11 ILLUSIONS CHALLENGE YOUR SENSE OF REALITY

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September/October 2012
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BRAIN MEDS
Why Drug Studies Need an Overhaul
page 34

How to Find Love in a Digital World

] WHAT SCIENCE SAYS [

SPECIAL REPORT: EDUCATION
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Meet Your Match

Curled up with a blanket, laptop and cup of tea, I checked my e-mails from the dating Web site I had recently joined. I had high hopes: much as I might hunt online for a new neighborhood café to try, I could now search for love just as systematically.

The messages I received told a different story. One suitor wrote: "Hey miss, dug your toe tag." (What!) Another: "You're asking for a lot in your profile (which is a bit boring I might add)." A third: "I stand out from the rest!! Reason 1 I am normal hehe LOL." My account did not stay active for long. "Dating in a Digital World," by Eli J. Finkel et al. on page 26, demystifies this psychological minefield, explaining the art of message writing and the ways online dating toys with our expectations. One tip for navigating these sites: strictly limit the time spent perusing profiles.

Reading numerous dating profiles taxes our working memory—a capacity that correlates with intelligence. New research shows that we can strengthen this ability to keep many items in mind. See "Building Better Brains," by John Jonides et al. on page 59, part of this issue's special report on education. Training working memory is one of several new approaches for improving learning. In "The Education of Character," on page 48, *Scientific American Mind*'s Ingrid Wickelgren visits a school that aims to augment children's academic skills by cultivating their self-control. Helping families manage chronic stress, which can harm young brains, also makes a difference, as Clancy Blair writes in "Treating a Toxin to Learning," on page 64.

Not all mental toxins can be countered with training. Unfortunately, many promising psychiatric drugs never reach the market. Gabriella Rosen investigates the common practices that may be causing clinical trials to fail in "Studying Drugs in All the Wrong People," on page 34.

Optimal mental health begins with self-knowledge. Whether seeking to crack the code for love or puzzling out a cipher in math class, let brain science be your guide.

Sandra Upson
Managing Editor
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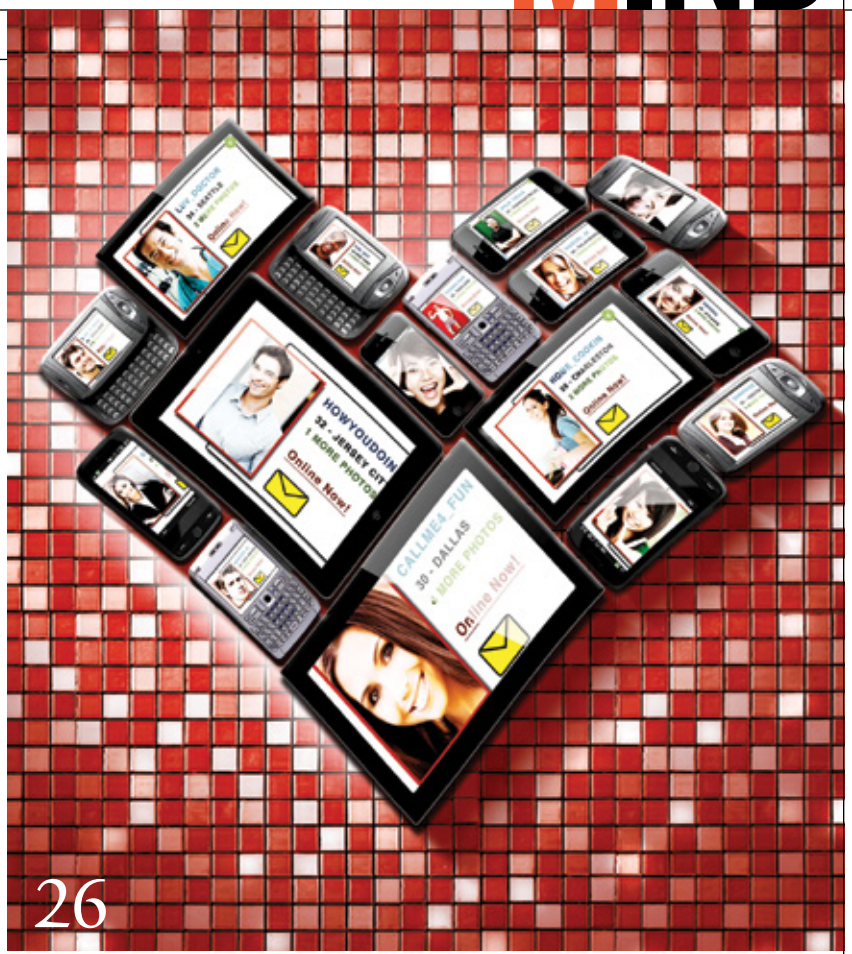
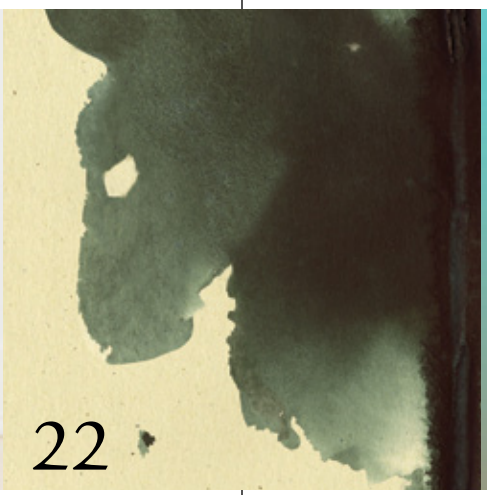
FEATURES



26

SPECIAL REPORT
EDUCATION

DEPARTMENTS



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FEELING FREE

I applaud Christof Koch for looking with fresh eyes into the puzzle of free will in "Finding Free Will." He is certainly correct that many of our overt actions are led by brain events we have no awareness of, and this can be a good thing. As William James once remarked, it's a good idea to run from the bear before you have a fully conscious experience of "bear." Drop a fragile object, and you react without getting tangled up in thought—the latter would be way too slow. But that says little about "the will to action" or the choice to do this or that "freely."

So the points of Koch's article are well taken, and I am delighted that he has both the courage and skills to pursue a topic that is as important as it is confusing.

The paradox, if there is one, is that I feel—right now—I am freely writing this. That is my internal response at the moment. Who knows what developmental histories in my life also contributed to this "free choice?" So scribble I do.

Neuroscientists and psychologists (and others) are becoming more alert to the fact that many of our critical brain "decisions" are nonconscious ones. The stories we construct come later, and these in themselves may have little to do with the true causal network that has been activated. In our stories we are free. Stories are stories. That may be it. But the phenomenology of sensed freedom is real.

I have no great (if any) insights into this but am delighted that the issues are being explored with the best tools we currently have available. I will not be surprised if, as the result of future analytical efforts, more surprises come down the road. I will be surprised if they don't.

John C. Fentress
Eugene, Ore.
commenting at
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LIFTED BY BELIEF

"Healthy Skepticism," by Sandra Upson, discusses the health and happiness of theists versus atheists in terms of community and like-minded people. Could it be that theists are healthier and happier (at least in part) because religion insulates/isolates the believers from the reality of the world around them? For instance, if you believe that you'll go to heaven, then you might find the unpleasantness of reality less depressing—God is testing you, and you want to pass the test, and this helps you have the strength to overcome the adversities you encounter.

Ted Grinthal
Berkeley Heights, N.J.

SUBTLY SWAYED

The highly interesting article "The Subtle Power of Hidden Messages," by Wolfgang Stroebe, failed to discuss one important item: the attitudinal effects of mere exposure, especially in those cases where the stimuli are presented either subliminally or masked by some other—distracting—stimuli.

To take just one of many more experiments: in 2004 Karl Szpunar of Harvard University and his colleagues found that music fragments were evaluated more positively the more they had been presented, at least when the subjects had not been listening to the music in a focused way but just heard it incidentally. Other investigators found similar results with polygons, photographs and other images that were administered subliminally.

Advertising in magazines and show bills in the street may work the same way.

It's not necessary that people *read* the messages. They probably don't even know which panels they have passed on the way to their office. But they may have noticed them incidentally, and so the repeated exposure gradually has been turning their attitude toward the positive. When they need something later on, the more positive attitude toward this particular product or brand name can (in addition to other influences, like the packing color) unconsciously influence the choice they make.

Pol Craeynest
Marke, Belgium

MIND-ALTERING METAPHORS

In regard to "This is Your Brain on Drugs," by Christof Koch [Consciousness Redux], we are to be surprised that taking hallucinogens results in reduced brain activity. After all, such drugs are called "consciousness-expanding" and "mind-expanding," based, I suppose, on the wow effect one experiences. Yet what are "consciousness-expanding" and "mind-expanding" supposed to mean? What actually expands? Wowness? Maybe the surprise is increased by a bad choice of hyperboles in the first place.

George Gillespie
Moorestown, N.J.

UP IN THE AIR

"The Aviator's Dilemma," by Stephen L. Macknik, Susana Martinez-Conde and Ellis C. Gayles, is a great article! The illusions that pilots experience were well explained. I flew as a passenger in navy P3 planes during the cold war, and it was easy to become somewhat disoriented flying between cloud layers that seem horizontal but aren't always actually horizontal; they form along pressure gradients rather than just altitude.

Not only that, but the relatively slow-moving P3 sometimes feels like it is flying backward after a great many hours of cruising. Not only does one get visual effects, but also auditory effects as one's ears try to make sense of the constant droning of engines and avionics. Sometimes I heard classical music—not like a replay in my mind, but I could actually hear it amid the droning of the engines. Knowing it was an illusion did not make it go away.

When you drop down to 500 feet above the oft-stormy sea to inspect a ship, you depend almost entirely on the radar altimeter and attitude indicator because there is no horizon, and you have absolutely no idea whether you are too close to little waves or adequately high above really big waves—it all looks the same. Then you finally see the ship and realize the waves are *really* big, twice the distance crest to crest as a supertanker is long.

"mggordon"
commenting at
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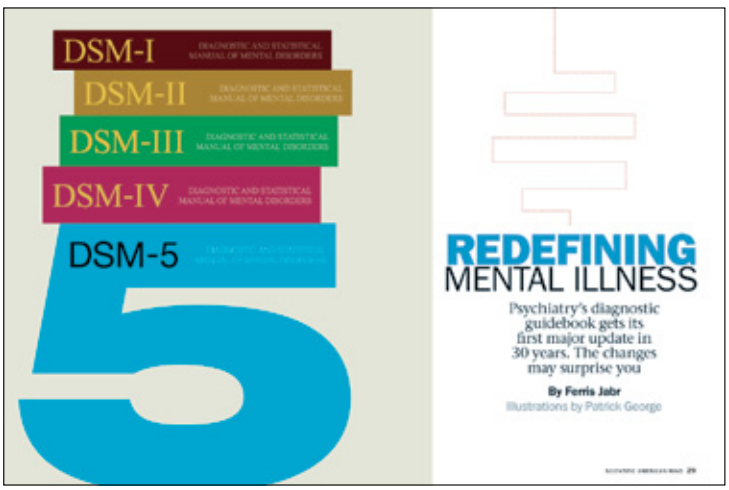

Is there a way to diagnose mentally ill patients as per psychiatry's diagnostic manual without losing sight of each individual's needs?

INTERPRETING THE "BIBLE"

In "Redefining Mental Illness," Ferris Jabr writes, "Although many psychiatrists do not sit down with the *DSM* and take its scripture literally …"

This is an important caveat. And it illustrates why more attention needs to be drawn not to what's in the book but to how the book is used.

As a practicing psychiatrist, I agree with Jabr that many clinicians rely "on personal expertise to make a diagnosis." What we are forced to write in the chart, however, is dictated by the *DSM*. From that point on, the diagnosis—NOT the patient—becomes the focus of treatment. The diagnosis serves as a gateway not only to a wide range of social services—which could be beneficial—but also to a potential lifetime of medication trials and other ill-advised treatments.

Most psychiatrists view the *DSM* and the diagnostic process as a necessary evil: "necessary" for reimbursement and to be able to help the people who seek our assistance but "evil" because in many systems the assistance we provide is dictated by the diagnosis, not by the unique needs of the individual.

"SteveBaltMD"
commenting at
www.Scientific
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POST-STRESS DISORDER

I am not sure what is new about Scott O. Lilienfeld and Hal Arkowitz's article "When Coping Fails: Revisiting the Role of Trauma in PTSD" [Facts and Fictions in Mental Health]. Complex PTSD (C-PTSD), proposed for inclusion in the *DSM-V*, was described in 1992 by trauma expert Judith Herman in her classic *Trauma and Recovery* (Basic Books). The notion, in a nutshell, is that various life stressors and events can collectively lead to PTSD-like symptoms and conditions, which may be remediated via treatments used for conventional PTSD, notably EMDR [eye movement desensitization and reprocessing].

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KATY LEMAY

>> PRIMING

Childhood Memories Serve as a Moral Compass

Thoughts of innocent times prompt ethical behavior

Recalling childhood memories can lead people to behave more ethically, according to a study published in April in the *Journal of Personality and Social Psychology.*

In a series of experiments done by Francesca Gino and Sreedhari Desai of Harvard University, participants were more likely to help the experimenters with an extra task, judge unethical behavior harshly and donate money to charity when they had actively remembered their childhood (as opposed to their teenage years). The effect held whether the memories were positive or negative—although, notably, the study subjects did not have traumatic histories.

These recollections seem to summon a heightened sense of moral purity. Youngsters may or may not behave especially ethically, but childhood tends to connote innocence—a frame of mind that affects behavior. "It's promising research in thinking about ways in which people are following their moral compass with very simple interventions," Gino says. Possible applications might include posting subway signs encouraging people to remember what it was like to be a kid or decorating workplaces with stuffed animals. —*Jessica Gross*

MIMICRY

Peer Pressure Starts Early

Toddlers and apes copy the crowd to learn a task

ANGELA AUCLAIR *Getty Images (left)*; GETTY IMAGES *(right)*

This may come as painful news to parents: toddlers are more likely to copy the actions of a crowd than those performed by one person, according to new research in *Current Biology*.

"When we think of peer pressure, we think of teenagers and the reasons they start smoking or drinking," says Daniel Haun of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. "We don't necessarily think of two-year-olds as being under peer pressure. But it turns out they are."

To investigate peer pressure's origins, Haun observed human toddlers and chimpanzees as they learned a simple task: placing a ball into one of three boxes. First the subjects watched other members of their species do it—both as one individual placed a ball three times into one box and as three individuals placed one ball each into a second box.

When it was the observer's turn, both humans and chimps tended to choose the box that was used by the majority. The chimps were even more prone than the children to copy the group. This tendency to conform might have provided an evolutionary benefit that helped humans learn new skills and avoid dangers. "If you know nothing, following the majority isn't a bad strategy," Haun says.

Haun now wants to see if chimps and toddlers, when performing a familiar task, might switch their behavior to fit with the majority, even if they know that the group is wrong. Such behavior has been observed in older children, although whether it serves any evolutionary advantage is less obvious. *—Ruth Williams*

PREFERENCES

Enchanted by Our Own Words

Talking about our opinions and experiences is worth more than money

People devote 30 to 40 percent of their total speaking time to describing their own opinions or experiences, according to much research. A new study suggests that self-expression is intrinsically rewarding, in the same way that sex or eating is. In fact, we find talking about ourselves so pleasurable that we will give up money to do so, as reported in the May 22 *Proceedings of the National Academy of Sciences USA*.

Diana Tamir and Jason Mitchell of Harvard University used functional MRI to study 195 volunteers between the ages of 18 and 27. They found that when the subjects talked about their opinions or their own personality, the pathways of the brain that register reward—known as the mesolimbic dopamine system—were far more active than when they judged the opinions or personalities of others.

In another experiment, participants were asked to choose several questions to answer from three categories: an inquiry about their own likes and dislikes, an invitation to guess about President Barack Obama's likes and dislikes, or a factual trivia question. The subjects earned between a penny and four cents a question, depending on the category. Although the subjects could have consistently chosen questions to maximize their profit, they preferred to answer the personal queries, forfeiting 54 to 63 cents per trial to talk about themselves.

The findings do not mean we are self-absorbed egotists, the researchers say. Telling others about ourselves helps to bring us together. "One of the ultimate functions of this behavior is social cohesion," Tamir says. *—Harvey Black*

PAIN

Brain Freeze Explained

Cold drinks cause a major artery in the skull to dilate

MARK GIBSON *iStockphoto*

Ice cream headache is a familiar summertime sensation, but the pain's source has been mysterious until now. A team led by Jorge Serrador of Harvard Medical School produced brain scans of "second-by-second changes" in blood flow while subjects sipped iced water through a straw pressed against the roof of the mouth, which caused the brain's major artery to widen. "Blood flow changes actually preceded the pain" that subjects reported, Serrador says. As the vessel narrowed again, the discomfort ebbed. He suspects that the influx of blood is meant to protect the brain from extreme cold and that increased pressure inside the skull could cause the pain. Serrador presented the results at Experimental Biology 2012 in April in San Diego. ***—Stephani Sutherland***

MIND-BODY CONNECTION

How Chronic Pain Affects Memory and Mood

Constant discomfort may halt neuron growth in the hippocampus

Anyone living with chronic pain knows that it amounts to much more than an unpleasant bodily sensation. Fuzzy thinking, faulty memory, anxiety and depression often accompany long-term pain, suggesting that the condition is more of a whole-brain disorder than simply pain signaling gone haywire. New research from Northwestern University reveals a possible cause: an impaired hippocampus, a region critical for learning, memory and emotional processing.

Using anatomical brain scans, the researchers found that people suffering from chronic back pain or complex regional pain syndrome had a smaller hippocampus than healthy people. They then studied mice for further clues about how this region

contributes to chronic pain's cognitive side effects. As reported April 25 in the *Journal of Neuroscience,* mice in chronic pain had trouble with a test of emotional learning, and they displayed greater anxietylike behaviors than normal mice. In the hippocampus, electrical and biochemical signaling was disrupted. Perhaps most striking was the mice's failure to produce new neurons in the hippocampus—one of the few brain areas where adult mice and humans can grow new neurons.

