows that being open to new experiences spurs innovation in the arts, sciences and life

By **Scott Barry Kaufman and Carolyn Gregoire**

ILLUSTRATIONS BY BRETT RYDER

Around the time that his cult-classic, drug-culture novel *Naked Lunch* was released, author William S. Burroughs was experimenting with a writing strategy that he called the cut-up technique. Burroughs would chop up random lines of text from a page and rearrange them to form new sentences, with the aim of freeing his mind and the minds of his readers from conventional, linear ways of thinking.

Beat Generation writers such as Burroughs sought to dismantle old belief systems and to encourage alternative ways of looking at the world. They celebrated intellectual exploration, engagement in art and music, unconventionality and deep spiritual questioning. Perhaps no artist captured this spirit more than Jack Kerouac, whose novels have become manifestos for adventure and nonconformity.

The revelations and methods of Burroughs, Kerouac and other Beat writers illuminated an important truth about creativity, which is now backed by scientific research: we *need* new and unusual experiences to think differently. In fact, cultivating a mind-set that is open and explorative might be the best thing we can do for our creative work. As Kerouac famously wrote, “The best teacher is experience.”

For not only artists but innovators of all stripes, novel experiences provide the crucial tissue of real-world material that can be spun into original work. Openness to experience—the drive for cognitive exploration of one’s inner and outer worlds—is the single



Adapted from *Wired to Create: Unraveling the Mysteries of the Creative Mind*, by Scott Barry Kaufman and Carolyn Gregoire. Available from Perigee, an imprint of Penguin Publishing Group, a division of Penguin Random House LLC. Copyright © 2015 by Scott Barry Kaufman and Carolyn Gregoire.





strongest and most consistent personality trait that predicts creative achievement.

Among the “big five” personality traits (openness to experience, conscientiousness, extraversion, agreeableness and neuroticism), openness to experience is absolutely *essential* to creativity. Those who are high in openness tend to be imaginative, curious, perceptive, creative, artistic, thoughtful and intellectual. They are driven to explore their own inner worlds of ideas, emotions,

The drive for exploration may be the single most important personal factor predicting creative achievement.

sensations, and fantasies and, outwardly, to constantly seek out and attempt to make meaning of new information in their environment.

Seeking Truth and Beauty

Openness as a personality trait hinges on engagement and exploration, but it is also more complex and multifaceted than that. Openness to experience comes in many forms, from a love of solving complex problems in math, science and technology, to a voracious love of learning, to an inclination to ask the big questions and seek a deeper meaning in life, to exhibiting intense emotional reactions to music and art. Visionary tech entrepreneurs, world travelers, spiritual seekers and original thinkers of all types tend to have highly open personalities.

Research conducted by one of us

(Kaufman) for his doctoral dissertation suggests that there are at least three major forms of cognitive engagement making up the core of openness. *Intellectual engagement* is characterized by a searching for truth, a love of problem solving and a drive to engage with ideas, whereas *affective engagement* has to do with exploration of the full depths of human emotion and is associated with a preference for using gut feeling, emotions, empathy and compassion to make deci-

sions. Finally, those who are high in *aesthetic engagement* exhibit a drive toward exploring fantasy and art and tend to experience emotional absorption in beauty. Kaufman found intellectual engagement to be associated with creative achievement in the sciences and affective engagement and aesthetic engagement to be linked with artistic creativity.

Kaufman’s research led him and his colleagues to another fascinating observation about “open” personalities. The desire to learn and discover seemed to have significantly more bearing on creative accomplishments than cognitive ability did. He found that people with high levels of cognitive engagement with imagination, emotions and beauty were more likely to make significant artistic creative achievements than people who were only high in IQ or divergent thinking ability (the ability to explore many possible solutions to a problem). Intellectual engagement was sometimes even a better predictor of scientific creative achievement than IQ was.

Looking at creativity across the arts and sciences, Kaufman and his colleagues found that openness to experience was more highly correlated with total creative achievement than other factors that had been traditionally associated with creativity, such as IQ, divergent thinking and other personality traits. Together

these findings suggest the drive for exploration, in its many forms, may be the *single most important personal factor* predicting creative achievement.

Indeed, openness to experience speaks to our desire and motivation to engage with ideas and emotions—to seek truth and beauty, newness and novelty—and the act of exploring often provides the raw material for great artistic and scientific innovations.

The Dopamine Drive

This engagement starts at the neurological level, with the way the brain reacts to unfamiliar situations and new information. What unites each individual form of openness to experience is an intense desire and motivation to seek new information that is rooted in the individual’s neurophysiology and forms the very core of his or her personality.

The drive for exploration hinges on the functioning of dopamine, which is probably the most well known of all the brain’s neurotransmitters. As you may know, dopamine plays a strong role in learning and motivation. Unfortunately, there are many misconceptions about dopamine, which is commonly seen as the “sex, drugs and rock ’n’ roll” neurotransmitter. Despite many popular descriptions, dopamine is not necessarily associated with pleasure and satisfaction.

Instead dopamine’s primary role is to make us *want* things. We get a huge surge of dopamine coursing through our brain at the possibility of a big payoff, but there is no guarantee that we will actually like or enjoy what we obtain. Psychologist Colin DeYoung of the University of Minnesota has explained that “the release of dopamine ... increases motivation to explore and facilitates cognitive and behavioral processes useful in exploration.” DeYoung has called dopamine the “neuromodulator of exploration.”

At the broadest level, dopamine facilitates psychological plasticity, a tendency to explore and engage flexibly with new things, in both behavior and thinking. Plasticity leads us to engage with uncertainty—whether it is pondering a new app to meet a consumer demand or question-

FAST FACTS

BEING OPEN

- 1 Openness to new experiences is the strongest and most consistent personality trait that predicts creative achievement in the arts and sciences.
- 2 Higher dopamine levels drive our motivation to explore and boost creativity but are also associated with an increased risk of mental illness.
- 3 New experiences can shift our perspective and inspire creative leaps.

ing the next step in our own life path—exploring the unknown and finding reward in seeking its positive potential. With plasticity comes enhanced cognitive and behavioral engagement and exploration and, frequently, a commitment to personal growth. Of course, there is no guarantee that our open engagement will yield a positive outcome. For most creative people, however, the engagement itself is enough if it provides fodder for innovation. Indeed, research shows that psychological plasticity is associated with high levels of idea generation, engagement with everyday creative activities and publicly recognized creative achievement.

Plasticity consists of a blend of both extraversion and openness to experience, and dopamine is a source of exploratory motivation. It is easy to see why this might be the case evolutionarily; the drive to explore, the ability to adapt to new environments and the ability to thrive in the face of uncertainty all provide important survival advantages.

Nevertheless, there are crucial differences between extraversion and openness to experience. Extraversion, the personality trait that is most strongly associated with high sensitivity to environmental rewards, manifests in qualities such as talkativeness, sociability, positive emotionality, assertiveness and excitement seeking. Extraverts tend to be more likely to explore and pursue more primal “appetitive” rewards such as chocolate, social attention, social status, sexual partners or drugs like cocaine. But dopamine, which is indeed important to extraversion, also has projections in the brain that are strongly linked to numerous other aspects of cognition. Individuals who are particularly open to experience get energized not merely through the possibility of appetitive rewards but through the



possibility of *discovering new information*. It is the thrill of the knowledge chase that most excites them.

This motivation for cognitive exploration engages and energizes us while influencing our drive for creative expression. We see the quality play out again and again in different realms of the arts and sciences. After all, it is difficult to imagine any great creative achievement that wasn't sparked by the drive to explore some aspect of the human experience.

“Leaky” Filters and Messy Minds

It is hardly a stretch to say that dopamine is the mother of invention. In addition to facilitating cognitive exploration, the neurotransmitter is associated with a number of processes that facilitate creativity, including dreaming. We know that both daydreaming and dreaming at night are invaluable tools to help us access deeper realms of creativity. People who are high in openness to experience report dreaming more often and having

more vivid dreams than those who are less open, possibly because of their higher dopamine production.

One intriguing possibility is that dopamine surges into the right hemisphere of the brain support both openness to experience and dreaming. Dreaming inspires creative insights, and those who have more creative insights show more activation in the brain's right hemisphere. Among people who are high in openness, the brain's dopamine systems are working day and night to inspire creative insights.

Another important cognitive process associated with creativity is latent inhibition—a mechanism in the brain that “filters out” objects in our environment that we have seen many times before and therefore consider irrelevant to our current goals and needs. In 2003 psychologist Shelley Carson of Harvard University

and her colleagues discovered that the university's eminent creative achievers were seven times more likely to have a *reduced* latent inhibition—meaning that they had a harder time filtering out seemingly irrelevant information and continued to notice familiar things.

But here's the thing: the information *did* turn out to be relevant! In related research, Kaufman found that those with a reduced latent inhibition had a greater faith in their intuitions, and their intuitions were, in fact, correct. Reduced latent inhibition speaks directly to the

THE AUTHORS

SCOTT BARRY KAUFMAN is scientific director of the Imagination Institute at the University of Pennsylvania's Positive Psychology Center and a frequent blogger for *Scientific American*.

CAROLYN GREGOIRE is a senior writer at the Huffington Post.

concept of a “messy mind,” often associated with creativity, because it reflects the tendency to tune in to greater amounts of information from our surroundings rather than automatically filtering and compartmentalizing.

The downside of this quality is that it might make creative people more prone to distraction than others. Researcher Darya Zabelina of Northwestern University found that people with a “leaky” sensory filter—meaning that their brain does not efficiently filter out irrelevant information from the environment—tend to be more creative than those with stronger sensory gating. Zabelina also observed that highly creative people are more sensitive to noises in their environment—a clock ticking, a conversation in the distance—than less creative people. “Sensory information is leaking in,” Zabelina has explained. “The brain is processing more information than it is in a typical person.”

This brain quirk was a known characteristic of many eminent creators, including Charles Darwin, Franz Kafka and Marcel Proust, who each expressed a hypersensitivity to sound. Proust kept his blinds drawn and lined his bedroom with cork to filter out unwanted light and noise and wore earplugs while he wrote, whereas Kafka said that he needed the solitude not of a hermit but of a “dead man” to write.

And although it may sometimes be a hindrance to creative work, this distractibility also seems to be distinctly beneficial to creative thinking. Sensory hypersensitivity most likely contributes to creativity by *widening* the brain’s scope of attention and allowing individuals to take note of more subtleties in their environment. Taking in a greater volume of information increases your chances of making new and unusual connections between distantly related pieces of information.



Genius or Madness?

These findings have deep implications for the long-standing mental illness–creativity debate. Research has linked dopamine production with not only reduced latent inhibition and creativity but also mental illness. To be clear: mental illness is neither necessary nor sufficient for creativity. Nevertheless, there does seem to be a nuanced link between the two because having an extremely open mind makes flights of fancy more likely. In support of this idea, there appear to be variations in the expression of dopamine receptors in certain areas of the brain among both creative individuals and those with psychotic symptoms.

In 2010 neuroscientist Fredrik Ullén of the Karolinska Institute in Stockholm and his colleagues found that dopamine systems in healthy, highly creative adults are similar in certain ways to those found in the brains of people with schizophrenia. In both cases, they observed a *lower* density of dopamine D2 receptors in the thalamus—a brain area associated with sensory perception and

motor function that also plays an important role in creative thought, suggesting one possible link between creativity and psychopathology.

Having fewer D2 receptors in the thalamus probably means that the brain is filtering less incoming stimuli, leading to a higher flow of information being transmitted from the thalamus to other parts of the brain. In individuals who are not also suffering from the damaging symptoms of mental illness, this flow can lead to an increase in creative thinking and may very well underlie several cognitive processes that determine creative achievement. “Thinking outside the box might be facilitated by having a somewhat less intact box,” Ullén and his colleagues said in the study.

An excess of dopamine may cause an influx of emotions, sensations and fantasy, so much

so that it causes substantial disruption to functions also important for creativity, such as working memory, critical thinking and reflection. Too little dopamine, however, and there may be less motivation and inspiration to create.

Dopamine aside, research has suggested similarities in brain activations between highly creative thinkers and people who are prone to psychosis. In 2014 neuropsychologist Andreas Fink of the University of Graz in Austria and his colleagues found that people scoring high in schizotypy—a personality continuum ranging from normal levels of openness to experience and imagination to extreme manifestations of magical thinking, apophenia (perceiving patterns that do not really exist) and psychosis—showed similar difficulty deactivating or suppressing activity in the precuneus region of the brain, an area associated with self-consciousness, a sense of self and the retrieval of deeply personal memories.

In reality, all of us lie somewhere on the schizotypy spectrum, and the exist-

tence of schizotypal characteristics does *not* necessarily indicate schizophrenia. Psychologically healthy biological relatives of people with full-blown schizophrenia tend to have unusually creative jobs and hobbies, compared with the general population, according to a 2001 study by Saybrook University psycholo-

when a filmmaker spends hours in front of a computer editing a rough cut.

Flow is essential to the artist's experience. In a study of 100 artists in music, visual arts, theater and literature, researchers Barnaby Nelson and David Rawlings, both at the University of Melbourne in Australia, found that those who said they

trigger a shift in quality of experience, generally in terms of an intensification or heightening of experience."

So what determines whether schizotypy goes the way of intense absorption and creative achievement or tips over into mental illness? This is where a number of other factors come into play. If mental illness is defined as extreme difficulty functioning effectively in the real world, then the complete inability to distinguish imagination from reality is surely going to increase the likelihood of mental illness. If, however, one has an overactive imagination but *also* has the ability to distinguish reality from imagination and can harness these capacities to flourish in daily life (with the help of things such as motivation, post-traumatic growth, resilience and a supportive environment), then that is *far* from mental illness.

Mental processes on the schizotypy spectrum may interact with protective mental qualities such as greater intellectual curiosity, improved working memory and cognitive flexibility. Indeed, in 2011 neuroscientist Hikaru Takeuchi of Tohoku University in Japan and his colleagues studied people with no history of neurological or psychiatric illness and found that the most creative thinkers among them were those who were able to *simultaneously* engage their executive attention in an effortful memory task and keep the imagination network in the brain active.