Lead researcher A. Vania Apkarian suspects that the hippocampal size difference seen in humans might reflect the lack of neuron growth and other problems seen in the mice. Without new neurons forming, memory and emotional processes would also become impaired. The work underscores the importance of treating "the suffering we associate with chronic pain" as a brain-based disorder, Apkarian says, in addition to trying to target its perceived source in the body. —*Stephani Sutherland*

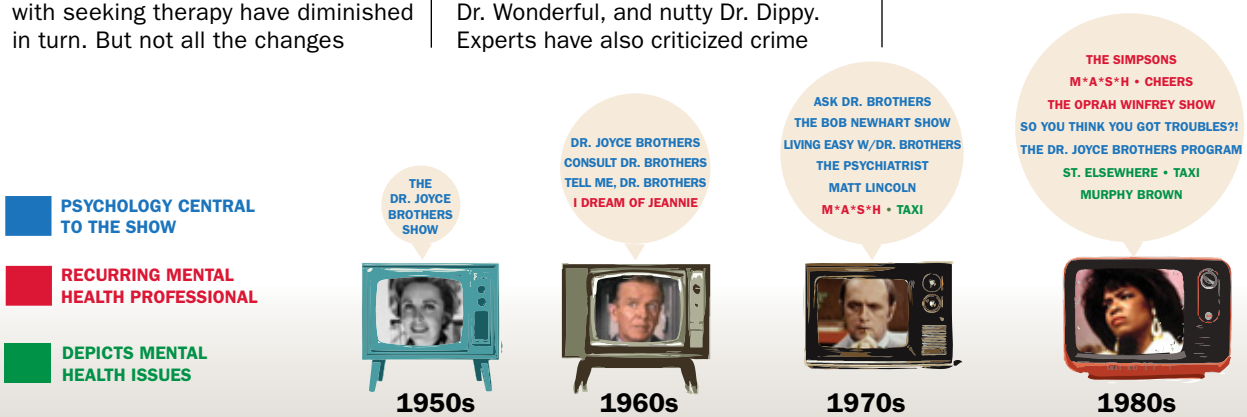
TING HOO Getty Images (person in pain); COMPLEX STORIES (TV timeline)

22 Percentage of heterosexual couples in the U.S. who met online.

Data are from 2007 to 2009—see page 26 for more

Psychology: As Seen on TV!

In 1958 psychologist Joyce Brothers was a lone voice sharing sex and relationship advice on television. Today mental health issues dominate TV programming, and stigmas linked with seeking therapy have diminished in turn. But not all the changes are positive. In 1987 psychiatrist Irving Schneider observed three main caricatures of mental health professionals that still linger in popular culture: the sadistic Dr. Evil, perfect Dr. Wonderful, and nutty Dr. Dippy. Experts have also criticized crime dramas for overrepresenting the mentally ill as violent. Tropes notwithstanding, the rising presence of psychology on TV makes one thing clear: the doctor is on! –*Daisy Yuhas*



FROM "RESTING-STATE QUANTITATIVE ELECTROENCEPHALOGRAPHY REVEALS INCREASED NEUROPHYSIOLOGIC CONNECTIVITY IN DEPRESSION," BY ANDREW F. LEUCHTER ET AL., IN *PLOS ONE*, VOL. 7, NO. 2: FEBRUARY 24, 2012

BRAIN IMAGING

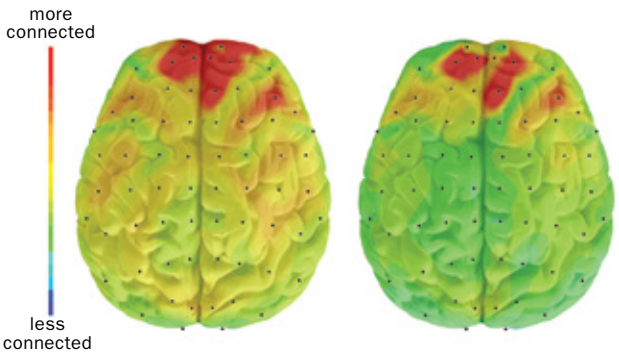
The Depression Connection

Brain regions may communicate excessively in depression

Like an overwhelmed traffic cop, the depressed brain may transmit signals among regions in a dysfunctional way. Recent brain-imaging studies suggest that areas of the brain involved in mood, concentration and conscious thought are hyperconnected, which scientists believe could lead to the problems with focus, anxiety and memory frequently seen in depression.

Using functional MRI and electroencephalography (EEG), psychiatrist Andrew Leuchter of the University of California, Los Angeles, and his colleagues measured the activity of depressed patients' brains at rest. They found that the limbic and cortical areas, which together produce and process our emotions, sent a barrage of neural messages back and forth to one another—much more than in the brains of healthy patients. These signals, Leuchter says, can amplify depressed people's negative thoughts and act like white noise, drowning out the other neural messages telling them to move on.

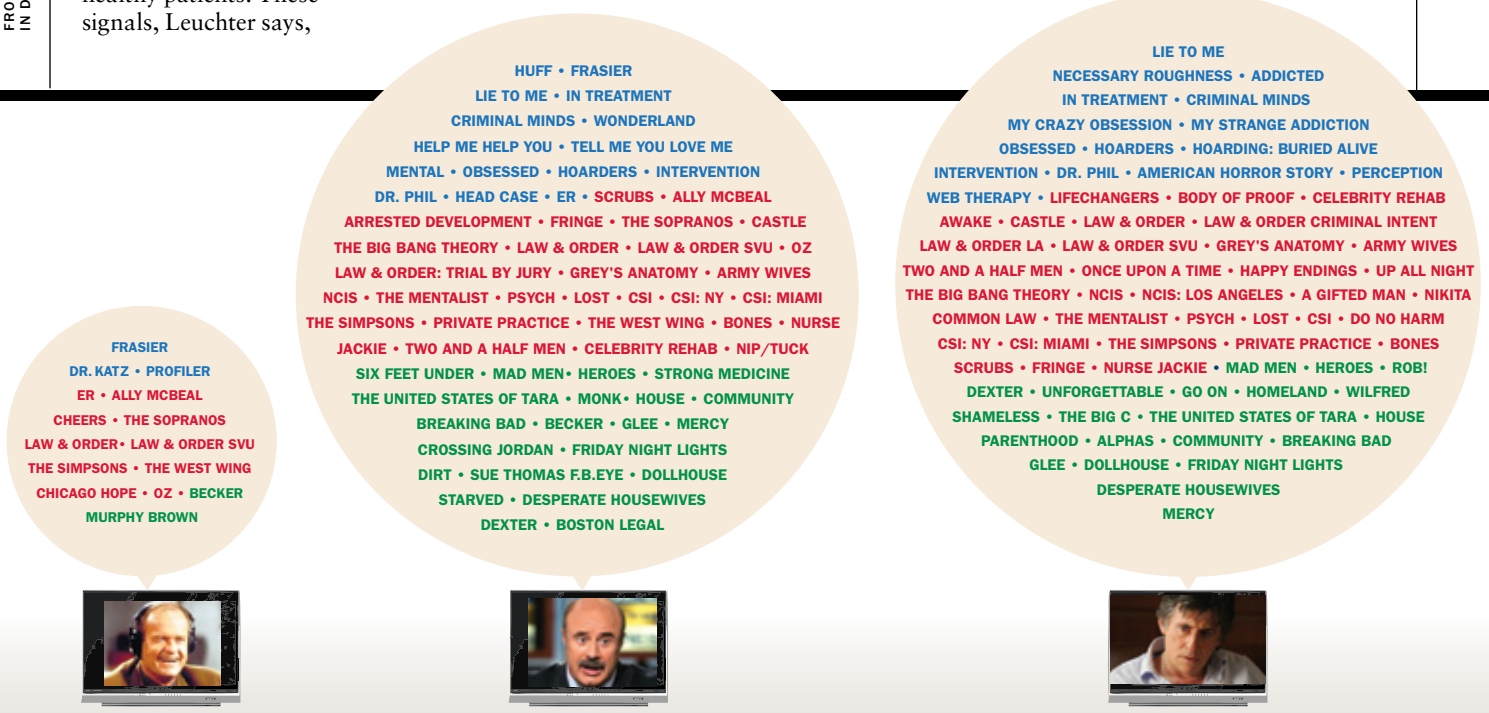
A separate study by psychiatrist Shuqiao Yao of Central South University in Hunan, China, produced a more nuanced view of these two areas' hyperconnectivity. In work published in *Biological Psychiatry* in April, Yao and his colleagues reported that stronger links among certain corticolimbic circuits are seen in patients more prone to rumination, the act of continuously replaying negative thoughts. Less connectivity in other corticolimbic circuits corresponded to autobiographical memory impairments, which is another common feature that appears in depression.



EEG data reveal how tightly connected the frontal cortex (*red*) is to the rest of the brain in depression (*left*) and health (*right*).

Scientists do not know whether these connectivity changes are a cause or an effect of depression. A study earlier this year in *Proceedings of the National Academy of Sciences USA*, however, found that electroconvulsive therapy—formerly known as shock therapy—both alleviates depression's symptoms and decreases connectivity in the hub where the cortical and limbic systems intersect. These results, says lead author Jennifer S. Perrin, a psychologist at the University of Aberdeen in Scotland, confirm that hyperconnectivity is a hallmark of depression in the brain and should provide a target for new drugs and treatments.

—*Carrie Arnold*



50

Approximate number of species in which homosexual behavior has been well documented.

>> SOCIAL BEHAVIOR

Rudeness on the Internet

Mean comments arise from a lack of eye contact more than from anonymity

Read any Web forum, and you'll agree: people are meaner online than in "real life." Psychologists have largely blamed this disinhibition on anonymity and invisibility: when you're online, no one knows who you are or what you look like. A new study in *Computers in Human Behavior,* however, suggests that above and beyond anything else, we're nasty on the Internet because we don't make eye contact with our compatriots.

Researchers at the University of Haifa in Israel asked 71 pairs of college students who did not know one another to debate an issue over Instant Messenger and try to come up with an agreeable solution. The pairs, seated in different rooms, chatted in various conditions: some were asked to share personal, identifying details; others could see side views of their partner's body through webcams; and others were asked to maintain near-constant eye contact with the aid of close-up cameras attached to the top of their computer.

Far more than anonymity or invisibility, whether or not the subjects had to look into their partner's eyes predicted how mean they were. When their eyes were hidden, participants were twice as likely to be hostile. Even if the subjects were both unrecognizable (with only their eyes on screen) and anonymous, they rarely made threats if they maintained eye contact. Although no one knows exactly why eye contact is so crucial, lead author and behavioral scientist Noam Lapidot-Lefler, now at the Max Stern Yezreel Valley College in Israel, notes that seeing a partner's eyes "helps you understand the other person's feelings, the signals that the person is trying to send you," which fosters empathy and communication.

—Melinda Wenner Moyer

>> LIE DETECTION

Group Interrogation Reveals Liars

Together suspects' speech patterns may indicate their trustworthiness

Interrogate suspects separately and get them to incriminate one another—that's how cops do it. New research suggests that a better way to catch colluding criminals might be to interview them together.

In a recent experiment in the *Journal of Applied Research in Memory and Cognition* with more than 40 pairs of subjects, half were told to steal £10 and then convince an interviewer of their innocence. The other pairs were told the money had gone missing. The truth tellers interrupted one another four times as often and were much more likely to add to or correct their friend's account. The liars said less and hardly interrupted.

The deceivers were not simply more taciturn, however. "It's a myth to think suspects are reluctant to talk," says social psychologist Aldert Vrij of the University of Portsmouth in England. "Mainly U.S. police manuals promote this myth." Further, in the antiterrorism situations for which Vrij's research is designed, a "no comment" could lead a person to be taken off a plane or denied entry to a country. Because liars must talk in such situations, an interviewer who paid attention to a pair's interruptions and contradictions might better tell truth from fiction than one seeking only suspicious silent types. [For more on how to spot a scoundrel, see page 70.]

A simple, straightforward narrative only hints at falsehoods when suspects share a cover story, Vrij says. One truth teller and one liar in a pair will act differently from either two liars or two truth tellers.

Because many terrorist acts are planned by groups, this finding suggests group interviews can be a useful tool for law enforcement and border patrols. As Vrij explains, "truth tellers' interaction with one another comes naturally and is not natural for liars."

—Rachel Kaufman

GOLDMUND LUKIC /*Stockphoto (woman)*; HEIDI KRISTENSEN /*Stockphoto (laptop)*; JOHN LUND AND SAM DIEPHUIS *Getty Images (lineup)*

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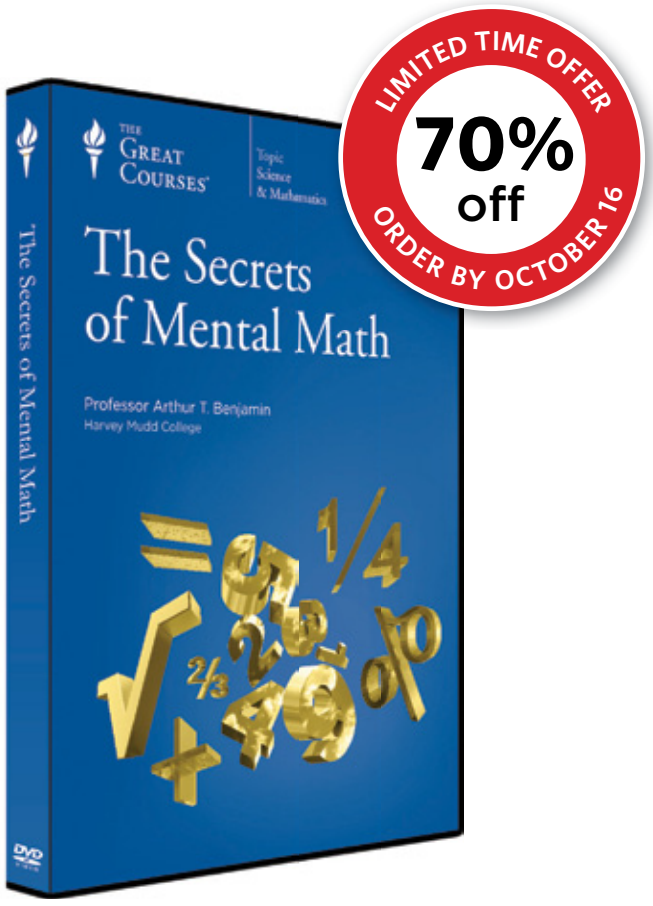

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2 Number of species known to experience RUNNER'S HIGH—humans and dogs.

SIDE EFFECTS

Botox Fights Depression

The wrinkle treatment prevents face muscles from registering negative emotions

A common complaint about wrinkle-masking Botox is that recipients have difficulty displaying emotions on their faces. That side effect might be a good thing, however, for people with treatment-resistant depression.

In the first randomized, controlled study on the effect of botulinum toxin—known commercially as Botox—on depression, researchers investigated whether it might aid patients with major depressive disorder who had not responded to antidepressant medications. Participants in the treatment group were given a single dose (consisting of five injections) of botulinum toxin in the area of the face between and just above the eyebrows, whereas the control group was given placebo injections. Depressive symptoms in the treatment group decreased 47 percent after six weeks, an improvement that remained through the 16-week study period. The placebo group had a 9 percent reduction in symptoms. The findings appeared in May in the *Journal of Psychiatric Research*.

Study author M. Axel Wollmer, a psychiatrist at the University of Basel in Switzerland, believes the treatment "interrupts feedback from the facial musculature to the brain, which may be involved in the development and maintenance of negative emotions." Past studies have shown that Botox impairs people's ability to identify others' feelings, and the new finding adds more evidence: the muscles of the face are instrumental for identifying and experiencing emotions, not just communicating them.

—Tori Rodriguez

INFECTIONS

Common Parasite Linked to Personality Changes

Eating a raw steak or owning a cat can make you more outgoing

Feeling sociable or reckless? You might have toxoplasmosis, an infection caused by the microscopic parasite *Toxoplasma gondii,* which the CDC estimates has infected about 22.5 percent of Americans older than 12 years old. Researchers tested participants for *T. gondii* infection and had them complete a personality questionnaire. They found that both men and women infected with *T. gondii* were more extroverted and less conscientious than the infection-free participants. These changes are thought to result from the parasite's influence on brain chemicals, the scientists write in the May/June issue of the *European Journal of Personality.*

"*Toxoplasma* manipulates the behavior of its animal host by increasing the concentration of dopamine and by changing levels of certain hormones," says study author Jaroslav Flegr of Charles University in Prague, Czech Republic.

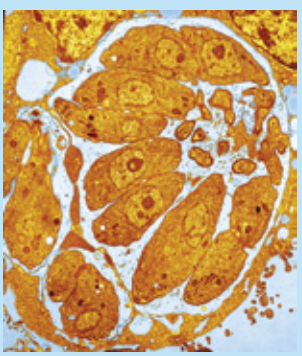
Although humans can carry the parasite, its life cycle must play out in cats and rodents. Infected mice and rats lose their fear of cats, increasing the chance they will be eaten, so that the parasite can then reproduce in a cat's body and spread through its feces [see "Protozoa Could Be Controlling Your Brain," by Christof Koch, Consciousness Redux; SCIENTIFIC AMERICAN MIND, May/June 2011].

In humans, *T. gondii*'s effects are more subtle; the infected population has a slightly higher rate of traffic accidents, studies have shown, and people with schizophrenia have higher rates of infection—but until recent years, the parasite was not thought to affect most people's daily lives.

In the new study, a pattern appeared in infected men: the longer they had been infected, the less conscientious they were. This correlation supports the researchers' hypothesis that the personality changes are a result of the parasite, rather than personality influencing the risk of infection. Past studies that used outdated personality surveys also found that toxoplasmosis-related personality changes increased with the length of infection.

T. gondii is most commonly contracted through exposure to undercooked contaminated meat (the rates of infection in France are much higher than in the U.S.), unwashed fruits or vegetables from contaminated soil, and tainted cat litter. The parasite is the reason pregnant women are advised not to clean litter boxes: *T. gondii* can do much more damage to the fetal brain than the personality tweak it inflicts on adults.