You never know—some of the most seemingly irrelevant or “crazy” ideas at one point may be just the ingredients for a brilliant insight or connection in a different context. It bears repeating: creativity is all about making new connections. **M**

Mental illness is neither necessary nor sufficient for creativity, but there is a nuanced link between the two.

gist Ruth Richards and her colleagues. Similarly, Simon Kyaga and his co-workers at the Karolinska Institute reported in 2013 that among more than 1.2 million Swedes, the siblings of patients with autism and the first-degree relatives of patients with schizophrenia were significantly overrepresented in scientific and artistic occupations.

It is possible that relatives of people with mental illness inherit creativity-boosting traits while avoiding the aspects of the mental illness that are more debilitating. In support of this observation, researchers have found that schizotypal characteristics—particularly the “positive” ones, such as unusual perceptual experiences and impulsive nonconformity—are related to creative personal qualities—individualistic, insightful, eclectic, reflective, resourceful and unconventional—as well as everyday creative achievements.

Go with the Flow

Schizotypy is related to so-called flow states of consciousness and absorption. Flow is the mental state of being completely present and fully absorbed in a task. When in a flow state, the creator and his or her world become one—outside distractions recede from consciousness, and the mind is fully open and attuned to the act of creating. This happens, for instance, when a playwright sits up all night crafting a new scene without realizing that the sun is rising or

experienced more flow during the creative process were also higher in schizotypy and openness to experience. Nelson and Rawlings linked their findings to latent inhibition, arguing that a leaky sensory filter is a common thread running through schizotypy and openness to experience—and, perhaps surprisingly, flow and absorption. The failure to pre-categorize incoming information as irrelevant, which is experienced by individuals with reduced latent inhibition, can, the researchers wrote, result in “immediate experience not being as shaped or determined by preceding events.”

In other words, an exceptionally large amount of information, far more than for those with higher levels of latent inhibition, enters their field of awareness and is explored by their mind. As Nelson and Rawlings explained, “it is precisely this newness of appreciation and the associated sense of exploration and discovery, that stimulates the deep immersion in the creative process, which itself may

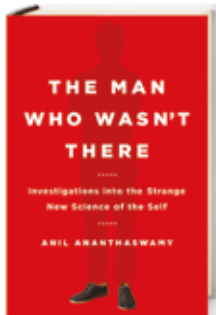
MORE TO EXPLORE

- **The Neuromodulator of Exploration: A Unifying Theory of the Role of Dopamine in Personality.** Colin G. DeYoung in *Frontiers in Human Neuroscience*, Vol. 7, Article No. 762. Published online November 14, 2013.
- **Opening Up Openness to Experience: A Four-Factor Model and Relations to Creative Achievement in the Arts and Sciences.** Scott Barry Kaufman in *Journal of Creative Behavior*, Vol. 47, No. 4, pages 233–255; December 2013.
- **Creativity and Sensory Gating Indexed by the P50: Selective Versus Leaky Sensory Gating in Divergent Thinkers and Creative Achievers.** Darya L. Zabelina et al. in *Neuropsychologia*, Vol. 69, pages 77–84; March 2015.

EVERYWHERE AND NOWHERE

The Man Who Wasn't There: Investigations into the Strange New Science of the Self

by Anil Ananthaswamy. Dutton, 2015 (\$26.95; 320 pages)



For centuries philosophers and psychologists—including René Descartes, the Buddha and William James—have mused over the nature of the self: Is it an illusion, or is it real? If it does exist, where in the brain does it reside?

Modern neuroscience has not resolved the debate but does offer tantalizing glimpses of the brain regions shaping our sense of self, argues science writer Ananthaswamy in his new book *The Man Who Wasn't There*. In particular, he focuses on what we can learn from certain neuropsychiatric disorders, such as Alzheimer's disease and schizophrenia, that ultimately serve to dissolve our identity.

Ananthaswamy recounts, for instance, the story of a patient who exhibited the hallmark symptom of Cotard's syndrome: he insisted he was brain-dead despite being alert enough to make that declaration.

This rare disorder challenges the classic Cartesian philosophy of the self: "I think, therefore I am." Studies reveal that sufferers show abnormally low metabolic activity in the frontoparietal network, which is involved in generating conscious awareness. The connection suggests that these neural networks may be at least partially responsible for our sense of self.

Other disorders also provide ideas about how our sense of identity may form in the brain. Ananthaswamy notes that people with schizophrenia face a twisted version of reality. Some lose agency over their thoughts, experiencing hallucinations and paranoia. Functional MRI studies indicate that those with auditory hallucinations exhibit hyperconnectivity among brain regions involved in speech production, speech perception, hearing and threats. These overactive neural networks, he says, change our core perceptions of the world and of ourselves—and may turn innocent thoughts and daydreams into something more malevolent.

Alzheimer's may offer some of the most profound clues about the origins of self. As the disease progresses, it ravages our memories. As a result, we irrevocably lose the knowledge of our history and the narrative we have created about who we are.

The Man Who Wasn't There is a thought-provoking read. Overall, Ananthaswamy's collection of intriguing

cases suggests that the self cannot be pinned to any one spot but emerges instead from an intricate network of brain regions. Although a complete understanding of the self may elude us, Ananthaswamy relays many interesting advances and, at the same time, challenges us to contemplate who we really are.

—Ciara Curtin

FOOD. GLORIOUS FOOD

First Bite: How We Learn to Eat

by Bee Wilson. Basic Books, 2015 (\$27.99; 352 pages)



Every bite forms a memory, and the most powerful ones are the first, says food writer Wilson. As children, we do not simply learn what we like and dislike by putting new foods in our mouth. We also learn by watching others eat—at home, at school and on TV. By the time we turn 18, we have each had some 33,000 unique learning experiences with food, Wilson estimates. In *First Bite*, she details the complex, often fraught relationship humans have with food and explores why, for some of us, eating can go so wrong.

Genetic differences may determine how we taste foods, even how much we

ROUNDUP

All about Animals

Three books probe the inner world of animals

What goes on in an animal's mind? How does it experience the world? In **Beyond Words: What Animals Think and Feel** (Henry Holt, 2015; 480 pages), ecologist Carl Safina explores these intriguing questions. "Speculation about animals' mental experiences happens to be the main quest of this book," Safina writes, as he skillfully weaves together research on animal behavior and cognition with tales of his journey across the globe to observe how different animals live. In his quest, he discovers that many mammals and birds possess rich

personalities and display complicated social behaviors and group politics. These traits sometimes parallel our own but are unique to them in other important ways. Elephant expert Cynthia Moss characterizes the distinction well: "Elephants experience joy. It may not be human joy. But it is joy."

Dolphins, in particular, seem to fascinate us. After swimming with dolphins while on vacation in Hawaii, best-selling author Susan Casey became entranced with the intelligent, beautiful creatures.

In **Voices in the Ocean: A Journey into the Wild and Haunting World of Dolphins** (Doubleday, 2015; 320 pages), Casey embarks on an exploration to understand dolphins and our relationship with them. She travels to meet people

who adore dolphins, delves into research on dolphin intelligence and social behaviors, and investigates humans' ongoing cruelty toward them. Although Casey often gets caught up in dolphin mystique instead of facts, she provides compelling insights into their world.

Another recent book chronicles the life and times of a different ocean dweller, the octopus. Slippery octopuses may be less popular than majestic dolphins, but award-winning author Sy Montgomery reveals their beauty in **The Soul of an Octopus: A Surprising Exploration into the Wonder of Consciousness** (Atria Books, 2015; 272 pages). The book takes its readers on a vivid tour of their complex inner world. Montgomery explores their proclivi-



ties, their relationships and their intelligence and ultimately tries to deduce whether they possess consciousness. Although much is still unknown about the octopus, it is hard to come away from this book without a new appreciation for these wonderful creatures.

—Victoria Stern

enjoy eating, but the environment in which we learn to eat ultimately shapes our dietary habits. For instance, most babies will stick their tongue out, spit or even cry when confronted with a bitter taste, although many will grow up to savor a pint of India pale ale or a cup of French roast coffee.

Learning to like new foods is largely a consequence of familiarity, Wilson says. Humans are wired to like what they know. A child will often decide to dislike a certain food before trying it because it may look or smell different from foods he or she already eats. Studies reveal that we acquire new tastes through “mere exposure,” a process that boils down to a tendency to learn to like new things by trying them repeatedly.

Although certain foods may always taste particularly acrid to a subset of genetic supertasters, people’s belief that tastes cannot be changed can dissuade them from sampling new foods and lead to bad or selective eating habits. In fact, Wilson claims, an estimated 25 percent of all adults never grow out of their childhood food fussiness.

In the most extreme cases, picky eating can lead to a lasting fear of certain foods, which can consume people’s life. Wilson describes one woman who made her choice of college based on the fact that the school cafeteria served plain pizza without the taint of oregano or spice.

In addition to describing such dire disordered eating, Wilson devotes a lot of space to more basic everyday bad habits. She explains how they develop—largely as a result of the food environment in which we learn to eat—and how we can overcome them. Being open to new food experiences is a start. At times, Wilson’s critique feels cloying, beating on overdone consumer health tropes, including the obesity epidemic and the pitfalls of a “Western” diet. She injects some levity into these weighty discussions, however, when she describes how she would often blitz through tubs of ice cream as a teenager.

First Bite is a worthy read that provides sharp insights into how our tastes evolve. Notably the book offers all of us Pringles fiends and Hostess hounds a chance at redemption with sage advice on how to quit junk-food addictions and change even the most ingrained eating habits.

—Lindsey Konkel

Q&A: DAVID EAGLEMAN

Exploring the Mysteries of the Brain



For many people of a certain age, the original 1980s PBS series *Cosmos* was a major event—a stunning love letter to astronomy that provided a novel way of thinking about ourselves and our place in the universe. Neuroscientist David Eagleman counts himself among those moved by *Cosmos*. He sees it as a model for his ambitious PBS series, *The Brain with David Eagleman*, a six-hour exploration of what has been called the most complex object in the known universe, the gelatinous mass that, somehow, makes us who we are. Eagleman answered questions from contributing editor Gareth Cook about the new show, which premiered in October. A fuller version of the interview appears online in *Mind Matters*, which can be found at www.ScientificAmerican.com/mind-matters. An edited transcript follows.

Your first episode addresses the question of how the brain “creates” reality. Can you explain what you mean by this and what is so challenging about trying to answer it?

Consider that whole beautiful world around you, with all its colors, sounds, smells and textures. Your brain is not directly experiencing any of that. Instead your brain is locked in a vault of silence and darkness inside your skull. All it ever experiences are electrochemical signals coursing around through its massive jungle of neurons. Those signals are all it has to work with and nothing more. From these signals, it extracts patterns, assigns meaning to them and creates your subjective experience of the outside world. Your reality is running entirely in a dark theater. Our conscious experience of the outside world is one of the great mysteries of neuroscience: not only do we not have a theory to explain how private subjective experience emerges from a network of cells, we aren’t even certain what such a theory would look like. In the series, I confront that mystery, among others, to give an indication of where the field is going and how this might get solved.

Those of us who are not psychologists or neuroscientists generally go through the day imagining that we consist of a unitary, conscious self, making decisions as we go. What are some of the ways the series challenges this assumption?

Glad you asked: I’ve devoted a whole episode to the question of how we make decisions. In that hour, it becomes clear that you, as an individual, are not single-minded. Instead you are built of competing neural networks, all of which have their own drives and all of which want to be in control. This is why we’re interesting and complicated. We can argue with ourselves, we can get mad at ourselves, we can make contracts with ourselves. Who exactly is talking with whom? It’s all you, but it’s different parts of you. In another episode entitled “Who Is in Control?” I tackle the question of how much control your conscious mind actually has, as opposed to all the rest of the brain activity that chugs along without your acquaintance or your ability to access it. Collectively, over the course of the six episodes, I hope that viewers will find their assumptions about actions, beliefs and reality put under the microscope.

The final show is called “Who Will We Be?” What was the motivation behind that episode, and what can we expect to learn from it?

I’m captivated by the ways that our technology is becoming married to our biology, thereby changing our trajectory as a species. I recently spoke about this issue at TED, where I unveiled a device we’ve invented in my lab to feed new information into the brain. This can expand the narrow human slice of perception. In the last episode, I extrapolate the technology-biology marriage into the distant future—exploring, for example, whether we can freeze your brain and thaw it out 1,000 years later to reboot you. Or whether we can circumvent biology altogether and run a full, detailed simulation of your brain in a computer—and whether that would be you. If any of this turns out to be possible, it would open up scenarios for space travel because the biology we come to the table with is not terribly useful for interstellar voyages. What’s more, the future-looking question of whether we could someday live in a simulation circles back to a very old question, contemplated by philosophers from Zhuang Zhou to Descartes to the Wachowski siblings [in *The Matrix*]: How would we know if we were already living in a simulation?



Can stress sometimes prove beneficial?

—Rowena Kong via e-mail



Ann S. Masten, a professor of child development at the University of Minnesota and author of *Ordinary Magic: Resilience in Development*, replies:

You raise one of the most intriguing questions in modern resilience science: Can adversity be good for development? The answer appears to be yes, depending on the timing and nature of the stresses. But it is important to note that it is a person's adaptive responses to life's challenges that are beneficial, not the exposure to adversity itself. Beneficial responses have been called steeling effects, stress inoculation and post-traumatic growth.

Extreme deprivation or stress can clearly cause lasting life consequences. Yet many individuals endure, recover and thrive in the aftermath of devastating events. A few, such as Malala Yousafzai, Stephen Hawking or Oprah Winfrey, even become famous. What distinguishes them?

An individual's resilience can be viewed as the capacity to adapt to adversity at a given point. Resilience is not innate, nor is it fixed. It can fluctuate throughout a person's lifetime and is influenced by a complex set of adaptive processes. Many of these protective systems improve with experience or require challenges to reach their full potential. On a biological and environmental level, our capabilities to fight off infections and respond to stress are both shaped by experience. For instance, we vaccinate our children to promote immunity to dangerous pathogens.

Similarly, exposure to manageable levels of psychological stress can improve future adaptation abilities. It is important to remember, however, that too much adversity can deplete the resources any child or adult needs to muster resilience. There is psychological and neurobiological evidence that prolonged or overwhelming stress can wear down our body and mind.

How is it that I can "see" memories?