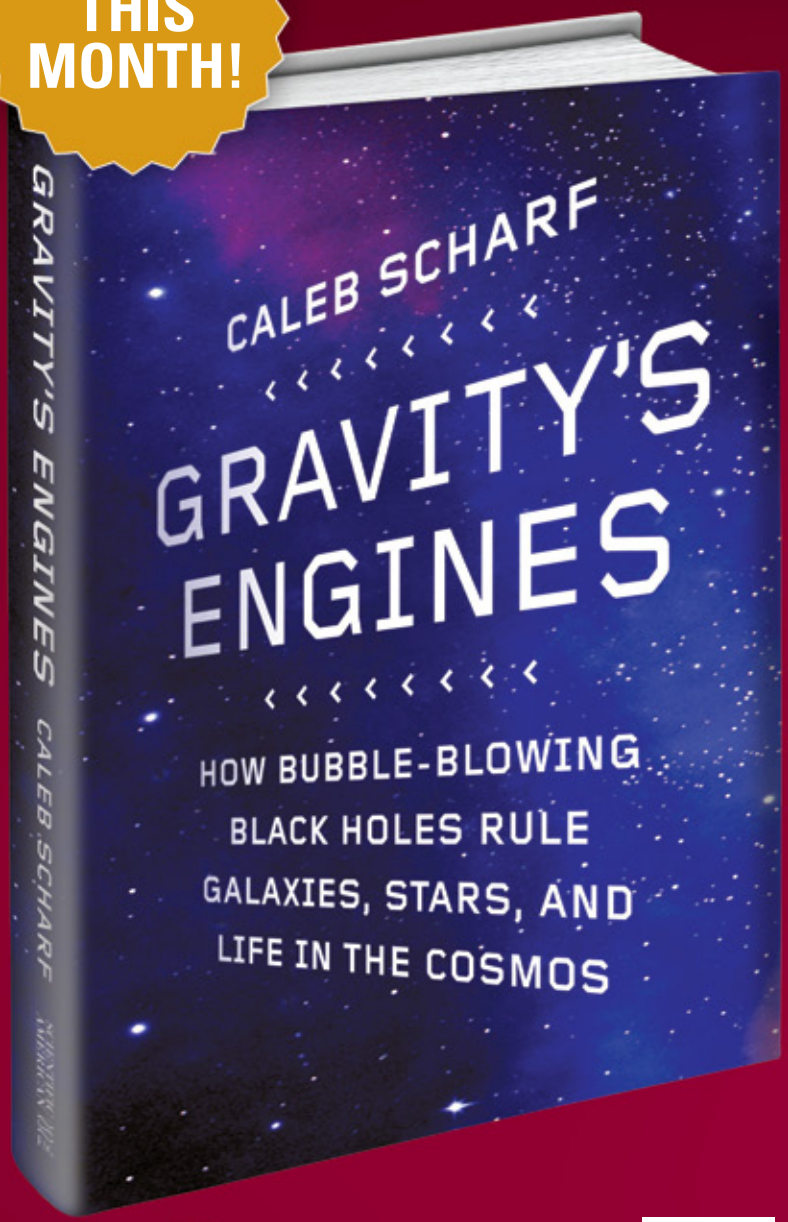
—Tori Rodriguez



***Toxoplasma gondii* in a human cell.**

CORBIS (*top*); KLAUS BOLLER *Photo Researchers, Inc.* (*bottom*)

NEW THIS MONTH!



"Caleb Scharf is a lively and eloquent writer as well as a fine scientist. *Gravity's Engines* is particularly welcome because it presents topics at the frontiers of our understanding that have not hitherto been presented so clearly to a general readership."

—MARTIN REES, author of *Just Six Numbers*

"Scharf's fun book takes you behind the scenes of the universe itself to see how the celestial heavyweights we call black holes help shape the cosmos."

—SEAN CARROLL, author of *From Eternity to Here*

"Scharf tells the mind-blowing story of 'supermassive' black holes, the true masters of the universe . . . They might appear esoteric and remote, but as Scharf explains, life on Earth may have been utterly impossible without them."

—MARCUS CHOWN, author of *The Matchbox That Ate a Forty-Ton Truck*

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THE EARTH FROM SPACE

Gary Lagerloef, Ph.D.

Earth From Space: A Dynamic Planet

The world's space programs have long focused on measurements of Earth. NASA has more than a dozen satellites collecting data on weather, climate change, the land, ocean and polar regions. They reveal Earth's dynamic biosphere, atmosphere, oceans and ice. Get a guided tour of an active and dynamic Earth with amazing and astonishing images and videos.

The Oceans Defined

Satellites have greatly enhanced the exploration & understanding of our oceans. From early weather satellite images detailing ocean currents to views of the marine biosphere, new satellite technologies have revolutionized our scientific understanding of the oceans. Find out what we can measure from space today, objectives of measurement, the amazing technology behind these abilities, and the latest compelling discoveries.

Climate Science in the Space Age

Climate variability and change are among the most important societal issues of our time. Signs of rising global temperatures are obvious in meteorology and oceanography. We'll discuss short, medium and long-term climate variability & change. You'll gain perspectives to effectively sort through contemporary debate about climate change.

The Aquarius/SAC-D Satellite Mission

Take an in-depth look at the Aquarius/SAC-D mission, an oceanographic partnership between the United States and Argentina. Get a behind-the-scenes look at the process of developing and launching a new satellite mission, a briefing on the core scientific mission, and a look at initial findings. Dive into a session that ties together mission, data, and applied science.

GEOLOGY

Speaker: Victor A. Ramos, Ph.D.

The Patagonia Terrain's Exotic Origins

Did Patagonia evolve as an independent microcontinent that fused with South America 265 million years ago? Dr. Ramos will give you the latest theory on the complex development of Patagonia. We'll look at the geologic evidence of Patagonia's close relationships with Antarctica, Africa, and South America, plus archaeological evidence suggestive of Patagonia's origins.

The Islands of the Scotia Arc

Delve into the dynamic nature of South Georgia and the South Sandwich and South Orkney Islands on the Scotia Plate, one of the youngest, and most active tectonic plates. Deepen your understanding of the geology, ecosystems, and history of the Scotia Arc, part of the backbone of the Americas.

The Andes: A History of Earthquakes and Volcanoes

Unfold deep time and learn how South America took shape. Get the details on how the Andes formed, how active Andean volcanoes are, the Andes as a unique climate change laboratory, and lessons learned from the Chilean earthquakes of 1960 and 2011. All certain to give you geologic food for thought on your voyage around the Horn.

Darwin in Southern South America

Darwin's voyage on the Beagle is an incredibly rich scientific and human adventure. Learn the highlights of HMS Beagle's mission in South America in 1833–1835, including Darwin's geological and biological observations. Gain a sense of South America's role in Darwin's life work, and an understanding of his contribution in the context of contemporary science.

PHYSICS

Speaker: Lawrence Krauss, Ph.D.

The Elusive Neutrino

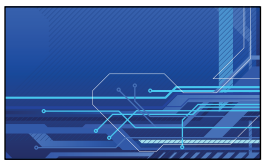
Neutrinos are the most remarkable elementary particles we know about. They are remarkable probes of the Universe, revealing information about everything from exploding stars to the fundamental structure of matter. Dr. Krauss will present a historical review of these elusive and exciting objects, and leave you with some of the most remarkable unsolved mysteries in physics.

The Physics of Star Trek

Join Lawrence Krauss for a whirlwind tour of the Star Trek Universe and the Real Universe — find out why the latter is even more exotic than the former. Dr. Krauss, the author of The Physics of Star Trek, will guide you through the Star Trek universe, which he uses as a launching pad to the fascinating world of modern physics.

Space Travel: Why Humans Aren't Meant for Space

The stars have beckoned humans since we first looked at the night sky. Humans set foot on the Moon over 40 years ago, so why aren't we now roaming our solar system or the galaxy in spacecraft? Dr. Krauss describes the daunting challenges facing human space exploration, and explores the realities surrounding our hopes for reaching the stars.



NANOSCIENCE

Chris Sorensen, Ph.D.

Fire, Fractals and the Divine Proportion

Physicist Chris Sorenson discusses the mysteries, beauties, and curiosities of soot. Take an unlikely journey of discovery of soot to find fractal structures with non-Euclidian dimensionality, networks that tenuously span space and commonalities among spirals, sunflowers and soot. Gain an appreciation for the unity of Nature, and the profound lessons in the commonplace as well as the sublime through soot!

Light Scattering

Take a *particle* physics perspective and ask: how do particles scatter light and why does light scatter in the first place? What are the effects of scattering on the polarization? How do rainbows, glories and sundogs work? How do light scattering and absorption effect the environment? Get the latest on scattering and see your universe in a new light.

Nanoparticles: The Technology.

Nanoscience has spawned a significant nanotechnology. Explore new nanomaterials such as self cleaning surfaces and fibers stronger yet lighter than steel. Then we'll do some informed daydreaming about far reaching possibilities like nanobots that could take a "fantastic voyage" inside your body or stealth materials for the invisible man. Enjoy reality science fiction at its best!

Nanoparticles: The Science.

What makes "nano" so special? Why does nano hold such great promise? Take a look at the clever chemistry that creates the nanoparticle building blocks of the new nanomaterials. Find out why physical properties of nanoparticles differ from larger particles. When this session is over, you'll understand why small can be better.

ASTROBIOLOGY

Speaker: Seth Shostak, Ph.D.

Hunting for Life Beyond Earth

Is Earth the only planet to sport life? Researchers are hot on the trail of biology beyond Earth, and there's good reason to think that we might find it within a decade or two. How will we find alien biology, and what would it mean to learn that life is not a miracle, but as common as cheap motels?

Finding E.T.

Life might be commonplace, but what about intelligent life? What's being done to find our cosmic confreres, and what are the chances we'll discover them soon? While most people expect that the cosmos is populated with anthropomorphic aliens aka "little gray guys with large eyes and no hair" you'll hear that the truth could be enormously different.

What Happens If We Find the Aliens?

One-third of the public believes that aliens are visiting Earth, pirouetting across the skies in their saucers. Few scientists agree, but researchers may soon discover intelligent beings sharing our part of the galaxy. Could we handle the news? What facts could be gleaned immediately, and what would be the long-term effects such a discovery would have on us and our institutions, such as religion?

The Entire History of the Universe

Where and when did the cosmos begin, and what's our deep, deep future? The book of Genesis gives only a short description of the birth of the cosmos, but modern science can tell a more complex tale. How did the universe get started, and could there be other universes? And how does it all end, or does it end at all?

SKEPTICISM

Speaker: Michael Shermer, Ph.D.

The Believing Brain: From Ghosts and Gods to Politics and Conspiracies — How We Construct Beliefs and Reinforce Them as Truths

The brain as a "belief engine"? Learn how our brains' pattern-recognition and confirmation bias help form and reinforce beliefs. Dr. Shermer provides real-world examples of the process from politics, economics, and religion to conspiracy theories, the supernatural, and the paranormal. This discussion will leave you confident that science is the best tool to determine whether beliefs match reality.

Skepticism 101: How to Think Like a Scientist

Harvest decades of insights for skeptical thinking and brush up on critical analysis skills in a lively session that addresses the most mysterious, controversial, and contentious issues in science and skepticism. Learn how to think scientifically and skeptically. You'll see how to be open-minded enough to accept new ideas without being *too* open-minded.

The Science of Good and Evil: The Origins of Morality and How to be Good Without God

Tackle two challenging questions of our age with Michael Shermer: (1) The origins of morality and (2) the foundations of ethics. Dr. Shermer peels back the inner layers covering our core being to reveal complex human motives — good and evil. Gain an understanding of the evolutionary and cultural underpinnings of morality and ethics and how these motives came into being.

The Mind of the Market: Compassionate Apes, Competitive Humans, and Other Lessons from Evolutionary Economics

How did we evolve from ancient hunter-gatherers to modern consumer-traders? Why are people so irrational when it comes to money and business? Michael Shermer argues that evolution provides an answer to both of these questions through the new science of evolutionary economics. Learn how evolution and economics are both examples of complex adaptive systems. Get your evolutionary economics tools together.

SCIENTIFIC AMERICAN Travel HIGHLIGHTS

IGUAZU FALLS

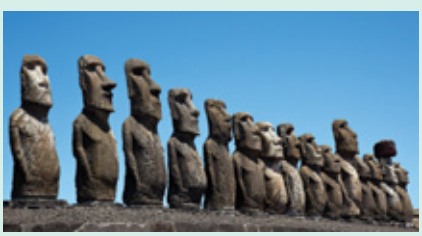
March 5–7, 2013 — Surround yourself with 260 degrees of 240 foot-high walls of water at Iguazu Falls. Straddling the Argentinian-Brazilian border, Iguazu Falls is split into about 270 discrete falls and at peak flow has a surface area of 1.3 million square feet. (By comparison, Niagara Falls has a surface area of under 600,000 square feet.) Iguazu is famous for its panoramic views and breath-taking vistas of huge sprays of water, lush rainforest, and diverse wildlife.

You'll walk Iguazu National Park's extensive and well-engineered circuit paths over the Falls, go on a boat ride under the Falls, be bowled over by the massiveness and eco-beauty, and take a bazillion pictures.

MACHU PICCHU

February 15–20, 2013 — Scale the Andes and absorb Machu Picchu's aura. Visit this legendary site of the Inca World, draped over the Eastern slopes of the Peruvian, wrapped in mystery. Whether it was an estate for the Inca emperor Pachacuti or a site for astronomical calculations, it captures the imagination. Visit Machu Picchu, and see for yourself the massive polished dry-stone structures, the Intihuatana ("Hitching Post of the Sun"), the Temple of the Sun, and the Room of the Three Windows. Iconic ruins, rich flora and fauna, and incomparable views await your eye (and your lens).

EASTER ISLAND



Febrruary 16–20, 2013 — The moai of Easter Island linger in many a mind's eye, monumental statues gazing inland, away from the South Pacific. Join Bright Horizons on a four-day pre-cruise excursion to explore the mysteries of Rapa Nui. Visit archaeological sites, learn about the complex cultural and natural history of the island, and absorb the ambiance of one of the most remote communities on Earth. Come along on an adventure where archaeology and environment create memories and food for thought.

GALAPAGOS

February 12–20, 2013 — Enter an unearthly natural world in an eight-day pre-cruise excursion to the Galapagos Islands. "See the world in a grain of sand" and hone your knowledge of evolution with your observations in the Galapagos, a self-contained natural history laboratory. We'll tour Santiago, Chile, and straddle the Equator at the "Middle of the World" complex in Quito, Ecuador. Then off to the Galapagos for a four-day expedition on the mv Galapagos Legend. Accompanied by certified naturalists see the incredibly diverse flora and fauna up close. You'll have the opportunity to swim and snorkel, and photograph legendary wildlife and wild landscapes. Join Bright Horizons in the Galapagos for all the intangibles that communing with nature provides.

>> NEURODEGENERATION

Could an Epilepsy Drug Prevent Alzheimer's?

Decreasing brain activity improves memory in people with early dementia

Years before a person is disabled by Alzheimer's disease, the memory problems of mild cognitive impairment (MCI) start causing difficulty in daily life. Research published in May in *Neuron* suggests that a drug currently used for epilepsy might improve sufferers' cognition—and perhaps even slow the progression of the disease—by quieting activity in the hippocampus.

Past research has found that people with MCI have an overactive hippocampus, the brain region associated with memory function. Whether this activity causes memory impairment or is the brain's way of compensating has been a matter of debate, but the new work suggests that the increased activity is indeed the culprit behind memory loss.

In the study, researchers gave 17 people with MCI an antiepilepsy drug called levetiracetam. "There had been studies showing that this drug was particularly effective in this piece of the brain," explains Michela Gallagher of Johns Hopkins University, who led the study. The drug reduced activity in the patients' hippocampus and, more important, improved their performance on a memory test.

Gallagher thinks that the drug might even slow or stop the decline into Alzheimer's. Higher levels of neural activity are linked to a faster buildup of amyloid-beta protein, which is the hallmark "plaque" of Alzheimer's pathology. If levetiracetam can suppress hippocampal activity, it might slow plaque deposition and thus slow the disease's progression—a hypothesis that Gallagher is eager to test next.

—Ruth Williams

>> ANXIETY DISORDERS

Compulsions Can Follow Trauma

Obsessive-compulsive behaviors may alleviate post-traumatic stress in some patients

Obsessive-compulsive disorder (OCD) is usually treated as a stand-alone mental illness. A growing body of research is now finding that some cases of OCD may stem from trauma. For these patients, successful treatment may hinge on targeting the coexisting post-traumatic stress disorder (PTSD).

Over the past decade researchers have discovered that for some people, obsessive behaviors such as repetitive washing or hoarding may be a way of coping with post-traumatic stress. In a 2003 study of patients with both disorders, psychiatrist Beth R. Gershuny of Bard College found that as OCD symptoms decreased with treatment, PTSD symptoms—such as flashbacks and nightmares—became worse. She more recently showed that 82 percent of treatment-resistant OCD patients reported a history of trauma, with 39 percent of those meeting the criteria for PTSD. A picture of the interplay began to emerge: if a patient's past trauma is not addressed, targeting his or her OCD will not restore mental health.

Most recently, a study of 1,000 adults with OCD supported the idea of a post-traumatic subtype of OCD. Published in the March *Journal of Anxiety Disorders,* the study compared the symptoms of three groups: those who developed OCD after PTSD (referred to in the study as post-traumatic OCD), those who developed OCD before PTSD, and those who did not have a history of trauma. People with post-traumatic OCD tended to have a more severe collection of symptoms than those in the other groups, including more thoughts of suicide, higher levels of anxiety and depression, and greater hoarding and compulsive spending.

Leonardo F. Fontenelle of the Institute of Psychiatry at the Federal University of Rio de Janeiro, and lead author of the March article, says it is difficult to say for sure whether some cases of OCD are actually caused by trauma, "but there are an increasing number of OCD cases being reported after traumatic events."

Currently clinicians do not routinely ask whether an OCD patient has experienced trauma, a potential obstacle to recovery. Both OCD and PTSD are anxiety disorders and are treated with similar drugs, but cognitive therapies for the two disorders differ. Cognitive-behavior therapy, a popular and effective type of talk therapy, treats OCD with mental exercises designed to curb its characteristic urges and ruminations. For the post-traumatic subtype of OCD, treatment "may be improved by the addition of anti-PTSD strategies," says Fontenelle, such as recalling the traumatic events systematically in a safe setting until the emotional power of the memories is diminished.

—Tori Rodriguez

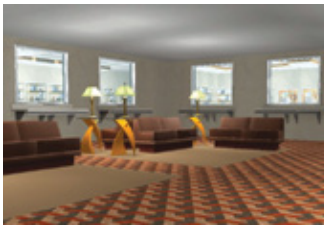
TAL SILVERMAN *Getty Images (hand with pill)*; ILZE LUCERO *iStockphoto (string)*; RYAN McVAY *Getty Images (pile of clothes)*

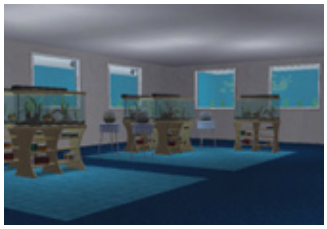
BRAIN QUIRKS

Similar Scenes Spark Déjà Vu

Virtual reality reveals that the feeling of familiarity arises from spatial layout

Déjà vu—that uncanny feeling of having experienced a situation before—may be triggered by the layout of a scene, according to research in the June issue of *Consciousness and Cognition.* Past studies found that déjà vu usually concerns places, so cognitive psychologist Anne Cleary of Colorado State University, Fort Collins, and her colleagues wanted to see if spaces modeled in virtual reality could replicate the striking experience. It worked: subjects most often reported déjà vu when the spatial layout of new settings closely matched that of scenes they had already visited but was not similar enough for them to consciously recognize the resemblance.

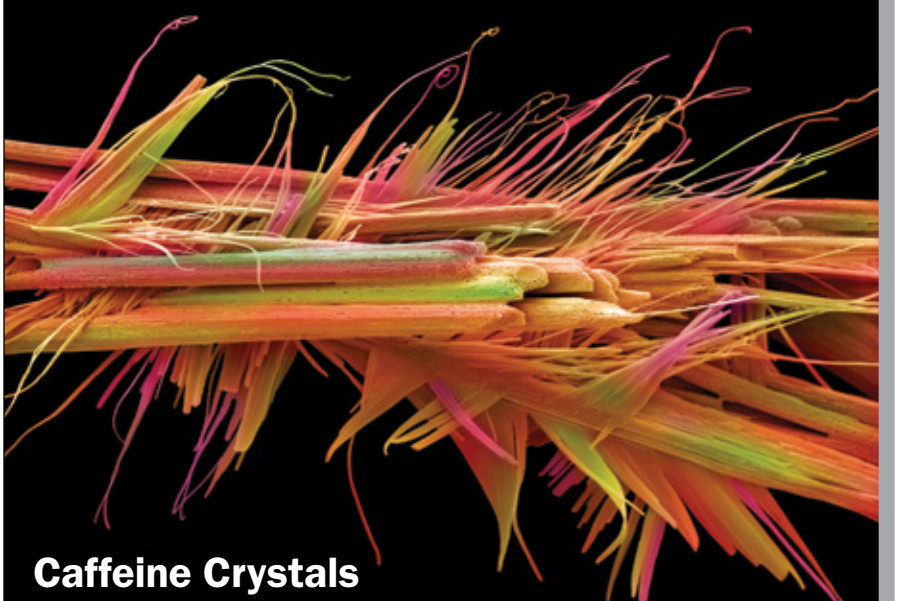




Virtual-reality rooms with similar layouts sparked déjà vu in the study participants.

For instance, a museum hall might have the same configuration as an earlier courtyard—the location of a central statue relative to the benches and rugs in the museum echoed the location of a central potted plant relative to bushes and plants in the courtyard. If subjects failed to register the spatial similarities, they felt only that eerie sense of familiarity in an unfamiliar place. *—Charles Q. Choi*

VISIONS



Caffeine Crystals

The world's most popular psychoactive drug, caffeine, is a crystal that grows in the seeds, fruit or leaves of many plants. This image was made in black and white using an electron microscope and then falsely colored in vibrant hues. The photograph won one of this year's Wellcome Image Awards.

PERCEPTION

How Babies See Race

By nine months old, babies differentiate faces of their own race better than those in other races

When babies are five months old, they can distinguish among faces of all races equally well. Past studies show they can, for instance, match a happy sound with many kinds of happy faces with equal ease. Yet by nine months, babies react more swiftly to their own race than others: they differentiate more readily between faces and match emotional sounds with facial expressions faster. A study from the University of Massachusetts Amherst, published in May in *Developmental Science,* showed that the younger infants use only the frontal part of the brain for the task. By nine months, babies also recruit the occipital-temporal region, where recognition happens in adults.

"The older babies are tending to use more of these adultlike face-processing, object-recognition regions of the brain," says psychologist Lisa Scott, an author of the study. "Their brains weren't trying as hard," she notes, because the older infants have more experiences to draw on. This finding adds to the theory that the newborn brain weighs most inputs and stimuli equally, perhaps resulting in the mingling of the senses known as synesthesia. As the brain matures, it learns to attend more to the sights and sounds important in the baby's life, such as faces that match his or her caregivers' race and sounds in the infant's native language. This theory matches physical neural development: a newborn's brain is massively connected, and over time important circuits are strengthened and unnecessary wiring is pruned. *—Amy Mayer*

COURTESY OF ANNE M. CLEARY *Colorado State University (top left);* JGI/JAMIE GRILL *Getty Images (top right);* COURTESY OF ANNIE CAVANAGH AND DAVID MCCARTHY *Wellcome Images (bottom)*

>> FICTION

You Are What You Read

How you identify with a protagonist in a story influences your attitudes and beliefs

Reading a good book immerses you in a character's world—and may change your views, according to a recent study at Ohio State University. Psychologists Geoff Kaufman and Lisa Libby assigned 78 heterosexual males to read one of three stories, two about a homosexual protagonist and one about a heterosexual protagonist. Afterward, the readers reported having no trouble identifying with the straight character, but their ability to relate to the gay protagonist varied based on when they discovered his orientation. Those who read a story in which the character was introduced as gay in the first paragraph did not connect to the character as strongly as those who learned of the character's orientation near the story's end. Most important, the latter group—the men who identified most with the gay protagonist—relied less on stereotypes to describe the character and reported more positive attitudes toward homosexuality in general. "Readers can emerge from a reading experience seeing the world, other people and themselves quite differently," Kaufman says. The findings remind readers to think critically about their reactions to characters and to be aware of the power of prose. —*Daisy Yuhas*

65.7 MILLION

NUMBER OF PEOPLE PREDICTED TO HAVE DEMENTIA BY 2030.

>> PERSONALITY AND HEALTH

Open Mind, Longer Life

The trait of openness improves health through creativity

Researchers have long been studying the connection between health and the five major personality traits: agreeableness, extraversion, neuroticism, openness and conscientiousness. A large body of research links neuroticism with poorer health and conscientiousness with superior health. Now openness, which measures cognitive flexibility and the willingness to entertain novel ideas, has emerged as a lifelong protective factor. The linchpin seems to be the creativity associated with the personality trait—creative thinking reduces stress and keeps the brain healthy.

A study published in the June issue of the *Journal of Aging and Health* found that higher openness predicted longer life, and other studies this year have linked that trait with lower metabolic risk, higher self-rated health and more appropriate stress response.

The June study sought to determine whether specific aspects of openness better predicted survival rates than overall openness, using data on more than 1,000 older men collected between 1990 and 2008. The researchers found that only creativity—not intelligence or overall openness—decreased mortality risk. One possible reason creativity is protective of health is because it draws on a variety of neural networks within the brain, says study author Nicholas Turiano, now at the University of Rochester Medical Center. "Individuals high in creativity maintain the integrity of their neural networks even into old age," Turiano says—a notion supported by a January study from Yale University that correlated openness with the robustness of study subjects' white matter, which supports connections between neurons in different parts of the brain.

Because the brain is the command center for all bodily functions, exercising it helps all systems to continue running smoothly. "Keeping the brain healthy may be one of the most important aspects of aging successfully—a fact shown by creative persons living longer in our study," Turiano says.

He also cites creative people's ability to handle stress—they tend not to get as easily flustered when faced with an emotional or physical hurdle. Stress is known to harm overall health, including cardiovascular, immune and cognitive systems. "Creative people may see stressors more as challenges that they can work to overcome rather than as stressful obstacles they can't overcome," Turiano says. Although studies thus far have looked at those who are naturally open-minded, the results suggest that practicing creative-thinking techniques could improve anyone's health by lowering stress and exercising the brain. —*Tori Rodriguez*

WERNER BAUM *Corbis (top)*; BARRY LEWIS *Corbis (bottom)*

A Faithful Resemblance

When seeing is believing

BY SUSANA MARTINEZ-CONDE AND STEPHEN L. MACKNIK

"There are things in that [wall]paper that nobody knows but me, or ever will. Behind that outside pattern the dim shapes get clearer every day. It is always the same shape, only very numerous. And it is like a woman stooping down and creeping about behind that pattern."

—Charlotte Perkins Gilman,
"The Yellow Wallpaper," 1892

THE PROTAGONIST in Charlotte Perkins Gilman's short story "The Yellow Wallpaper" suffers from the most notable case of pareidolia in fiction. Pareidolia, the misperception of an accidental or vague stimulus as distinct and meaningful, explains many supposedly paranormal and mystical phenomena, including UFO and Bigfoot sightings and other visions. In Gilman's story, the heroine, secluded in her hideously wallpapered bedroom and having nothing with which to occupy herself, is driven to insanity—full-blown paranoid schizophrenia—by the woman behind the yellow pattern. As she descends into madness, she comes to believe that she is imprisoned by the wallpaper.

Mental disease can aggravate pareidolia, as can fatigue and sleepiness. After a recent surgery, one of us (Martinez-Conde) noticed faces everywhere, in places as unlikely as the ultrasound images of her left arm during an examination of potential postsurgical blood clots. She realized at once that the ubiquitous faces were the product of lack of sleep and the high titer of pain medication in her bloodstream, so she was more fascinated than concerned. Her doctor agreed but made a note in her file for a different drug regime in the future. Just in case. Luckily, the hospital room's walls were bare, and there was no yellow wallpaper in sight.

Our brain is wired to find meaning. Our aptitude to identify structure and order around us, combined with our superior talent for face detection, can lead to spectacular cases of pareidolia, with significant effects in society and in culture. M

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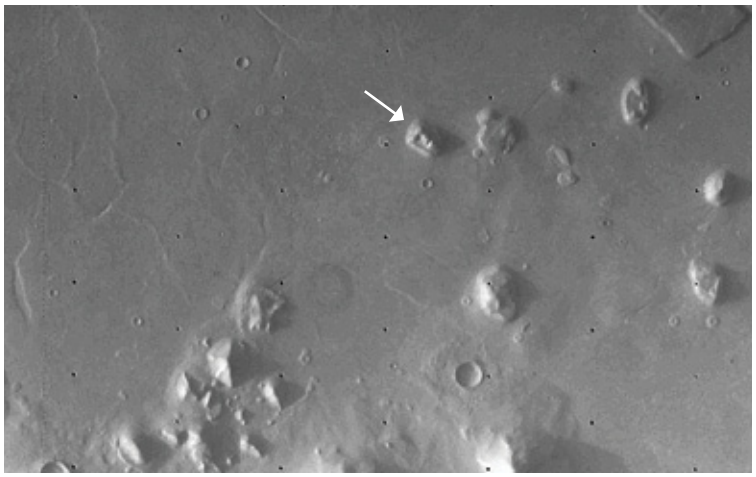
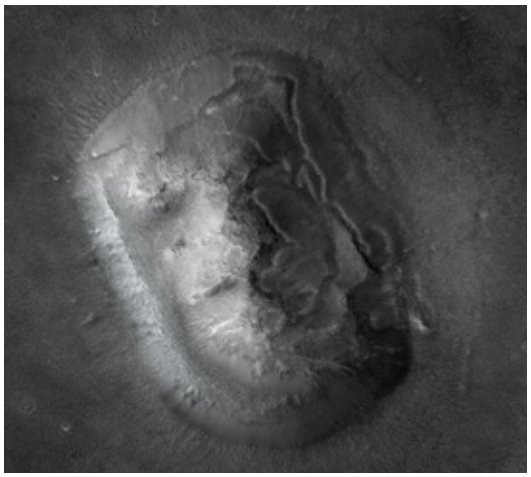
MARK D. PHILLIPS markdphillips.com

SATAN IN THE SMOKE

Photojournalist Mark D. Phillips captured the World Trade Center, engulfed in smoke and flames, seconds after the second plane attack on 9/11. Unknown to Phillips at the time, the picture, distributed by Associated Press and published on the front pages of several newspapers, contained the face of none other than the Prince of Darkness. A media frenzy ensued, and Phillips, who retired from photojournalism that same day, received more than 30,000 messages related to the "face of evil" in the murky cloud and the feelings it brought forth in the viewers.

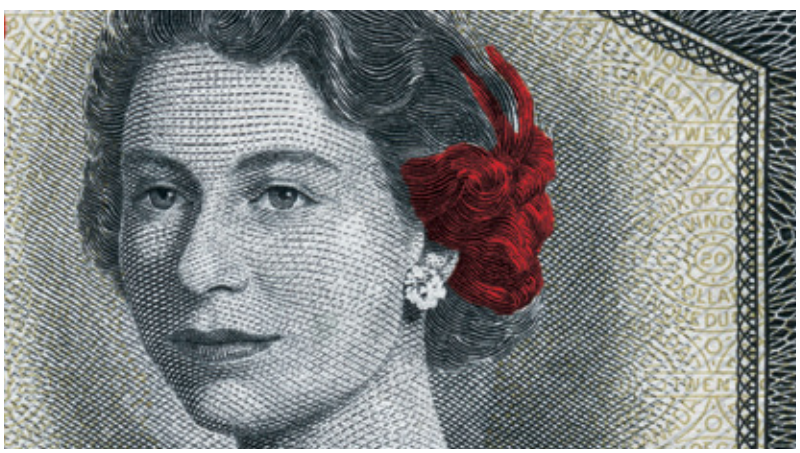
One year later computer scientists Vladik Kreinovich and Dima Iourinski of the University of Texas at El Paso published a geometric analysis of the face in the photograph, also seen in a different image from CNN. The analysis showed that perturbations in the smoke can consist of horizontal lines (such as the "eyes" and "mouth"), and vertical lines (such as the "nose") overlaid on a conic surface (the "head"). The scientists concluded that both the background shape (the cone) and the features on the background (horizontal and vertical lines) are naturally explained by the physics and geometry of smoke plumes emanating from fire.





THE FACE FROM SPACE

In 1976, as NASA's Viking 1 circled Mars looking for possible landing sites for its sister ship Viking 2, it spotted the likeness of a mile-wide human (or maybe Martian?) face, staring back from the Red Planet's region of Cydonia. Scientists believed that the Martian "sphinx" was one of numerous mesas around Cydonia and that unusual shadows made it look like a humongous head. Conspiracy theorists favored the alternative explanation of a government cover-up, however, and criticized NASA's unsuccessful attempts to hide the remnants of an ancient Martian civilization. Eighteen years later obtaining high-resolution images of Cydonia was a priority for NASA. "We felt this was important to taxpayers," says Jim Garvin, chief scientist for NASA's Mars Exploration Program. "We photographed the Face as soon as we could get a good shot at it." In April 1998 the Mars Orbiter Camera team snapped a picture 10 times sharper than the original Viking photos, revealing the mystifying Face on Mars to be ... a mesa.



GOD SAVE THE QUEEN

Canadian banknotes issued in 1954 featured a portrait of British monarch Elizabeth II. The young queen looked majestic and serene, despite the grinning demon tucked in the curls behind her regal ear (colored red, to make it easier to see). Talk about having a royally bad hair day! Canadians were understandably appalled by what became known as the "Devil's head" or "Devil's face" series. In 1956 the Bank of Canada ordered banknote companies to darken the highlights in the queen's hair, effectively exorcising the King of Hell from Canadian currency.

HOLY TOAST

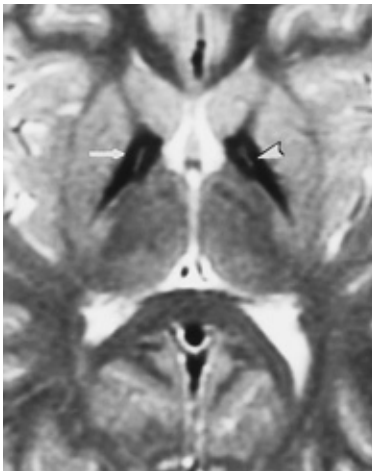
A brain region called the fusiform gyrus is responsible for our extraordinary face-detection abilities. Neurons in this area are so exquisitely attuned to sense faces in the environment that they often signal false positive results in the presence of sparse information, such as when we "see" faces in clouds, in wallpaper patterns, the front of cars or food items.

Diane Duyse of Florida had taken a small bite out of a grilled-cheese sandwich when she noticed an image burned into the bread. "I saw this lady looking back at me," she said. Ten years later the sandwich, said to bear an image of the Virgin Mary, sold on eBay for $28,000. Pareidolia can be lucrative.

COURTESY OF NASA (*Mars*); GORD CARTER *National Currency Collection/Currency Museum/Bank of Canada (banknotes)*; *MIAMI HERALD, 2004 (toast)*

EYE OF THE TIGER

Neurologists Péricles Maranhão-Filho and Maurice B. Vincent of the Federal University of Rio de Janeiro advocate the use of face-detection illusions as heuristics to help doctors diagnose neurological diseases. One is PKAN, or pantothenate kinase–associated neurodegenerative disease, which results from mutations in the genes encoding the enzyme responsible for the biosynthesis of coenzyme A. Typically PKAN starts during childhood, and most patients lose the ability to walk within 15 years. The brains of PKAN patients show decreased intensity of the globus pallidus (involved in motor control) from iron accumulation, with a central area of increased intensity from necrosis. The image looks decidedly feline, providing the so-called eye-of-the-tiger sign.



THE "OW! MY BALLS!" ILLUSION

Medical imaging is a new fertile ground for pareidolia. Urologists G. Gregory Roberts and Naji J. Touma of Queen's University in Ontario were shocked to discover a face, contorted in agony, in the scrotal ultrasound images (*left*) of a 45-year-old man afflicted with severe testicular pain. The doctors toyed with the idea that the image might be a manifestation of Min, the Egyptian god of male virility, but ultimately deemed the facial features in the benign mass accidental.