—Alexandra Coppinger
Melbourne, Australia



Jamie Ward, a professor of cognitive neuroscience and head of synesthesia research at the University of Sussex in England, answers:

What you are describing is termed mental imagery, or the ability to create a mental picture of a person, place or experience without any external cues or stimuli. People differ greatly in the extent to which their recollections are visual.

Constructing a mental image relies on coordinating several different processes in the brain. The hippocampus, long regarded as the main storage site for memories of complex events, has recently—and perhaps surprisingly—been found to be important for imagining new or fictitious events. Indeed, recent research has shown that patients with damage to the hippocampus not only have problems remembering the past, they also struggle to imagine the future.

Although the hippocampus may be involved in combining various elements from a real or imagined scene, it probably has little to do with the experience of "seeing" an image in your mind. Creating a mental image requires further coordination involving regions of the brain that contribute to vision, such as the parietal lobes—which aid in perceiving spatial relations and perspective—and the temporal lobes—which help us to discern shape, color and faces. When we recall a friend's face, for instance, we activate the same neurons that would be involved in actually seeing the person if he or she was standing right in front of us, as well as those neurons in the hippocampus that encode memories. Thus, intriguingly, with mental imagery, we see from the inside out rather than the outside in.

An exciting frontier of resilience science focuses on the complex interactions of genes, neurobiology, social relationships, culture and life experiences in developing our adaptive capacity. Studies of adversity in early childhood document its influences on gene expression, brain development and the calibration of stress-response systems. Scientists have also demonstrated the biological effects of good parenting and the efficacy of interventions that target caregiving for restoring normal stress regulation or boosting resilience.

As our knowledge grows, the core questions about resilience are shifting. Investigators are increasingly asking what kinds of experiences are harmful or beneficial for whom, under what conditions and when—and, concomitantly, what works to foster human capabilities for responding well to the inevitable vicissitudes of life.

What is “chemo brain”? —Name withheld



Graham J. McDougall, Jr.,

a behavioral scientist, nurse practitioner and gerontologist at the University of Alabama, responds:

Chemo brain is a mental cloudiness reported by about 30 percent of cancer patients who receive chemotherapy. Symptoms typically include impairments in attention, concentration, executive function, memory and visuospatial skills.

Since the 1990s researchers have tried to understand this phenomenon, particularly in breast cancer patients. But the exact cause of chemo brain remains unclear. Some studies indicate that chemotherapy may trigger a variety of related neurological symptoms. One study, which examined the effects of chemotherapy in 42 breast cancer patients who underwent a neuropsychological evaluation before and after treatment, found that almost three times more patients displayed signs of cognitive dysfunction after treatment as compared with before (21 versus 61 percent). A 2012 review of 17 studies considering 807 breast cancer patients found that cognitive changes after chemotherapy were pervasive. Other research indicates that the degree of mental foginess that a patient experiences may be directly related to how much chemotherapy that person receives: higher doses lead to greater dysfunction.

There are several possible mechanisms to explain the cognitive changes associated with chemotherapy treatments. The drugs may have direct neurotoxic effects on the brain or may indirectly trigger immunological responses that may cause an

inflammatory reaction in the brain.

Chemotherapy, however, is not the only possible culprit. Research also shows that cancer itself may cause changes to the brain. In addition, it is possible that the observed cognitive decline may simply be part of the natural aging process, especially considering that many cancer patients are older than 50 years.

Of interest, some studies have failed to document actual cognitive impairment in patients complaining of chemo brain. One such study, comparing the cognitive function in breast cancer patients with that of healthy individuals, did not find significant differences on neuropsychological tests but revealed that the cancer patients perceived that their cognitive functioning, quality of life and psychological well-being had all declined sharply. Experts estimate that in about 10 to 40 percent of cancer patients and survivors, chemo brain symptoms may arise from anxiety, depression or physical fatigue after treatment or diagnosis.

Regardless of the source, scientists are investigating interventions that can help reduce the symptoms of chemo brain. One study has tested the effectiveness of a cognitive-behavior therapy following chemotherapy in women newly diagnosed with breast cancer. After the intervention, these women showed significant improvements in verbal and executive function and reported subjective improvements in cognitive function and quality of life.

My colleagues and I have also tested the effects of the Senior WISE memory-training intervention, which includes relaxation and stress-reducing techniques, as well as confidence-building exercises and memory training. Overall, we have found that after the intervention, participants experienced memory gains and less anxiety. Thus, despite our murky understanding of where chemo brain comes from, there is hope and help for its sufferers.

STATEMENT OF OWNERSHIP, MANAGEMENT, AND CIRCULATION

1. Publication title: Scientific American Mind. 2. Publication number: 2-3113. 3. Filing date: 10/1/2015. 4. Issue frequency: bimonthly. 5. Number of issues published annually: 6. 6. Annual subscription price: U.S. and its possessions, 1 year, \$19.95; Canada, 1 year, \$30.00; all other countries, 1 year, \$30.00. 7. Complete mailing address of known office of publication: Scientific American, One New York Plaza, Suite 4500, New York, NY 10004-1562, USA. 7a. Contact person: Karen Dawson; telephone: 212-726-9369. 8. Complete mailing address of the headquarters or general business office of the publisher: Scientific American, a division of Nature America, Inc., One New York Plaza, Suite 4500, New York, NY 10004-1562, USA. 9. Full names and complete mailing addresses of publisher, editor and managing editor: Publisher, Michael Florek, Scientific American, One New York Plaza, Suite 4500, New York, NY 10004-1562, USA. Editor, Mariette DiChristina, Scientific American, One New York Plaza, Suite 4500, New York, NY 10004-1562, USA. Managing Editor, Claudia Wallis, Scientific American, One New York Plaza, Suite 4500, New York, NY 10004-1562, USA. 10. Owner: Scientific American, a division of Nature America, Inc., One New York Plaza, Suite 4500, New York, NY 10004-1562, USA. 11. Known bondholders, mortgagees and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities: none. 12. Tax status: has not changed during preceding 12 months. 13. Publication title: Scientific American Mind. 14. Issue date for circulation data: September/October 2015. 15. Extent and nature of circulation: a. Total number of copies (net press run): average number of copies of each issue during preceding 12 months: 251,155; number of copies of single issue published nearest to filing date: 247,864. b. Paid circulation (by mail and outside the mail): (1) mailed outside-county paid subscriptions stated on PS Form 3541 (include paid distribution above nominal rate, advertiser's proof copies, and exchange copies): average number of copies of each issue during preceding 12 months: 56,669; number of copies of single issue published nearest to filing date: 51,315. (2) mailed in-county paid subscriptions stated on PS Form 3541 (include paid distribution above nominal rate, advertiser's proof copies, and exchange copies): average number of copies of each issue during preceding 12 months: 0; number of copies of single issue published nearest to filing date: 0. (3) paid circulation outside the mails through dealers and carriers, street vendors, counter sales, and other paid distribution outside USPS®: average number of copies of each issue during preceding 12 months: 65,202; number of copies of single issue published nearest to filing date: 62,691. (4) paid distribution by other classes of mail through the USPS (e.g., First-Class Mail®): average number of copies of each issue during preceding 12 months: 0; number of copies of single issue published nearest to filing date: 0. c. Total paid circulation (sum of 15b (1), (2), (3) and (4)): average number of copies of each issue during preceding 12 months: 121,871; number of copies of single issue published nearest to filing date: 114,006. d. Free or nominal rate distribution (by mail and outside the mail): (1) free or nominal rate outside-county included on PS Form 3541: average number of copies of each issue during preceding 12 months: 814; number of copies of single issue published nearest to filing date: 782. (2) free or nominal rate in-county copies included on PS Form 3541: average number of copies of each issue during preceding 12 months: 0; number of copies of single issue published nearest to filing date: 0. (3) free or nominal rate copies mailed at other classes through the USPS (e.g., First-Class Mail): average number of copies of each issue during preceding 12 months: 0; number of copies of single issue published nearest to filing date: 89. e. Total free or nominal rate distribution (sum of 15d (1), (2), (3) and (4)): average number of copies of each issue during preceding 12 months: 901; number of copies of single issue published nearest to filing date: 871. f. Total distribution (sum of 15c and 15e): average number of copies of each issue during preceding 12 months: 122,772; number of copies of single issue published nearest to filing date: 114,877. g. Copies not distributed (see instructions to publishers #4 (page #3)): average number of copies of each issue during preceding 12 months: 128,383; number of copies of single issue published nearest to filing date: 132,987. h. Total (sum of 15f and 15g): average number of copies of each issue during preceding 12 months: 251,155; number of copies of single issue published nearest to filing date: 247,864. i. Percent paid (15c divided by 15f times 100): average number of copies of each issue during preceding 12 months: 99.3%; number of copies of single issue published nearest to filing date: 99.2%. 16. Total circulation does not include electronic copies. 17. Publication of statement of ownership: If the publication is a general publication, publication of this statement is required. Will be printed in the January/February 2016 issue of this publication. 18. I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on this form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties). Signature and title of Editor, Publisher, Business Manager, or Owner: (signed) Michael Florek, Executive Vice President. Date: 10/1/2015.

SCIENTIFIC AMERICAN™ *Classics*

Discover the Future through Our Past.



SCIENTIFIC AMERICAN Classics are single-topic anthologies compiled from SCIENTIFIC AMERICAN's 170 years of extensive historical archives as 70+ page PDFs. New Classics are priced at \$9.99 per issue

Learn more at [ScientificAmerican.com/classics](https://www.ScientificAmerican.com/classics) and start your collection today.

Collection includes: A New Look at Human Evolution, The Hidden Mind, Birth of Flight, Reality-Bending Black Holes, Tragedy and Triumph, Your Sexual Brain, The Titanic and Age of the Transatlantic Steamship

1 SUMMING SHAPES

Each shape in this grid has a numerical value. The sum of each row and column is given except for the top row. Find the missing sum.

				?
				85
				87
				82
87	86	93	79	

2 KEEP COUNT

One week ago Ashleigh had three times as many blog posts as Keisha. Both of them posted once every day this week. Now Ashleigh has twice as many blog posts as Keisha. How many posts does each blog have?

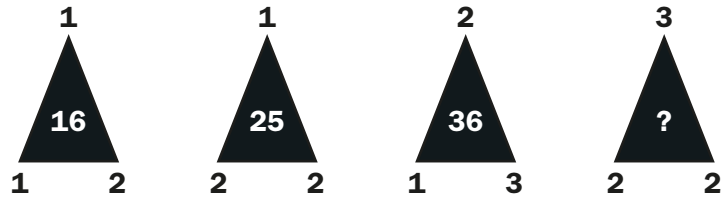
3 SIMPLE SUDOKU

Arrange the numbers 1, 2, 3 and 4 in a four-by-four grid so that each row has one of each number and the same number is never next to itself in any row or column or along the two four-number diagonals. Each row will add up to 10. Two numbers have been filled in, and there are at least three correct combinations.

1			
		1	

4 TRIANGLES AND SQUARES

The numbers on the triangles below follow a pattern. Figure out the pattern and find the missing number.



5 MAGIC SQUARE

Fill the boxes to the right with the letters S, N, O and W such that each row, column and four-letter diagonal contains each letter only once. Their order is not important. Three letters are already in place to give you a start.

S			N
		S	

6 PUZZLERS' PROBLEM

If six puzzle solvers can solve 12 puzzles in 12 minutes, how long will it take one puzzle solver to solve 60 puzzles?

7 FIND THE TIME

Jim goes to visit a friend who lives six miles away. He walks at three miles per hour on the way there. He spends 90 minutes at his friend's house, and then his friend drives him home by car at a rate of 30 miles per hour. Jim gets home at 2 P.M. At what time did he leave?

8 ODD WORD OUT

Which of the following scrambled words is least like the others?

- ZSUE
- RPSEESU
- MCRUYER
- MRCEIAA

9 MYSTERY NUMBER

What is the highest four-digit number, containing no 0s, in which the first digit is one quarter of the third digit, the second digit is three times the first digit, and the third and fourth digits are the same?

© 2015 AMERICAN MENSA, LTD. LEARN MORE AT AMERICANMENSA.ORG/JOIN

Answers

1. 91. 2. Ashleigh has 28 blog posts, Keisha has 14.

3.

2	1	4	3
4	3	2	1
3	4	1	2
1	2	3	4

4. 49.

5.

S	O	W	N
N	W	O	S
O	S	N	W
W	N	O	S

6. 360 minutes, or six hours.

7. 10:18 A.M. He spent two hours walking to his friend's house, an hour and a half visiting, and 12 minutes getting home by car for a total of three hours and 42 minutes.

8. AMERICA. The other three—ZEUS, PERSEUS and MERCURY—are figures from Greek or Roman mythology.

9. 2,688.



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

Voyage to the ancient Mediterranean with Bright Horizons. Sail along the Greek Islands and Turkish coast and get the latest in science knowledge. Explore the region where archaeology matured from the exercise of curiosity to a scientific discipline. Join a community for lifelong learning in a visit to a region where pride in the mythical and historical past balances with enjoyment of life and living in the moment.

Aboard ship, study contemporary science. In port, graze on the layered traces of Greek, Roman, and Byzantine, eras through architecture and art. Take field trips for in-depth study of the Mediterranean diet. Visit the spectacular volcanic caldera of Santorini. Experience blue Aegean waters and glowing sunsets. Chat with locals and walk breezy beaches known to Odysseus. Savor the moment with a friend.

Linger in the timeless beauty and warm hospitality of the Greek Isles and Turkey while inhabiting a roving scientific community. Make your reservation today!

Cruise prices vary from \$2,039 for an Interior Stateroom to \$9,999 for a Pinnacle Suite, per person (pp). For those attending our SEMINARS, there is a \$1,475 fee. Add'l pp fees: gov't taxes and fees (\$209), booking fee (\$100), tour leader gratuities (\$120), and onboard gratuities (for your cabin steward and dining room staff, approx \$11.50 per day). The Program, cruise pricing, and options are subject to change. For more information email us at Concierge@InsightCruises.com.



Art and Archeology in the Ancient World

Speaker: Diana McDonald, Ph.D.

Olympia: Games for the Gods

Olympia is famous today as the origin point of the Olympic Games in 776 B.C. Learn about the art that this Greek "culture of competition" inspired, the way artists glorified athletes and fighters, and the link between warfare, sports, and religion. Finally, investigate how Olympic art may have influenced modern attitudes toward sports and athletes.