The brain's capacity to establish false links among things that are not actually connected is essential to the "paranoiac-critical method" artistic technique invented by Spanish surrealistic painter Salvador Dalí. (Paranoia and pareidolia have the same etymology, from the Greek *para-* for "instead of" and *-oid, -oeides* or *-eidos* for "form.") In Dalí's *Slave Market with the Disappearing Bust of Voltaire,* several features in Voltaire's face are formed by the bodies of people in the scene (*below*).

Dartmouth College neuroscientist Ming Meng and his colleagues recently imaged the brains of observers while they viewed faces and objects that looked like faces. The left fusiform gyrus was activated by both faces and objects resembling them, whereas the right fusiform gyrus showed much stronger activation to actual faces than to look-alikes.

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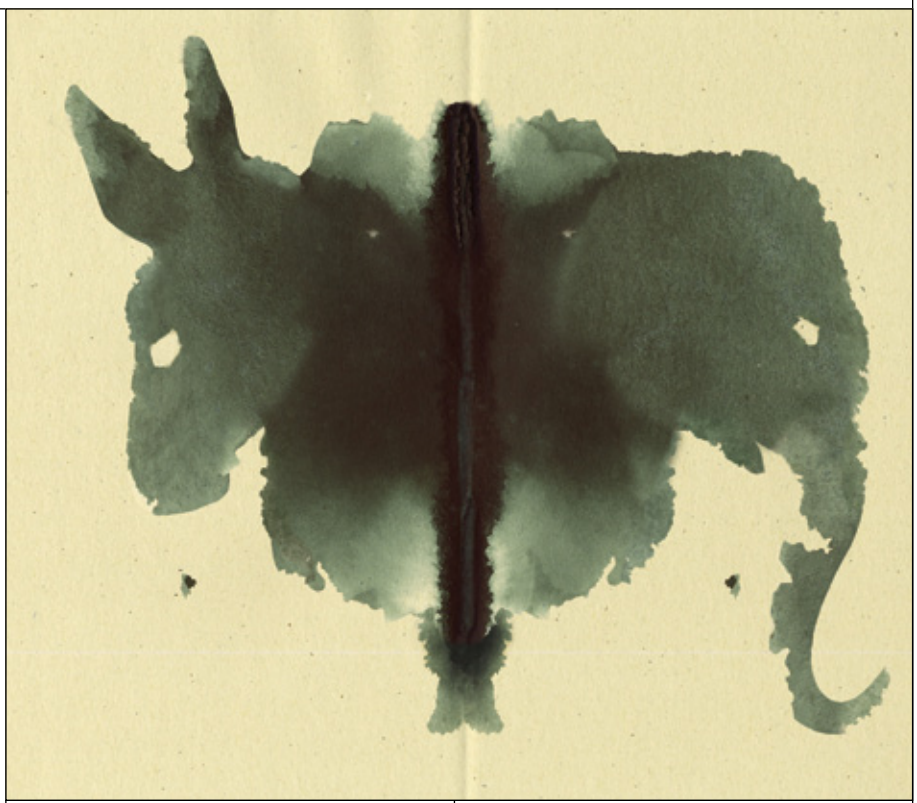
Calling a Truce in the Political Wars

Psychological insights might tone down the bitter feuding between Democrats and Republicans

BY EMILY LABER-WARREN



ELLEN WEINSTEIN

BLUE STATE, red state. Big government, big business. Gay rights, fetal rights. The United States is riven by the politics of extremes. To paraphrase humor columnist Dave Barry, Republicans think of Democrats as godless, unpatriotic, Volvo-driving, France-loving, elitist latte guzzlers, whereas Democrats dismiss Republicans as ignorant, NASCAR-obsessed, gun-fondling religious fanatics. An exaggeration, for sure, but the reality is still pretty stark. Congress is in a perpetual stalemate because of the two parties' inability to find middle ground on practically anything.

According to the experts who study political leanings, liberals and conservatives do not just see things differently. They *are* different—in their personalities and even their unconscious reactions to the world around them. For example, in a study published in January, a team led by psychologist Michael Dodd and political scientist John Hibbing of the University of Nebraska–Lincoln found that when viewing a collage of photographs, conservatives' eyes unconsciously lingered 15 percent longer on repellent images, such as car wrecks and excrement—suggesting that conservatives are more attuned than liberals to assessing potential threats.

Meanwhile examining the contents of 76 college students' bedrooms, as one group did in a 2008 study, revealed that conservatives possessed more cleaning and organizational items, such as ironing boards and calendars, confirmation that they are orderly and self-disciplined. Liberals owned more books and travel-related memorabilia, which conforms with previous research suggesting that they are open and novelty-seeking.

"These are not superficial differences. They are psychologically deep," says psychologist John Jost of New York University, a co-author of the bedroom study. "My hunch is that the capacity to organize the political world into left or right may be a part of human nature."

Although conservatives and liberals are fundamentally different, hints are emerging about how to bring them together—or at least help them coexist. In his recent book *The Righteous Mind*, psychologist Jonathan Haidt of the N.Y.U. Stern School of Business argues that liberals and conservatives need not revile one another as immoral on issues such as birth control, gay marriage or health care reform. Even if these two worldviews clash, they are equally grounded in ethics, he writes. Meanwhile studies by Jost and others suggest that political views reside on a continuum that is mediated in part by universal human emotions such as fear. Under certain circumstances, everyone can shift closer to the middle—or drift further apart.

The Fear Factor

Psychologists have found that conservatives are fundamentally more anxious than liberals, which may be why they typically desire stability, structure and clear answers even to complicated questions. "Conservatism, apparently, helps to protect people against some of the natural difficulties of living," says social psychologist Paul Nail of the University of Central Arkansas. "The fact is we don't live in a completely safe world. Things can and do go wrong. But if I can impose this order on it by my

worldview, I can keep my anxiety to a manageable level."

Anxiety is an emotion that waxes and wanes in all of us, and as it swings up or down our political views can shift in its wake. When people feel safe and secure, they become more liberal; when they feel threatened, they become more conservative. Research conducted by Nail and his colleague in the weeks after September 11, 2001, showed that people of all political persuasions became more conservative in the wake of the terrorist attacks. Meanwhile, in an upcoming study, a team led by Yale University psychologist Jaime Napier found that asking Republicans to imagine that they possessed superpowers and were impermeable to injury made them more liberal. "There is some range within which people can be moved," Jost says.

More practically, instead of trying to change people's emotional state (an effect that is temporary), astute policy makers might be able to phrase their ideas in a way that appeals to different worldviews. In a 2010 paper Irina Feygina, a social psychology doctoral student at N.Y.U. who works with Jost, found a way to bring conservatives and liberals together on global warming. She and her colleagues wondered whether the impulse to defend the status quo might be driving the conservative pooh-poohing of environmental issues.

In an ingenious experiment, the psychologists reframed climate change not as a challenge to government and industry but as "a threat to the American way of life." After reading a passage that couched environmental action as patriotic, study participants who displayed traits typical of conservatives were much more likely to sign petitions about preventing oil spills and protecting the Arctic National Wildlife Refuge.

Environmentalism may be an ideal place to find common political ground. "Conservatives who are religious have this mind-set about being good stewards of the earth, to protect God's creation, and that is very compatible with green energy and conservation and other ideas that are usually classified as liberal," Nail says.

Moral Scorecards

On topics where liberals and conservatives will never see eye to eye, opposing sides can try to cultivate mutual respect. In *The Righteous Mind,* Haidt identifies several areas of morality. Liberals, he says, tend to value two of them: caring for people who are vulnerable and fairness, which for liberals tends to mean sharing resources equally. Conservatives care about those things, too, but for them fairness means proportionality—that people should get what they deserve based on the amount of effort they have put in. Conservatives also emphasize loyalty and authority, values helpful for maintaining a stable society.

In a 2009 study Haidt and two of his colleagues presented more than 8,000 people with a series of hypothetical actions. Among them: kick a dog in the head; discard a box of ballots to help your candidate win; publicly bet against a favorite sports team; curse your parents to their faces; and receive a blood transfusion from a child molester. Participants had to say whether they would do these deeds for money and, if so, for how much—$10? $1,000? $100,000? More? Liberals were reluctant to harm a living thing or act unfairly, even for $1 million, but they were willing to betray group loyalty, disrespect authority or do something disgusting, such as eating their own dog after it dies, for cash. Conservatives said they were less willing to compromise on any of the moral categories.

Haidt has a message for both sides. He wants the left to acknowledge that the right's emphasis on laws, institutions, customs and religion is valuable. Conservatives recognize that democracy is a huge achievement and that maintaining the social order requires imposing constraints on people. Liberal values, on the other hand, also serve important roles: ensuring that the rights of weaker members of society are respected; limiting the harmful effects, such as pollution, that corporations sometimes pass on to others; and fostering innovation by supporting diverse ideas and ways of life.

Haidt is not out to change people's deepest moral beliefs. Yet he thinks that if people could see that those they disagree with are not immoral but simply emphasizing different moral principles, some of the antagonism would subside. Intriguingly, Haidt himself has morphed from liberal to centrist over the course of his research. He now finds value in conservative tenets that he used to reject reflexively: "It's yin and yang. Both sides see different threats; both sides are wise to different virtues." M

When people feel safe and secure, they become more liberal; **when they feel threatened**, they become more conservative.

EMILY LABER-WARREN, a freelance writer in New Jersey, directs a science-reporting program at the C.U.N.Y. Graduate School of Journalism.

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Safely Switching Consciousness Off and On Again

What can we learn about consciousness from anesthetized patients?

BY CHRISTOF KOCH

Two studies of anesthetized patients' brain activity offer intriguing—if somewhat conflicting—clues about the seat of consciousness.

WE TAKE IT for granted that any kind of surgical procedure, whether extracting a wisdom tooth or replacing a heart valve, will be painless and won't leave any bad memories. Every year tens of millions of patients worldwide remember being prepared for an operation—then nothing, until they wake up in the recovery room. This is the magic of general anesthesia, which safely knocks out that most precious of life's possessions, conscious experience, then reliably restores it without any lasting consequences. Of course, it was not always thus. Until the discovery of nitrous oxide as an anesthetic in the mid-19th century, surgery was an extreme and dangerous intervention of last resort whose effects could, at best, be blunted by opium or alcohol.

Today anesthesiologists can choose from an astonishing variety of chemicals to separately and independently eliminate pain (analgesia), memory (amnesia), mobility, and responsiveness to the cutting, scraping, drilling or cauterizing of the surgical procedure, and, most important from the point of view of the patient, awareness (loss of consciousness). Two types of anesthetics exist: intravenous agents that are injected into the bloodstream for the rapid induction and maintenance of anesthesia, such as barbiturates, propofol and ketamine, and inhalation agents, such as laughing gas (nitrous oxide) or vapors of volatile liquids, including isoflurane and sevoflurane.

Much is known about the molecular action of these substances. With the singular exception of the dissociative ketamine (abused at low doses as a street drug known as vitamin K or special K and not further discussed here), anesthetics strengthen neuronal inhibition either by activating inhibitory chemical synapses, which constrain activity in the neurons they are connected to, or by binding to membrane proteins that keep the electrical activity of neurons—and therefore their ability to transmit information and command—in check. Their net effect is to reduce overall brain activity. Every functional brain-imaging study carried out to date proves this point. For anesthesiologists, the technique of choice is positron emission tomography (PET), in which a small amount of radioactive tracer is injected into the bloodstream of the subject. Brain regions that are more or less active than neighboring areas consume metabolic resources in the same ratio. This metabolic activity can be reliably measured in a PET device, albeit with a crude temporal (on the order of tens of seconds) and spatial (on the order of the size of a pea) resolution.

PET imaging demonstrates that essentially all anesthetics decrease global cerebral metabolism in a dose-dependent manner. The more of the anesthetic dispensed, the bigger the activity reduction in regions of the brain stem responsible for promoting wakefulness and in the neocortex and the closely allied thalamus underneath it. The neocortex is the most recently evolved part of the cerebral cortex, the folded layers of neurons that constitute the proverbial gray matter. It occupies most of the forebrain and is a unique hallmark of mammals. The thalamus is a quail egg–size structure in the middle of the brain that regulates all input into the neocortex and receives massive feedback from it.

Cortex Off, Consciousness Off

This dramatic reduction in brain activity after loss of consciousness is scarcely surprising. The link between consciousness and this organ is tight, as expressed in the adage "No brain: never mind!" Yet neuroscientists are trying to track the footprints of consciousness to its actual lair. Which region in the cortex, the thalamus or elsewhere is essential to be conscious at all? Consider the following two experiments.

TIM PANNELL *Corbis*

Neuroscientists are **trying to track** the footprints of consciousness to its actual lair.

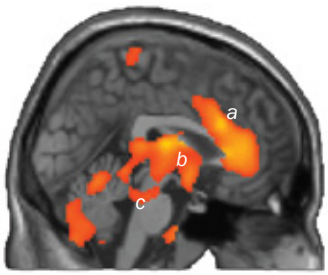
Twenty-five patients with Parkinson's disease were anesthetized with propofol or sevoflurane while the electrical activity of both the cortex and thalamus was monitored by a group under François Gouin of the Timone University Hospital Center at the University of the Mediterranean in Marseille, France. Their neocortex was monitored by a conventional electroencephalographic (EEG) electrode placed on the scalp on top of the head, whereas thalamic activity was recorded by an electrode implanted deep inside the brain in the subthalamic nucleus. This electrode stimulates the brain to alleviate the shaking that is the hallmark of Parkinson's. Experimenters assessed consciousness by tapping patients on the shoulder and asking them every 20 seconds to open their eyes.

When consciousness was lost after anesthesia was initiated—that is, when the patients no longer opened their eyes following the command—the cortical EEG changed dramatically, switching from low amplitude and irregular activity into readings dominated by large and slow brain waves that occur about once every second. Such so-called delta band activity is characteristic of deep sleep. Furthermore, the complexity of the cortical EEG signal decreased significantly when patients stopped responding. None of these changes occurs in the thalamic electrode at the time that consciousness is lost.

Indeed, it is only several minutes later that the thalamic voltage signal matches that of the cortex. The data—consistent for two quite different anesthetic agents, one injected and the other one inhaled—argue that the drivers for the loss of consciousness are parts (or all) of the neocortex and that the thalamus follows.

Returning from Oblivion

In a second experiment, by a group primarily based at the University of Turku in Finland, involving Harry Scheinin, Jaakko W. Långsjö and Michael T. Alkire, 20 volunteers were put to sleep with two different substances, dexmedetomidine and propofol (again, to make sure that the outcome does not depend on any one specific agent). After being injected with the radioactive tracer, the subjects lay down inside a PET scanner. The anesthesiologists measured the regional cerebral blood flow when the patients regained consciousness—that is, when the subjects could open their eyes again in response to a persistent command (albeit given only once every five minutes).



Colored areas indicate the parts of the brain that first come online when patients emerge from consciousness after being anesthetized with one of two different agents. The three critical regions are the anterior cingulate cortex (*a*), the thalamus (*b*) and parts of the brain stem (*c*).

Subsequent statistical analysis fingered phylogenetically older regions in the brain stem (in particular, the locus coeruleus and parabrachial area that contains the noradrenergic neurons that project widely throughout the corticothalamic complex and exert broad effects on the brain). They mediate the arousal needed for behavioral responses—such as blinking the eyes—to occur. As consciousness returns, the thalamus is exuberantly active, whereas the cortex shows a much more circumscribed response, primarily in those frontal regions responsible for monitoring of the self.

The conjoined activation of both the cortex and thalamus appears at odds with the previous study, which implicated the cortex as the driver and the thalamus as the follower. Yet the two techniques (EEG versus PET imaging) measure distinct signals (voltage versus blood flow, which is 1,000 times more sluggish), compounded by the fact that the first study checked whether or not the patients were conscious every 20 seconds, whereas the second one inquired only every five minutes.

Furthermore, although consciousness waxes and wanes during anesthesia, many other processes—the overall level of brain arousal, the ability to move and to remember, the experience of pain and other sensations, and so on, each with their own neuronal signature—also vary and confound the search for the sources of consciousness. Finally, just as the sequence of operations on booting up a computer are not the same as those that occur when the machine is shut down, the brain events accompanying the return of consciousness are unlikely to be identical to those that cause consciousness to cease.

These two exemplary studies point to the difficulties, but also to the progress, of the quest to unravel the mind-body riddle. M

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DATING IN A DIGITAL WORLD

Understanding the psychology of online dating can turn a frustrating experience into a fruitful mission

By Eli J. Finkel, Paul W. Eastwick, Benjamin R. Karney, Harry T. Reis and Susan Sprecher

Romantic relationships can begin anywhere. When Cupid's arrow strikes, you might be at church or at school, playing chess or softball, flirting with a friend of a friend at a party or minding your own business on the train. Sometimes, however, Cupid goes on vacation, or takes a long nap, or kicks back for a marathon of Lifetime original movies. Instead of waiting for the capricious arrow slinger to get back to work, people are increasingly joining online-dating sites to assert some control over their romantic lives.

For millennia cultures have invented practices to fulfill the evolutionary imperatives of mating and reproduction. In the Western world today, individuals are largely expected to identify romantic partners on their own, a process that can consume significant time, effort and emotional energy. The ability to hunt for dates online offers singles a modicum of control over a seemingly random process and grants them access to hundreds, potentially thousands, of eligible mates.

The unprecedented opportunity to pursue romance beyond one's social circles and neighborhood haunts has developed into a billion-dollar industry. Most online-dating sites work in this way: users create profiles describing themselves and then search a Web site for possible romantic partners according to various criteria—within a town or city, for example, or perhaps by educational levels, age range or religion. Some sites attempt to play the role of matchmaker and use proprietary algorithms to suggest pairings between users, whereas other services give their customers free rein. Our best estimate is that online dating will launch 20 to 25

WILLIAM SCHULTZ/*iStockphoto (silhouetted people)*; PHOTOILLUSTRATION BY AARON GOODMAN

Meeting online is the second most common way

With online dating, singles can now search for romance whenever they want, including while cozy in their pajamas.

percent of new romantic relationships this year.

Two decades ago almost no couples met online, whereas now it is the second most common way to find a partner, trailing slightly behind connecting through friends. Rather than dabbing on perfume or cologne and preparing for a night on the town, singles can peruse potential partners while drinking their morning cup of coffee, during meetings at work or when lying in bed for 10 minutes before nodding off. In short, online services have fundamentally altered the dating landscape.

The changes are not all constructive, however. Critical assumptions lurk in the mechanisms of online dating. One supposition is that people are good judges of which qualities described in an online profile will appeal to them in person. A second premise is that comparing multiple potential partners side by side is an effective way to evaluate compatibility. A third is that having many options allows people to make good decisions about their romantic future. Several lines of scientific work suggest that none of these guesses is likely to be true.

This disconnect between the assumptions underlying online dating and the realities of human psychology often yields dissatisfaction. Users may invest tens of hours every month in browsing profiles and only rarely arrange a date. They may contact dozens of users and hear back only from a small fraction of them. They may set up dates with individuals who seem perfect "on paper" only to learn on the first date that as a pair they have no chemistry.

For online daters, what follows is a survival guide. For others, a look at today's dating methods offers revealing insights into the human psyche.

Set Limits for Yourself

Online dating is almost nothing like a typical night out on the prowl. At a bar, a man might size up the room before letting his gaze settle on the thirtysomething brunette with the welcoming smile and the serious eyes. If he approached her and managed to strike up a conversation, he could take in her nonverbal cues–such as her gestures, posture and scent—as he tried to make her laugh.

If he were instead reading her profile on an online-dating site, he would have learned that she plays board games on the weekends, works as a pastry chef and loves horror movies. A connoisseur of art-house films, he might have already dismissed her for her questionable taste.

With the carrot of romance always dangling a mere mouse click away, the temptation to scan—and cavalierly dismiss—dozens of profiles is strong. We all value having options, but too many can produce choice overload, undermining our ability to make good decisions. In a famous illustration of this effect, supermarket shoppers encountered a tasting booth that displayed either six or 24 flavors of jam. Although shoppers were more likely to stop at the display with the larger array of jams than the booth with the smaller selection, they were 10 times more likely to purchase an item from the smaller group than the larger. Presumably the larger array paralyzed them with indecision.

Similarly, several studies in the romantic domain suggest that people become overwhelmed as the number of online-dating profiles they browse

ANDERS ANDERSSON Getty Images

FAST FACTS

Mindful Matchmaking

1» **Online dating, a billion-dollar industry, offers singles an unparalleled opportunity to meet and arrange dates with people outside their own social circles.**

2» **Often these services encourage users to rely on decision-making styles that are not well suited to the development of successful relationships.**

3» **Awareness of the obstacles in this psychological terrain can help online daters make the most of these services.**

grows larger. In a recent study, participants viewed either four or 20 such profiles. Those considering the larger set were more prone to misremembering information in them. In a second experiment, as the number of profiles grew from four to 24 to 64, users increasingly switched from time-consuming choice strategies that attend to and integrate multiple cues to more frugal strategies that examine few elements and do not combine them effectively.

No studies have investigated how satisfied online daters are with their choices after considering small versus large numbers of profiles, but other research suggests that exposure to numerous options leads to low satisfaction with a given choice. Those who selected one chocolate out of six, for example, thought the treat tasted significantly better than did participants who picked their chocolate from an array of 30. By analogy, online daters choosing from a small rather than a large batch of potential partners are more likely to enjoy the person with whom they end up sharing a candlelit dinner.

These cognitive biases are hard but not impossible to counteract. Remain aware of how many profiles you have scanned in a browsing session and impose a time limit. View profiles in manageable clusters and consider reaching out to, say, one out of every 20 users. Keep in mind that behind the profile is a flesh-and-blood person, with nuance and depth that is easily lost online.

Monitor Your Mind-set

People also tend to evaluate romantic prospects differently depending on how they encounter them. Many studies in nonromantic domains have demonstrated that people frequently prioritize different qualities when they compare multiple options side by side—referred to as a joint evaluation mind-set—than when they size up one specific possibility in isolation, known as a separate evaluation mind-set.

A study of incoming college freshmen explored

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A large body of research shows that people are better at choosing from small sets than larger ones, whether at a supermarket or on an online-dating site.

this idea in the context of their dormitory assignments. Before learning which one of 12 dormitories they would be randomly assigned to, the students tended to predict that physical features, such as the building's location and the size of its rooms, would strongly influence their future happiness. None of these attributes ultimately predicted their well-being. Instead experiential qualities—such as the relationship with one's roommate and the social atmosphere of the dormitory—trounced any of the lodgings' physical characteristics.

One explanation for this discrepancy between expectation and reality is that the freshmen were in a joint evaluation mind-set when making the predictions and in a separate evaluation mind-set when living in the assigned dorm. Before moving in, they were more sensitive to unimportant physical variations simply because those differences were easy to judge. Browsing profiles of potential romantic partners is also likely to trigger a joint evaluation mind-set and cause users to overvalue qualities that are easy to assess but unlikely to determine compatibility. Indeed, profiles are chock-full of details that tend to be largely unrelated to the hard-to-discern, experiential characteristics that promote relationship well-being. Levels of education or physical attractiveness can be easily assessed through a profile, for example, whereas rapport and attraction are best evaluated face-to-face.

Appraising numerous dating profiles side by side can easily overwhelm online daters. Imposing a time limit can help.

Engaging in joint evaluation can also strengthen so-called assessment mind-sets and undermine locomotion mind-sets. When in an assessment mind-set, a person critically evaluates a specific option against available alternatives. A person in a locomotion mind-set focuses on a certain selection, such as a desirable mate, and pursues it vigorously. To be sure, all dating involves some degree of assessment. The side-by-side evaluation of countless online-dating profiles, however, seems to invoke a strong assessment mind-set regarding the general pool and a weak locomotion mind-set with respect to any single person. One way to ward off a problematic mind-set is to take a moment to imagine what it might be like to talk to any profilee face-to-face. Mentally simulating a social interaction is likely to make you less critical and more motivated to consider possible ways you might be compatible. As with managing choice overload, do not waste time comparing a profile with too many others.

Cast a Wide Net

Studies suggest that online daters typically aim too high. They contact the most objectively desirable individuals at massively higher rates than others. In a real-world dating scenario, attendees at a party would not all strive to mob one attractive individual, which is effectively what happens online, because these daters cannot see how much attention a person is already receiving. These highly sought-after people are the least likely to respond to e-mails, and both the deluged daters and the pursuers can experience frustration as a result.

Part of the problem appears to stem from the attitudes that daters adopt, intentionally or not, when on these sites. In one 2010 study Rebecca Heino of Georgetown University and her colleagues described online dating as "relationshopping." The metaphor of shopping is apt. Much like hunting for size 8 leather shoes on Zappos.com, online daters seek partners by searching through profiles using attributes such as income and hair color, as opposed to arguably more important factors, such as a sense of humor or rapport. One online dater illustrated the shopping mentality as follows: "You know, 'I'll take her, her, her'—like out of a catalogue." A second online dater agreed: "I can pick and choose; I can choose what size I want, it's like buying a car, what options am I looking for."

This checklist mentality underscores our lack of self-knowledge when it comes to romance. In one experiment, research participants who evaluated an online dater's written profile expressed more attraction toward a person whose description was rigged to match their own idiosyncratic preferences. After a brief live interaction, however, the participants' ideals no longer predicted romantic interest. These experiments tell us a few things. First, daters by and large think they covet the same people. Further, we are bad at predicting what we will find attractive in real life. Last, the easy acces-

Singles at a party would not all mob one attractive

ISTOCKPHOTO

(The Authors)

THE AUTHORS are all social psychologists. ELI J. FINKEL is based at Northwestern University, PAUL W. EASTWICK at Texas A&M University, BENJAMIN R. KARNEY at the University of California, Los Angeles, HARRY T. REIS at the University of Rochester and SUSAN SPRECHER at Illinois State University.

Deprived of the social cues that modulate dating behavior in face-to-face interactions, online daters tend to contact the most objectively desirable people at much higher rates than other individuals.

person, which is effectively what happens online.

sibility of profiles may exacerbate these tendencies by encouraging us to evaluate potential partners in an ineffectual manner.

Rather than reaching out to the most desirable people "on paper," consider looking for more idiosyncratic features that are likely to appeal to some daters more than others. More important, get away from profiles as soon as you can and do not expect too much from them in the first place. Stay open-minded about whom you might end up falling for—and who might love you back.

Communicate with Care

Online-dating sites include easy methods, such as e-mail and online chat functions, for users to communicate with prospective dates. In fact, dating hopefuls must converse through one of these methods before switching to a personal e-mail account or arranging for a telephone call. If these interactions go well, the romance seekers typically agree to meet in person in short order.

Unfortunately, many matches never get the chance to blossom. One reason is that not all profiles on a site represent paying or active users. In addition, responses to initial overtures can be few and far between. In one recent study, men replied to one out of four messages they received through a dating site, and women replied to one in six. More promisingly, this study found no evidence that eager responses were a turnoff; the faster the reply, the more likely that reciprocal communication continued. If you sense a spark, don't play hard to get.

Putting some effort into the initial e-mail can also pay off. A linguistic analysis of 167,276 initial e-mails sent by 3,657 online daters revealed that the messages more likely to receive a response were characterized by less use of the pronoun "I" and of leisure words such as "movie" and by higher use of the pronoun "you" and of social-process words such as "relationship" and "helpful."

At this stage, the incipient relationship is still fragile. Do not wait too long to set up a date. Most of the pairings that start communicating outside the dating site's messaging systems meet face-to-face within a month, frequently within a week, according to two studies from 2008. Doing so is wise, as research shows that although a small amount of e-mailing or chatting online can increase attraction when two daters meet, too much of it tends to instill overly specific expectations.

MORE SCIENCE See the *Psychological Science in the Public Interest* article, "Online Dating: A Critical Analysis from the Perspective of Psychological Science," on which this story for *Scientific American Mind* is based, at the Association for Psychological Science's Web site: **www.psychologicalscience.org**

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Ultimately there is *something* that people must assess face-to-face before a romantic relationship can begin. Scholars are still working to identify exactly what that something is, but it appears to reside at the intersection of experiential attributes, chemistry and gut-level evaluations. Some emotional reactions could even be based on sensory experiences, such as olfaction, that cannot be gleaned any other way. Meeting in person also serves as an important reality check before intimacy progresses: people are less likely to misrepresent their observable attributes in a real-world setting as compared with online correspondence.

Don't Bet on Matching Algorithms

Several high-profile dating sites promise to match users with an especially compatible individual using a proprietary matching algorithm. Unfortunately, these companies have so far failed to offer convincing evidence supporting this claim. We encourage users to consider this limitation before investing the sometimes considerable resources required to join such services.

To their credit, dating-site algorithms can probably discern which people have an increased risk of experiencing relationship problems by assessing individual differences such as neuroticism and a history of substance abuse. Evidence that some people are better at sustaining intimacy than others is strong and unequivocal. By assessing these types of characteristics, online-dating sites can in principle screen out the relationally challenged more efficiently and effectively than a human can. This is a potentially useful service, as long as you are not one of the unlucky folks who gets eliminated.

This filtering service, however, yields far less than what algorithm-based matching sites typically promise their users. They pledge to identify potential mates who are particularly compatible with their customers—even soul mates—a claim that is hard to swallow for two simple reasons. No matching site has mustered any scientifically compelling evidence that its algorithm is effective. Second, decades of research on relationships suggest that the most important determinants of a relationship's fate emerge only after the pair have met—factors such as the way the couple navigates interpersonal conflict, responds to unpredictable events or shares good news. Because matching sites have demonstrated insufficient ambition or creativity, their ap-

Brief interactions online can boost attraction, but

The information that best predicts a relationship's success can only be gleaned in person, such as rapport and compatible senses of humor.

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proaches are based solely on qualities of individuals that can be known prior to meeting in person. As a result, these algorithms are poorly equipped to predict whether strangers on a date will linger over dessert or quickly demand the check. Discerning whether two people will live happily ever after is even further out of reach.

Particularly exasperating is the fact that these matching sites could so easily test whether their algorithm actually works. If the proprietors would reveal their secret sauce—perhaps with patent protection from the federal government, as in the pharmaceutical industry—scientists could test its validity by randomly assigning online daters to one of four experimental conditions. In the wait-list control group, participants would experience no intervention. A placebo-control group would consist of subjects who believe they are being matched by the site's algorithm but are actually matched at random. Daters in a relationship-aptitude control group would be paired with people who tend to be good at relationships in general and are not, say, especially neurotic. Last, individuals in an algorithm group would view profiles selected by the site's matching technology.

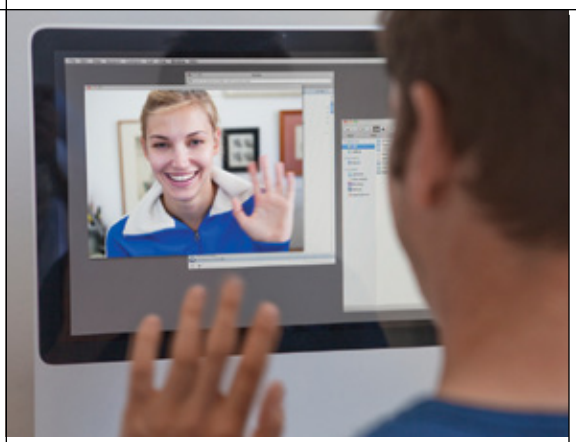
If the members of the fourth group experienced romantic outcomes superior to those of the participants in the other three groups, then we would have evidence that the algorithm is effective. Given that we have repeatedly spelled out how matching sites could demonstrate their value, it seems suspicious than no site has done so—or allowed independent scholars to perform the study on its behalf. Until matching sites that claim to use science actually conduct minimally adequate experiments, online daters should think twice before paying a premium for such services.

Know What Works

Some aspects of online-dating services are marvelous. They open up access to potential sources of romance that might never otherwise be available to their clients. They can transcend geographic and social-network boundaries to an unprecedented degree. These benefits may be especially powerful for those people who need it the most—including those who are socially anxious, have struggled to find like-minded partners or have recently moved to a new city.

Even though our decision making falters under trying conditions, it is worth noting that we are actually quite skilled at deducing certain personality characteristics from sparse amounts of information. Past research demonstrates that people can accurately assess a broad range of facts about others based on a brief exposure to their photographs. For example, when study participants viewed snapshots of the faces of chief executive officers from Fortune 1,000 companies, their ratings of those CEOs' leadership ability correlated strongly with the companies' profits. What people cannot discern from an image, however, is how compatible they might be with the individual pictured. This capability also so far eludes online-dating sites, unfortunately.

In general, however, online-dating sites present a unique opportunity to bring happiness into the world. The industry is still in its infancy, which is probably one reason it contains so many flaws. As these services increasingly incorporate the best relationship science, they will evolve and improve. When wielded with skill and rigor, these tools can help millions of lonely hearts find love. M



DIMITRI VERVITSIOTIS *Getty Images*

Although communication through video chat and other methods can help acquaint two people, ultimately only an in-person meeting can kindle romance.

too much can lead to overly specific expectations.

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STUDYING DRUGS IN ALL THE WRONG PEOPLE

How the costly race to enroll subjects in psychiatric research trials is harming patients and compromising treatment

By Gabriella Rosen

One evening in the emergency room, I was asked to evaluate a patient requesting admission to the psychiatric unit. Gia was waiting for me, looking pale but fit. (All individuals identified only by their first name have been assigned pseudonyms, and their identifying details have been changed.) She had heard that the hospital was recruiting inpatients for a study of bipolar disorder and wanted to participate. She described herself as moody—upbeat for a few hours, then down, then happy again.

"How do you feel right now?" I asked.

"Okay," she shrugged.

Psychiatric diagnosis is as much an art as a science, and it relies largely on a physician's observations and a patient's self-reports. Gia's calm, even speech, her pleasant demeanor and her relaxed manner were not in keeping with a bipolar diagnosis, nor were the symptoms and history she related. At the same time, all was not well—her lab work and vital signs revealed several abnormalities, including low blood pressure, anemia and troubling results on liver tests.

"Are there any medical conditions you forgot to mention?" I asked, puzzled. "Or medications?" I ran through an exhaustive list of symptoms—itchiness, weight loss, lightheadedness. At last, when I asked about possible chemical exposures in her line of work, Gia produced a stack of business cards.

"Your employers?" I held seven or eight cards. The names included several nutritional and biomedical companies. "What do you do for them?"

"I try things. Drugs. Pills. Products."

Gia took these drugs for money. Yes, she said, she had participated in psychiatric studies before. I expressed concern about her lab results and asked if she could recall more details about the pills she had taken. She said she was not sure how many different experimental agents might be in her system at that moment. I shuffled and reshuffled the cards in my hand.

"So …" Gia said, breaking the silence. "Is there room in the study?"

Researchers involved in psychiatric drug development know patients like Gia well. They ask to join studies in which they may not really belong, motivated by the monetary compensation. The question is not why such individuals wish to take part but why anyone would want to enroll them. Testing a drug for bipolar disorder—or any other ailment—on people who feign the condition will skew the results. And yet these subjects are enrolled in trials, over and over again. The reasons why reveal a troubled system, one in which study

TATIANA POPOVA *iStockphoto (pill)*; FERRAN TRAITE SOLER *Getty Images (man with name tags)*

What if this drug helps people who cannot get relief from current medications? If studies of it failed because the wrong subjects were enrolled, those patients would never get a chance to try it.

ADAM GAULT *Getty Images*

sponsors reward researchers for recruiting as many subjects as they can. As a result, studies can produce suspect findings, which then sway doctors' treatment decisions for countless others.

Some of these trials fail altogether, and it may well be because the wrong patients are enrolled. The corresponding increase in the cost of drug development—currently on the order of $1.8 billion to bring a single new drug to market—carries downstream to all of us, as both health care consumers and taxpayers. The problem is particularly acute in psychiatry because the subjective nature of its ailments makes it comparatively easier to enroll the wrong patients. As this country undertakes a historic, and expensive, overhaul of our national health care system, we cannot afford to miss this piece of the puzzle.