Athens: The Acropolis and the Parthenon

Many consider the Parthenon the most perfect building ever created. How did it reach those heights? We'll see how the crowning glory and symbol of Classical Age Greece was the result of a long development in architecture and a refinement of the principles that underlay Greek culture and ideology.

Ephesus: The Temple of Artemis and the Goddess Cults

The Temple of Artemis of Ephesus is said to have been founded by Amazons, and was a center for goddess cults and an emblem of women's importance in the ancient world. We'll look at the famous many-breasted sculptures of Artemis, and link her to her forebears from the Neolithic and Bronze Age worlds.

Santorini: The Early Cultures of Greece

The eruption of Thera (circa 1500 BCE) was one of the largest catastrophic volcanic events on Earth. Did this eruption incite the subsequent collapse of the Bronze Age Minoan civilization? Learn about this enigmatic early island culture, including its elegant art and still undeciphered script, and what we know of its downfall.



A Review of the Ancient Mediterranean Civilizations

Speaker: Kenneth W. Harl, Ph.D.

Sea Power in the Ancient Mediterranean

The city-states of Athens and Venice had the two greatest navies in Mediterranean history. From their political organizations, market economies and trade, to the pivotal galley-driven battles of Salamis and Lepanto—two sites our cruise will sail by—learn the impact sea power had on the shape of European history.



Struggle for the Mastery of Greece, 480–338 B.C.

Learn why the Athenian city-state gave way to a united Greece. We'll tackle compelling questions such as, was civil war inevitable? Did an oligarchy like Sparta have advantages over a democracy like Athens? And why, in spite of bringing peace and unity, were the Macedonian Philip II and Alexander the Great hated as oppressors?

Constantinople to Kostantiniyye

Survey the evolution of Constantinople from Byzantium, a part of "old Rome," into "New Rome," through the glorious flowering of the Byzantine Empire, the destruction by the Crusaders, and the city's rebuilding by the Ottoman Turks. We'll look at the people and the societal factors behind this turbulent progression.

Markets, Trade, and Money in the Mediterranean World

As we travel the Aegean, learn where the money that created its architectural and cultural artifacts came from and where it went. We'll investigate the invention and use of coins, the use of credit and banking, and the role of cities in economies to understand the economic systems of the Mediterranean world.

Religious and Cultural Change in Anatolia

Turkey's landmarks tell a story about how Anatolia's religious landscape has been successively rewritten. Experience the sweep of Anatolian history, from the first known Neolithic village where the roots of future gods Zeus and Cybele lie, to the creation of secular Turkey, and gain a context for Asia Minor's cultural highlights.



Theoretical Physics

Speaker: Tara C. Shears, Ph.D.

The Power of Symmetry

In ancient Greece Plato thought that symmetry was related to harmony and beauty, and we have associated symmetry with the universe's nature ever since. Learn how modern scientists have found that symmetries are intimately linked to invariances, conserved quantities and the physical laws of nature.

The Particle Physics World

The modern theory of particle physics, the Standard Model, is so good that we haven't yet made a measurement that disagrees with it. It is our most successful fundamental theory ever—but we think it isn't correct. We'll explore what we understand about the subatomic world and what makes physicists think we're missing something.

Antimatter

Antimatter sounds like science fiction but it's actually science fact. According to our theories, matter and antimatter should be symmetric and behave identically, but experimentally we find this symmetry doesn't quite hold. Learn why antimatter is one of the greatest mysteries in physics and what we're doing to try to solve it.

Toward an Ultimate Theory of the Universe

Physicists' preference for a simple, symmetric universe has got us this far and left us with a list of outstanding mysteries: antimatter, dark matter, even gravity. Can symmetry help us out again? We'll survey the theories invoking new symmetries in nature that might explain more, and discuss experimental ways to test them.



Architecture in the Ancient World

Speaker: Stephen Ressler, Ph.D.

Building in Stone: From Quarry to Temple

How were the stones for buildings like the Parthenon extracted with only iron-tipped picks? How were they shaped with only hand tools, and then positioned with such precision? We'll answer these questions by following a block of stone from its point of origin to its final resting place in the wall of a Greek temple.

Stone Masonry Perfected: The Greek Temple

The colonnaded temple was one of the crowning achievements of Classical Greek civilization. But where did this iconic struc-

ture originate? Learn how the familiar architectural form was strongly influenced by the structural limitations of its post-and-lintel structural system, and how later Roman engineers overcame these limitations to open new realms of architectural possibility.

Roman Engineering at Ephesus

The Romans were the most accomplished engineers of the ancient world and the city of Ephesus offers ample evidence of their engineering prowess. We'll examine Roman arches, vaults, water systems and bath complexes as engineered systems and explore some of the many examples of these technologies that have survived in Ephesus today.

The Church of Hagia Sophia

Hagia Sophia, the Church of Holy Wisdom, is the world's most majestic example of Byzantine architecture. Learn about the mechanics of its great central dome and how its integrated system of columns, arches, vaults, semi-domes and buttresses supports the dome while simultaneously creating an interior space of incomparable grandeur.

Reconstructing the Trireme

The trireme was a 125-foot-long wooden warship, rowed by 170 men arrayed on three levels, used in battle as a human-powered torpedo. We'll examine this extraordinary technological system, and how, by the fifth century B.C., it had become the principal means of asserting political power in the eastern Mediterranean.



SCIENTIFIC AMERICAN Travel HIGHLIGHTS INSIDER'S TOUR OF CERN



Pre-Cruise Full-Day Tour Tuesday – Thursday, May 2–4

From the tiniest constituents of matter to the immensity of the cosmos, discover the wonders of science and technology at CERN. Join Bright Horizons for a private pre-cruise, custom, full-day tour/visit of this iconic facility.

Whether you lean toward concept or application there's much to pique your curiosity. Discover the excitement of fundamental research and get a behind-the-scenes, insider's look at the world's largest particle physics laboratory.

ADDICTION

BY DWAYNE GODWIN
& JORGE CHAM

ADDICTION COSTS AMERICANS MORE THAN \$700 BILLION A YEAR IN LOST WORK, TREATMENT AND DRUG-RELATED CRIME.



BUT WHAT IS ADDICTION... AND HOW DO WE BREAK IT?

ADDICTION HAS ITS ROOTS IN THE BRAIN'S REWARD SYSTEM.



IT'S THE SYSTEM MEANT TO REINFORCE BEHAVIORS NEEDED FOR SURVIVAL, SUCH AS EATING AND HAVING SEX.

ONE IMPORTANT COMPONENT IN THIS SYSTEM IS THE MESOLIMBIC PATHWAY ...