FAST FACTS

Subject to Interpretation

1» **Pharmaceutical companies offer financial incentives to researchers to fill drug studies quickly with large numbers of patients who may not be strictly suited to the trial.**

2» **These inappropriate study subjects skew the results or cause trials to fail, and promising drugs never reach the patients they could have helped.**

3» **The rising costs of these failed trials carry downstream to health care consumers and taxpayers.**

When Quantity Trumps Quality

Ten years ago, when I first entered medical school, the pharmaceutical industry was barely on my radar. I would see residents carrying briefcases emblazoned with various companies' logos, perhaps stopping in at sponsored luncheons to grab a tuna wrap on their way back to the wards. That was about it. The medical research in which I participated as a student was, to my knowledge, sponsored entirely by the government. Only years later did I realize how anomalous such publicly funded research was fast becoming.

Today less and less drug research is conducted in academic settings, and a still smaller sliver is not industry-sponsored. In 1994 an estimated 70 percent of clinical researchers were affiliated with academic medical centers, but by 2006 only 36 percent were, according to the Tufts Center for the Study of Drug Development. Even within academic institutions, 36 percent of the grants to run clinical trials come from industry.

In the past few years the federal government has enacted various regulations to combat the worrisome influence of pharmaceutical companies on medical practice [*see box on opposite page*]. The extent of their influence on medical research, however, is less widely appreciated. Within psychiatric research, the harmful effects of industry-sponsored incentives for subject recruitment on study integrity and patient well-being are especially pernicious.

Here is a typical scenario for a psychiatric drug trial: A pharmaceutical company wants to test a

Investigators may receive direct payments of anywhere from $10,000 to $30,000 per patient enrolled.

compound that has been shown to, say, reduce depressive behavior in mice. First, it needs to demonstrate with small trials that the compound is safe for ingestion by humans. The next step is to give it to a large number of depressed patients and see if it helps. The subjects are randomized to receive either the potential new drug or a comparison pill, which may be an existing treatment or a placebo—a sugar pill. The researchers and health professionals running the study do not know who is getting which pill. At the end of a prearranged time period, the patients are assessed, and the numbers are crunched to see if the drug helped patients more than the placebo or existing treatment.

A major hurdle during this process is that study subjects are in short supply. "Where there used to be 50 schizophrenia trial sites, there must be thousands now, and they're scrambling over each other to do these things," says Joseph McEvoy, a schizophrenia researcher and Duke University professor. The profitability of psychiatric drugs fuels the drive for new products. In 2010 antipsychotics and antidepressants were among the top-five highest-selling classes of drugs, generating $16.9 billion and $16.1 billion, respectively, that year, according to consulting group IMS Health.

Despite the difficulty of recruiting subjects, many doctors continue to take part in this process in the hope of developing better treatments down the road. Academic physicians are also often compelled by the need to publish papers: their job depends on it. In the past two decades, however, a third motivation—direct profit—has come strikingly to the fore. Industry-sponsored studies now employ a variety of financial incentives to accelerate the recruitment of trial subjects. Investigators may receive direct payments of anywhere from $10,000 to $30,000 per patient enrolled, according to McEvoy. Competitive enrollment, in which multiple sites vie to enlist as many patients as they can before a study is full, also encourages haste. Recruiters may even receive bonuses after they have enlisted a certain number of patients. The process can become a kind of a race, with new monetary rewards at every turn. Investigators are motivated to enroll more patients, not better ones, as quickly as possible.

"There's a lot of concern about this [recruitment issue]. Substantial bonuses are paid for each patient who's actually included in the study, so you're giving people incentives to fudge," says Paul S. Appelbaum, a Columbia University professor of law and ethics and a past president of the American Psychiatric Association. "It is understandable why you might be seeing enrollment of people who are not truly eligible for the study."

With such enormous sums hanging in the balance, it would be tempting to enroll everyone you know. Quantity rather than quality becomes the goal.

Regulating Conflicts of Interest

Mounting revelations about conflicts of interest in medicine have triggered a number of attempts at reform across the U.S.

Under the Physician Payments Sunshine provisions in the Patient Protection and Affordable Care Act, as of 2013 the pharmaceutical industry will be required to report any payments made to physicians and teaching hospitals to the federal government.

Medical research centers have also begun changing several long-held practices. Many academic campuses around the country have banned pharmaceutical company–sponsored lunches and even standard freebies such as pens. During the past decade internal review boards at many academic medical centers have been lowering the monetary threshold for the disclosure of conflicts of interest.

At the federal level, in May 2011 the U.S. Food and Drug Administration toughened its financial disclosure requirements in response to a damning report by the Department of Health and Human Services. Last July the federal Office for Human Research Protections suggested mandating that researchers disclose their financial interests in a study to potential subjects. —*G.R.*

J. EMILIO FLORES *Redux Pictures*

People may line up to participate in studies if they cannot afford treatment otherwise.

CHRIS WHITEHEAD *Getty Images*

Room to Fudge

Although financial incentives exist in a variety of research fields, psychiatry is uniquely vulnerable to the problem of inappropriate subject selection. This is because of the imprecision of psychiatric metrics. To be admitted to a study of anticholesterol agents, a person's lipid profile must meet particular thresholds. No such laboratory tests exist for psychiatric disorders. "There's no way we can determine whether or not a patient is truly hearing voices, for example," says John M. Kane, an Albert Einstein College of Medicine professor who researches schizophrenia.

To minimize subjectivity, doctors use rating scales to verify that a psychiatric patient has a given disorder. For studies of bipolar disorder, say, researchers often use the Young Mania Rating Scale to assess the severity of the "up," or manic, half of the disease. These questionnaires rely heavily on self-reporting; a savvy subject could exaggerate his or her way into enrollment. The measures include just enough wiggle room for the evaluating physician to tip the balance, too.

The mismatch between a patient and a trial can be subtle—the patient may carry the correct diagnosis but not be acutely ill, or the diagnosis may seem slightly off. Other times, however, the claims can strain credulity.

Jack, a doctor who trained at a well-regarded academic hospital, recalls a teaching session in which a psychiatrist interviewed a patient, Eileen. Eileen had been admitted to the ward the night before as part of a study. In the interview, she spoke of her relationship troubles, her feelings of abandonment, her frequent crying spells. She sat slumped in her chair, did not make eye contact, spoke slowly and conveyed a sense of hopelessness. It did not take a professional to apply the word "depressed."

After the session, the group discussed her case. Jack asked Ann, the resident treating Eileen, to which study Eileen had been admitted.

"The bipolar study," Ann said. "Of acute mania."

The psychiatrist, visiting from another hospital, rolled his eyes. The exuberance of mania was as far from Eileen's state as symptoms could be.

In other cases, the patients themselves, such as Gia, wish to enroll in studies in which they do not belong. "What I see is malingering patients who want money, who aren't even mentally ill," says Helene, an inpatient psychiatric nurse who has worked in both academic and private hospitals. "They brag about what other studies they've done. I see no symptoms of anything. They're coming in for the money." When she expresses hesitation about the appropriateness of a patient for a given study, she says, research assistants give her a half smile and walk away.

Failed Trials, Stalled Drugs

One outcome of studies populated by inappropriate subjects is that the drugs in question may fail to pass the test: they may appear no more effective than a placebo or other current treatments. Failed trials have a far-reaching impact. Patients who may have benefited from the drug will never receive it. Pharmaceutical companies must make up the wasted money by raising prices for prescriptions. Ac-

(The Author)

GABRIELLA ROSEN is a physician and a writer who covers issues in contemporary medicine for film and print. She did her internship in psychiatry.

Researchers with a financial stake deem patients significantly more ill than scientists not motivated to fill a study.

cording to a report in 2003 by the U.S. Department of Health and Human Services, pharmaceuticals represent the fastest-growing health care expenditure and the largest source of cost increases among federal health care programs.

Within psychiatry, trials fail at astounding rates. Half of all antidepressant trials, for example, do not pass muster. A trial might produce poor results for a number of possible reasons, but in psychiatry, the main problem is that the drugs are not showing any benefit over placebos. This could be because the new compounds are worthless. But there are signs that something else is going on. For the past two decades the number of psychiatric subjects who appear to be getting better on placebos has been increasing. High placebo response rates make it difficult to tell if a drug works: if half of all the patients who take a sugar pill get better, significantly more than half who take the drug must improve for it to look effective.

A growing body of studies has directly implicated inappropriate subject selection as a cause for the rising placebo response rate. These studies compare subject evaluations done by disinterested researchers with those of researchers who have incentives to fill studies. Investigators with a financial stake have been shown to deem patients significantly more ill than scientists not motivated to fill a study. When subjects are later evaluated for improvement, the participants in the financially motivated groups appear to have gotten better across the board.

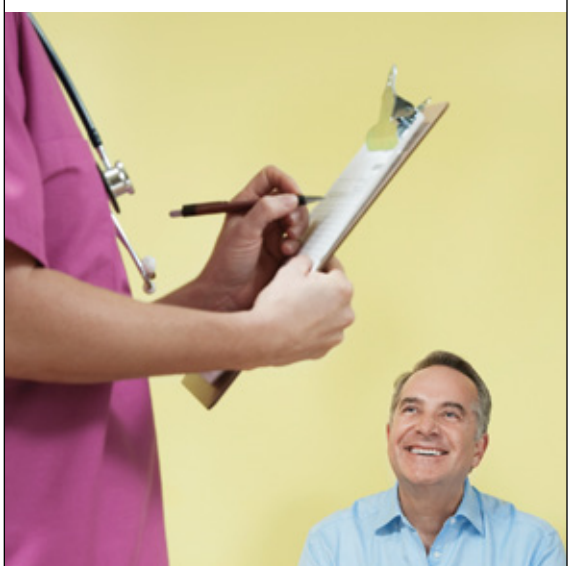
To understand how this affects placebo rates, let us imagine a potential subject, Paul. To be eligible for a depression study, Paul must be given an 8 out of 10 rating on a depression scale. Even though Paul is really only a 6 out of 10, the researcher rates him an 8, so he can enroll. Any subsequent ratings that show Paul is a 6 will look like improvements—but in fact, he was always a 6. In any given study, half of the pool will be taking a placebo; hence, patients such as Paul will appear to be getting better—even on a sugar pill.

Much of the data on subject enrollment comes from companies with a financial interest in the findings. Called centralized ratings companies, these contractors employ off-site physicians to remotely evaluate psychiatric subjects via video. They claim to offer pharmaceutical companies more accurate assessments than on-site researchers. A 2010 paper funded by MedAvante, one of the largest of such companies, for example, found that MedAvante's raters excluded more subjects than did local raters at the research site and had lower placebo response rates. In other words, when subjects were more objectively selected, the placebo response rate declined.

Some experts question whether these studies can be trusted because of their origin. It is an important consideration. Nevertheless, the data add up. McEvoy concurs: "My belief is that this [high placebo response rate] is almost entirely related to subject selection," he says. "Twenty or 30 years ago you would find large placebo-drug differences. [Patients taking] placebo would get worse and [those taking an] active drug would get a lot better because they actually put the right people into the trial."

Consequences for Patients

The most troubling repercussions of using inappropriate subjects are those felt by patients themselves. When a drug fails after being tested on the wrong people, there is no way to know whether it might have actually worked on the right ones. Patients in need never get the chance to try these treatments. In the meantime, subjects have needlessly been exposed to risk. Even a recent paper by Glaxo-



CORBIS

Nurses report tending to patients who are clearly not ill but malingering so that they can be paid to be in a study. The time nurses spend administering to such research subjects means less time spent on patients who are truly in need.

SmithKline employees makes note of this outcome. Given that half of all antidepressant trials are failing, half of all patients enrolled in those trials place their health in jeopardy with "no probability of a contribution to knowledge."

The risks to study participants are numerous. Most obvious is the exposure to the experimental chemical itself, which may have been tested only in animals. In addition, when patients start on a new drug, they must usually stop taking the medications already known to treat their conditions. As a result, their mental states may worsen, even putting them at risk for suicide. These risks are greatest when patients end up in the placebo group. For this reason, placebo-controlled trials remain controversial within psychiatry, even when subjects are well matched to a study. When researchers are given incentives to include as many patients as possible, they may be less careful in selecting those who can safely transition to a placebo.

A psychiatrist named Ethan, who worked in the same academic hospital as Jack, once tried to protect a patient from the risks of a placebo-controlled trial. The patient in question, a woman in her late 40s, had suffered from violent delusions for many months before her family convinced her to get help. During her inpatient admission, the research team on that ward had approached her about participating in a placebo-controlled trial. Ethan felt she would suffer too greatly if she ended up in the placebo arm. He counseled her accordingly, only to receive a dressing down by his bosses, who needed recruits for the study. "There's a feeling of ambivalence," he says, "of wanting to learn something from your superiors and also finding what they're doing is unethical."

The larger shift to rewarding good science over fast science seems inevitable now that speed has proved unprofitable.

Another risk to patients in trials comes from the exclusion of supplemental medications. Imagine that you have a migraine. In the emergency room, you agree to participate in a study because you have no insurance. You are then randomized to receive either nothing or a drug that *may* work. You are also informed that you cannot take even Tylenol, lest it compromise the results. In antipsychotic trials, commonly used adjunctive medications such as sedatives are frequently excluded. So when an actively psychotic, agitated, anxious, insomniac patient asks his doctor for something to help him calm down, the doctor is not allowed to give him the most effective medications available. As a physician, the inability to provide relief for one's patient is heartbreaking. The inability to provide relief when good, proved treatments exist is maddening. Without the incentives to rapidly recruit new patients for trials, researchers could be more careful to include only those for whom a trial would not be too dangerous or painful.

Patients can always refuse the invitation to be in a study, of course. But if they need the stipend or

Psychiatric diagnosis is an imprecise science. Patients can exaggerate their symptoms, or researchers may judge someone to be more ill than they really are.

STEVE COLE Getty Images

have run out of treatment options, they may "elect" to participate. Is it coercion? Historically, subject enrollment might have been more literally coercive in, say, asylum or prison populations. Nevertheless, many in the field worry that lower-income patients who either need the money or cannot afford conventional treatment are subject to a different kind of pressure. It is "coercion through lack of income," explains David J. Rothman, a Columbia professor with expertise in medical ethics. Monetary need may cloud a patient's decision making, exposing the individual to a greater level of risk than he or she might otherwise accept.

At the Tipping Point

The good news is that pharmaceutical companies cannot afford to continue business as usual. Their most lucrative drugs are going off patent, with no adequate replacements in sight. Large-scale drug trials—phase III in the Food and Drug Administration's approval process—fail 42 percent of the time, according to a 2006 article in *McKinsey Quarterly*, a business journal. The cost of these failures is astounding. Cutting Edge Information, a life sciences consulting firm, reports that the per-patient cost of running phase III trials has nearly doubled since 2008, from roughly $50,000 per patient to $100,000. Now figure that phase III trials involve hundreds to thousands of patients each, and the financial impact of unsuccessful trials becomes clear.

As more and more trials fail, and costs soar, pharmaceutical companies will have no choice but to rethink their enrollment incentives. The central ratings model represents one possible solution, although a fair amount of resistance to and skepticism about it remains within the field. The larger shift to rewarding good science over fast science seems inevitable now that speed has proved unprofitable. How exactly that will work remains to be seen.

The goal of these efforts should not be to separate medical research from industry but to shape the interaction so as to encourage the best science possible. "If we separate the talent and the skills of people in medical schools from the talent and skills of drug companies, we won't have any new products," says Eric G. Campbell, a Harvard University professor who studies physician conflict of interest. Ultimately responsibility for recruiting the right patients has to lie with the researchers themselves. One of the greatest obstacles for physician researchers to surmount so that they can effectively police their own work may in fact be denial. "I think there's a good deal of resistance, still, to believing that physicians can be influenced in these indirect ways," Columbia's Appelbaum explains. "There is a strong tendency within the profession to believe that we are objective, but in fact we are just like everybody else."

With any luck, a radical restructuring of researcher incentives will soon bolster physicians looking to do the right thing. Everyone—patients, doctors, pharmaceutical executives, taxpayers—stands to benefit from such reinvention. M

When off-site physicians with no financial stake in the research evaluate patients via video, they rate the subjects as less ill.

PAULINE ST. DENIS *Corbis*

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- Report concerns about research practices at a particular site, anonymously or not, by contacting the Office for Human Research Protections (for federally funded studies) via telephone or e-mail: toll-free at (866) 447-4777 or OHRP@hhs.gov. For any FDA-regulated trials, send e-mail to gcp.questions@fda.hhs.gov

RE-CREATING THE REAL WORLD

To what extent do we truly experience reality? **By Bruce Hood**

In the 1999 Hollywood blockbuster *The Matrix*, intelligent machines have imprisoned the human race in a state of virtual reality. They feed a computer program, the Matrix, into every brain to simulate an external real world and then harvest the imprisoned humans' biochemical electricity for their own energy needs. To the humans, their existence seems normal and mundane, but in fact, they are living an illusion.

Although the Matrix is fictional, our mind runs on its own type of virtual reality. The brain creates a model of the world that we assume is accurate most of the time. Yet in numerous instances, it is not. Visual illusions vividly illustrate the brain's mistaken interpretations. In some cases, it makes false assumptions about the world, distorting our perception.

Recent work has revealed neural activity in the brain underlying—or corresponding to—several types of illusory perceptions. Instead of simply seeing what is there, these findings suggest we are perpetually re-creating the world around us using the Matrix inside our head.

I Think, Therefore I Am

For centuries philosophers and scientists have floated the idea that the mind creates its own version of its surroundings. Plato proposed that there are dimensions to reality beyond our reach and that humans are living out only a shadow of the truth. In the 17th century René Descartes famously contemplated his own mind and came to the conclusion that experiencing reality was not foolproof and that the only certainty was the experience of thought. Hence, "I think, therefore I am."

In the late 1800s German physician and physicist Hermann von Helmholtz recognized that illusions reveal the active processes of interpreting the external world and that these phenomena could be studied and measured. One hundred years later my former colleague Richard L. Gregory, a psychologist at the University of Bristol in England, spent much of his life investigating illusions as hypotheses that the brain generates to interpret a complicated, obfuscated and ambiguous

GETTY IMAGES

In this illusion, the girl looks larger than the boy and the man because the brain assumes a box-shaped room. In reality, the room is trapezoidal. The girl is closer and on higher ground than the males, who are of equal height and taller than she is.

The world does not passively impose itself on our mind; rather it has to be actively interpreted.

world. The world does not passively impose itself on our mind; rather it has to be actively interpreted.