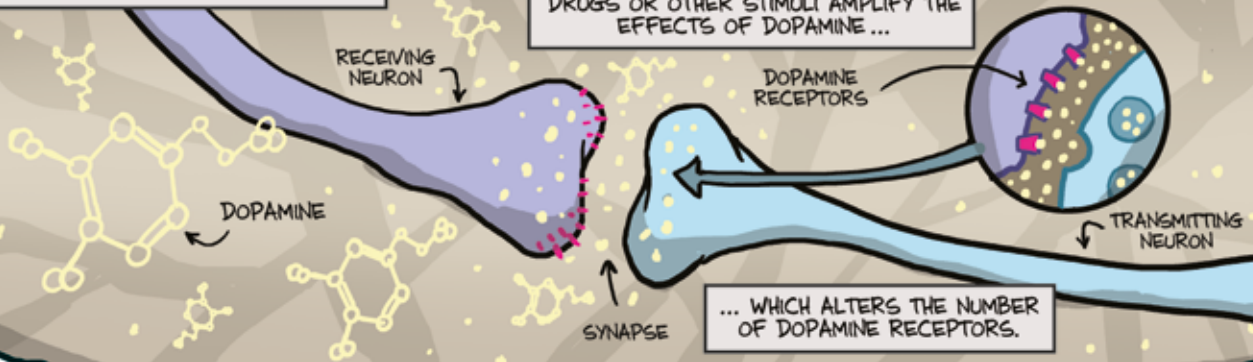


... A COLLECTION OF NEURONS THAT PRODUCES AND RELEASES DOPAMINE WHENEVER YOU ENGAGE IN REWARDING BEHAVIORS.

DOPAMINE IS A NEUROTRANSMITTER THAT, AMONG MANY OTHER THINGS, GIVES YOU THE SENSATION OF PLEASURE WHEN RELEASED IN CERTAIN BRAIN AREAS.

ADDICTION CAN OCCUR WHEN THIS PATHWAY IS HIJACKED REPEATEDLY BY DRUGS OR OTHER STIMULI, CREATING CHANGES IN THE SYNAPTIC CONNECTION THAT ARE HARD TO REVERSE.

DRUGS OR OTHER STIMULI AMPLIFY THE EFFECTS OF DOPAMINE ...



... WHICH ALTERS THE NUMBER OF DOPAMINE RECEPTORS.

THIS CHANGED PATHWAY, ALONG WITH INCREASED STRESS DURING WITHDRAWAL, DRIVES ADDICTS TO COMPULSIVELY SEEK OUT THE STIMULUS ...



... DESPITE LONG-TERM NEGATIVE CONSEQUENCES.

NOT ALL DRUGS OR ADDICTS ARE THE SAME. SOME PEOPLE ARE GENETICALLY MORE SUSCEPTIBLE TO ADDICTION ...



... AND A DRUG'S ADDICTIVENESS SEEMS TO DEPEND ON HOW RAPIDLY IT ACTS ON YOUR SYSTEM.

HEALING ADDICTION IS A DIFFICULT PROCESS, AIDED BY GROUP SUPPORT.



THE BEST WAY TO BEAT A HARMFUL DEPENDENCY IS BY DEPENDING ON OTHERS.

● 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

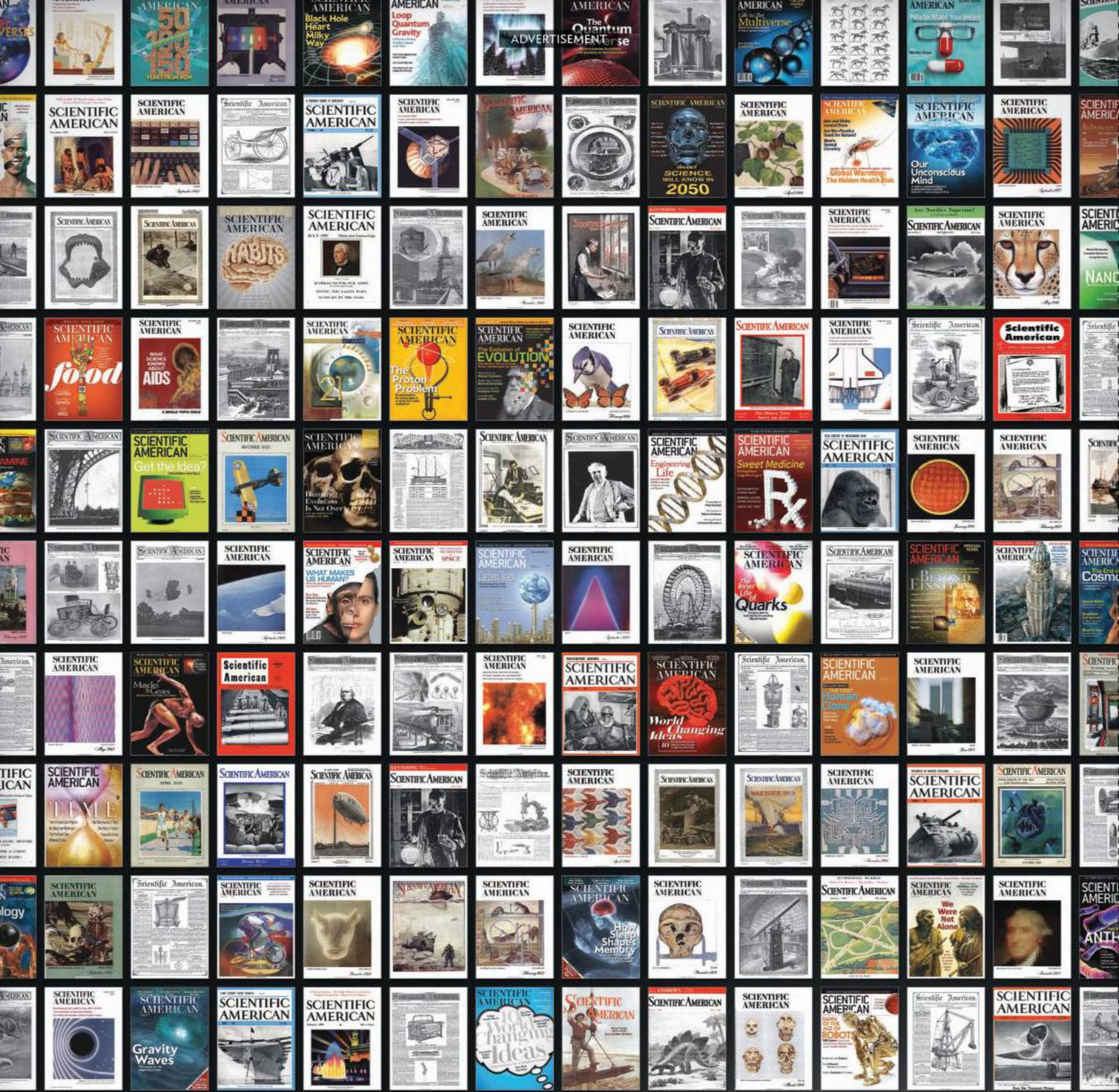
50 • 100 • 150 YEARS AGO



A new treasure hunt every month at scientificamerican.com/years

Travel back in time as chronicled in *Scientific American* 50, 100, and 150 years ago. Each month, our Senior Editors dust off a new collection of three vintage issues filled with fascinating science history frozen in time. View this month's treasures at www.scientificamerican.com/years

**SCIENTIFIC
AMERICAN™**



What issue are you looking for?

We discovered a lot in our long history. Now our award-winning Archives are available for purchase in digital format. Browse and download any single issue from any year—1845 to the present.

www.scientificamerican.com/archives

SCIENTIFIC AMERICAN™ | **THE ARCHIVES**

Copyright © 2014 by Scientific American, a division of Nature America, Inc. All rights reserved.