Some of this interpretation comes from top-down processes that reflect knowledge that is acquired through experience. For example, perspective cues in the Ames room illusion fool the brain into thinking that the room conforms to the usual geometry—all walls and floor meet at a 90-degree angle [*see illustration above*].

Because we assume it is a normal room, we conclude that the individuals pictured are at the same distance from the observer—and that the girl must be much larger than the two males. In reality, however, the room is a trapezoid, with the floor slanting steeply upward toward the right. The males are of equal height, and the girl is much smaller than they are. Perspective cues provide the framework for our judgments of size.

Such cues also help us to maintain constancy of perception as we move around in a world in which objects project changing size information onto the retina, the layers of light-receiving cells at the back of the eye. For example, the brain calibrates its estimate of the size of objects using other features of the environment, such as the texture of the ground. As a result, things that are farther away do not seem smaller even though they project a smaller image on the retina. A similar adjustment explains the lunar illusion in which the moon seems much larger on the horizon than it does in the sky: on the horizon, the eyes compare its size with known landmarks, whereas the sky contains no such visual guideposts.

Perspective illusions are not unique to humans. The male great bowerbird (*Chlamydera nuchalis*) of Australia constructs an elaborate bower made of two stick walls to create an avenue [*see illustration at right*]. This structure acts as a court where the female sits and watches the male perform mating displays outside. At the end where he struts his stuff, the ground is covered with a collection of shells, stones and bones.

(The Author)

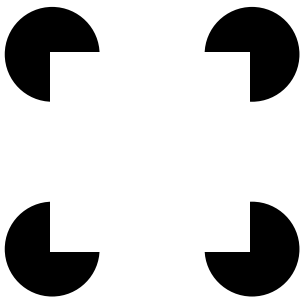
BRUCE HOOD is professor of developmental psychology in society at the University of Bristol in England and author of *The Self Illusion: How the Social Brain Creates Identity* (Oxford University Press, 2012). He presented the 2011 Royal Institution Christmas Lectures, a three-part series called "Meet Your Brain," which was later broadcast on the BBC (http://richannel.org).

Remarkably, the male bowerbird places objects of increasing size farther away from the vantage point of the female, creating an illusion similar to the Ames room in which the bird's stage appears foreshortened. This design is deliberate. In a study published in January ecologists Laura Kelley and John Endler of Deakin University in Australia rearranged the objects, putting large items closer to the bower. The male bowerbirds rapidly restored the items to their original configuration. One speculation is that the illusion captures the female's attention long enough for the male to enter the bower and mate.

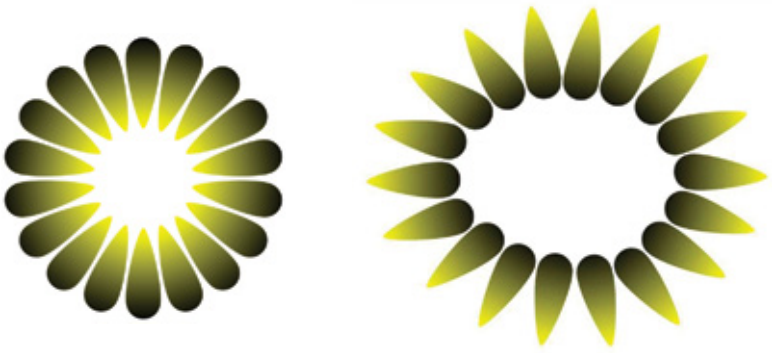
Other illusions are less top-down and more bottom-up—that is, rooted in the neural machinery underlying basic sensory experience. For example, when the vehicle in which you have been traveling comes to a stop, you see the world start to move in the opposite direction—an illusion called the motion aftereffect. The brain calculates direction by adding input from various movement detectors. In this effect, the visual cells that process perceived motion in the original direc-

The male great bowerbird arranges shells, stones and bones such that smaller ones are closer to the stick edifice in which a female waits. The resulting illusion of a foreshortened stage (on which the male performs mating displays) is thought to capture the female's attention.

COURTESY OF THE ROYAL INSTITUTION AND PAUL WILKINSON (*top*); COURTESY OF L. A. KELLEY *Deakin University* (*bottom*)



Cells in the brain that underlie our perception of real boundaries also respond to illusory edges such as those depicted here.



Look at the center of each of design. Which one seems brighter? Most people say the one on the left, although they are, in fact, equally bright. Nevertheless, researchers found the pupil constricts more when we look at the image on the left, indicating that our nervous systems respond to perceived brightness rather than actual luminance.

tion become temporarily "habituated," or tired, causing them to stop sending signals. Cells processing motion in the opposite direction are still active, however. The temporary imbalance makes the visual world appear to shift in the opposite direction.

Duped Neurons

In recent years scientists have begun to investigate the bottom-up neural mechanisms that produce top-down illusions. Psychologist Gaetano Kanizsa, the late founder of the Institute of Psychology of Trieste in Italy, popularized illusory contour images, which create the impression of geometric shapes with edges and surfaces that are in fact nonexistent [*see illustration at top left*].

In 1984 neurophysiologist Rudiger von der Heydt and his colleagues at Johns Hopkins University discovered visual neurons called end-stopped cells that responded to real boundaries but also registered illusory contours. The activity of these cells causes the brain to interpret the illusory boundaries as real.

Since this initial discovery, a number of studies have shown that the brain treats Kanizsa shapes as if they were real objects. For example, in 1985 neuropsychologist Vilayanur S. Ramachandran of the University of California, San Diego, reported that a common trick used by animators to create the perception of an object's movement also applies to illusory contour images. When these illusory shapes are transposed between two locations on subsequent frames, they appear to have migrated. In 2006 neuroscientists Mohamed Seghier and Patrik Vuilleumier of the University of Geneva in Switzerland published neuroimaging findings showing that the apparent movement of these shapes activates motion-sensitive regions of the visual cortex. The brain treats these geometric ghosts as if they were real moving objects.

In February psychologists Bruno Laeng and Tor Endestad of the University of Oslo in Norway used pupil dilation to reveal the most dramatic example so far of the real effects of illusions. The pupil automatically constricts in response to strong light to protect receptors in the retina from damage. Scientists have assumed that the reflex is involuntary, as it is evident in comatose patients, and that it is triggered by the amount of absolute luminance. In their study Laeng and Endestad used an infrared sensor to measure the pupil size of observers as they looked at the brightness illusion shown in the two illustrations at the top right. Although the center of each design has the same amount of physical luminance, the pattern on the left appears subjectively brighter. Accordingly, the researchers found that participants' pupils constricted more in response to the image on the left than to the one on the right, indicating that a subjective experience of brightness—not actual luminance—governs this response. Regardless of reality, the visual system interprets the apparently brighter pattern as a greater threat to the eye.

Researchers have also found neural correlates for illusions involving senses other than vision, such as hearing and touch. At one level, these findings are unremarkable because it is generally accepted that mental experiences must have a basis in the brain. On another level, they demonstrate that we have no direct contact with reality. Our brain is always abstracting and interpreting the world around us. Even when we know the true nature of an illusion, this insight often does not change our experience. As far as the brain is concerned, if an event is an illusion, it might as well be real. M

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SCIENTIFIC AMERICAN MIND (*left*); COURTESY OF AKIYOSHI KITAOKA *Ritsumeikan University* (*right*)

CHANGING A CHILD'S MIND

Children come to school with different aptitudes, many of which determine their ability to learn. Some are quicker at grasping the concepts and skills that form the core of most educational curricula. Others are better able to concentrate or make friends. Some seem lazy; others determined. As a result, we label children as smart, attentive, social and hardworking—or as slow, distracted, shy and lackadaisical. The labels suggest fixed traits, not teachable skills.

In recent years, however, researchers have begun to parse the basic brain functions that form the foundation for many of the qualities and abilities necessary to succeed in school—and in later life. These "executive functions" include the mental lifting and maneuvering that manifest as intelligence, as well as the behavioral control vital for qualities such as focus, persistence and restraint. New research now suggests that these essential brain functions are not immutable. They are rapidly developing in youngsters, and the environment can alter their course.

Educators and scientists are weaving curricula into classrooms that are designed to mold executive functions and, through them, the character traits important for academic achievement and beyond. One major goal of these programs, as we report on page 48, is to give children better control over their own thoughts and emotions. Meanwhile researchers have discovered a method of brain training that can boost intelligence in children and adults alike (page 59). Scientists have also demonstrated that stress is a powerful and ubiquitous impediment to both brain function and success in school (page 64). Efforts to counteract this toxin to thinking are therefore critical for enabling children to reach their full potential.

—The Editors

ILLUSTRATIONS BY PATRICK GEORGE

THE EDUCATION OF CHARACTER

Scientists, politicians and celebrities are **remaking schools** as gyms for the brain where teachers build the mental brawn for attention, perseverance and emotional control

By Ingrid Wickelgren

PHOTOGRAPHY BY CHRISTOPHER MORRIS

A tiny dark-haired girl bedecked in a brown dress with a crinoline skirt sits calmly on the rug in front of her class of fellow kindergartners; her pink boots, dotted with sparkles, are tucked neatly under her legs. Wielding a small metal rod, she taps on a triangular chime. At the tone, her classmates clasp their hands together like a cup, with the back of one hand in the palm of the other, close their eyes, fall silent, and proceed to say and do apparently nothing.

Minutes pass. Then the fancily frocked girl strikes the triangle a second time. Kids begin to open their eyes, and after a pause a sweet, high-pitched "thank you" emerges from the girl, and she reassumes her place among her classmates.

In this exercise performed three times every day in Patricia Morris's class at Renfrew Elementary School in Vancouver, B.C., the children focus on their breathing, an activity that hardly seems pedagogical. Proponents say, however, these meditative bouts hone the ability to concentrate and to relax, tuning a child's brain for learning and for life. They are one piece of a program called MindUP conceived by actor Goldie Hawn, who debuted it in this city several years ago. Today the Vancouver school board sanctions it, and fueled by success stories, it is spreading through the U.S. and trickling into other countries.

Hawn's program, which also includes brain anatomy lessons and strategies spun from positive psychology such as training in optimism, is one of several curricula aimed at

Social and emotional learning is designed to sculpt fundamental abilities such as paying attention and exercising self-control. In one program, children learn to focus on, and control, their breathing.

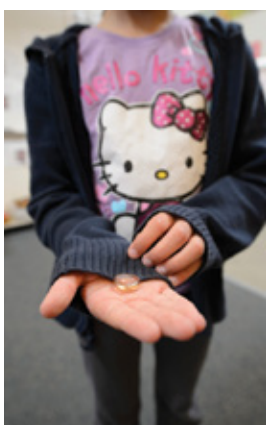
A student points to a region of the brain at Sir William Van Horne Elementary School in Vancouver. She and her classmates invoke brain anatomy daily in lessons that teach more than just science. The exercise of thinking about thinking—or metacognition—is designed to help children better regulate their own thoughts and actions.

redesigning education. A burgeoning number of researchers and educators believe that school should include more than remembering and analyzing information. It also should sharpen fundamental psychological skills called executive functions that are needed to plan and carry out goals. Akin to an air traffic-control system that manages the comings and goings of planes on multiple runways, these brain functions include the ability to hold and manipulate information in mind (working memory), to switch mental gears and to inhibit inappropriate responses.

Facility with some of these mental knobs is closely tied to intelligence [see "Building Better Brains," on page 59]. Yet others constitute a gold mine of brilliance that has proved to be more important to success and well-being than have measures of IQ. In particular, inhibitory control, also called self-regulation in some contexts, underlies the ability to pay attention and to act in a way that furthers your goals even when you really want to do something else. Learning issues afflict large numbers of children who have trouble focusing, say, or following through in the face of frustration. "Even more important than your achievement test score is this idea that if you fail, you'll try again, that you don't need people to bail you out, that you'll persevere in the face of difficulty," says developmental psychologist Dale Farran of Vanderbilt University. "These are the key to the grades you get in school."

Beyond grades, the ability to handle emotions and behave appropriately helps us deal with life. Emotional control buffers kids against mental health problems such as anxiety and depression. It also helps them maintain good relationships with others. "Self-regulation is a critical skill that needs explicit, intentional focus in the school curriculum," says developmental psychologist Kimberly A. Schonert-Reichl of the University of British Columbia. "It has such long-range implications for kids' functioning."

Attempts to teach executive function, typically couched as social and emotional learning, have gained political support in recent years. The Collaborative for Academic, Social, and Emotional Learning (CASEL), a non-



When a child is down, she can grasp a "gratitude stone," a soothing reminder to be grateful.

FAST FACTS

Schooling Self-Control

1» Some researchers and educators believe that school should hone psychological skills called executive functions that are needed to plan and carry out goal-directed activity.

2» Learning issues afflict large numbers of children not because they are unintelligent but because they have trouble focusing or following through in the face of frustration.

3» A dispassionate focus on the present—mindfulness—helps to ward off stress and can improve brain function.

4» Thinking about thinking, known as metacognition, may give kids better control over how they think and feel in ways that could enhance learning.

"**SELF-REGULATION** IS A CRITICAL SKILL THAT NEEDS EXPLICIT, INTENTIONAL FOCUS IN THE SCHOOL CURRICULUM. IT HAS SUCH **LONG-RANGE IMPLICATIONS** FOR KIDS' FUNCTIONING."

profit advocacy group, has allocated $7 million this year to establish this type of teaching as an essential part of education. Ohio congressman Tim Ryan, along with representatives Judy Biggert of Illinois and Dale E. Kildee of Michigan, introduced the Academic, Social, and Emotional Learning Act of 2011 to "expand the availability of programs that teach students skills such as problem-solving, conflict resolution, responsible decision-making, relationship building, goal-setting and self discipline," according to the CASEL Web site. This pending legislation is currently awaiting consideration by the House of Representatives.

A third-grade boy uses mindfulness, an unemotional focus on the present, to observe changes in a caterpillar. This type of exercise tunes brain regions essential for success in school and later life.

Meanwhile teachers are already sprinkling the school day with breathing exercises, mood meters, demonstrations of distressed amygdalas, facial-expression cards, and the like, looking for the essential recipe that will nourish children to become the kind of adults we want in the world. Data support each ingredient, and initial studies of these add-on curricula are largely producing positive results. Measuring executive function in children is still an imperfect science, however, making outcomes hard to assess. In addition, the active ingredients of these multipart, "cocktail" interventions are not always obvious, leading researchers to make some guesses in the programs' designs. Yet many educators are toasting their promise—and the accompanying possibility of shaping the character of the developing mind.

I Can't Wait!

Back in the late 1960s psychologist Walter Mischel, then at Stanford University, and his colleagues offered preschoolers attending the Bing Nursery School a choice: they could pick out a cookie, pretzel or marshmallow and eat it now, or if they waited a while, they would get two treats instead of one. Fast-forward to high school: the kids who could wait for the second treat had higher SAT scores. On average, 210 points separated the student who could wait 15 minutes at four years old and the one who stalled only 30 seconds. The patient preschoolers also were better able to pay attention as adolescents; they found it easier to maintain friendships and were less likely to display behavioral problems at school and at home. Mischel trailed this clan into their 30s. He found that the ones who had staved off temptation as children were thinner and less likely to have had drug problems as adults.

From the other side of the globe, last year psychologist Terrie E. Moffitt of Duke University and her colleagues similarly reported a strong connection between self-control and success in 1,000 kids born in Dunedin, New Zealand. Every other year teachers and parents evaluated each child between the ages of three and 11 on his or her levels of aggression, hyperactivity, lack of persistence, inattention and impulsivity. These ratings, along with those from the children themselves, led to a self-control score for every child.

At 32 years old, the boys and girls who had had lower scores were poorer, had worse health, and were more likely to have committed a crime than those exhibiting more self-control. Poor ratings were a stronger predictor of financial troubles than was social class or IQ. In a separate set of 500 sibling pairs, the researchers found that despite a shared family background, the sibling with lower self-control was more likely to smoke, engage in antisocial behaviors and struggle in school.

These studies and others suggest self-control might be a stable characteristic. Yet Moffit's team noticed that some of the Dunedin children improved their scores, as measured by a personality assessment in young adulthood. Mischel, now at Columbia University, and his colleagues also found that children

THE BREATHING CALMS **THE EMOTIONAL STORM**, MAKING THE SKIES FOR LEARNING BLUE AGAIN. FOCUSING ON BREATHING TEACHES KIDS TO PAY ATTENTION TO **MOMENT-BY-MOMENT EXPERIENCE**.

from low-income families in the Bronx had more trouble delaying gratification than did wealthier kids from Palo Alto, suggesting that kids from richer families may be exposed to strategies that facilitate patience more often. "Self-control is malleable, but it is easier for some than for others," Mischel concludes.

Researchers and educators are now testing out different strategies for teaching these pivotal skills. MindUP, one of the more promising initiatives, grew out of Hawn's fascination with brain science as a vehicle for self-improvement. While she was living in Vancouver in 2002, her thoughts turned to children. She invited educational psychologists, neuroscientists and teachers to develop a new curriculum with a brain science scaffold that centered on social and emotional learning. Now MindUP has spread to more than 75 U.S. schools, nearly 175 in Canada, seven in the U.K., two in Australia and one in Venezuela.

Breathe

"What does the breathing do?" Morris asks her class.

"It calms your amygdala down," offers one child.

"It will make your prefrontal cortex so much smarter!" says another.

Morris's charges have become miniature authorities on brain anatomy. The amygdala, at the center of the brain, is a hub of emotional responses, they will tell you. The prefrontal cortex, which blankets part of the brain's surface just behind the forehead, is the seat of executive function. It regulates our emotions, thoughts and actions. The two regions are connected, and their relationship is deep. A storm of emotions raging in the amygdala can weaken the prefrontal cortex, hampering our ability to think and to learn. Kids under a lot of emotional stress, a condition more prevalent in lower-income families, do worse in school because the stress itself impairs executive function [see "Treating a Toxin to Learning," on page 64].

The breathing, as the children report, calms the emotional storm, making the skies for learning blue again. By focusing on their breath, they are learning to pay attention to moment-by-moment experience without judging or thinking too deeply about it. This type of dispassionate focus on the present, called mindfulness, helps to ward off stress that arises from "time travel" into the remembered past, leading to rumination, or the imagined future, spawning anxiety. "It helps me as a teacher because I have a calmer class and I'm calmer," says Marianne

Prins, a gregarious 26-year veteran teacher who teaches MindUP to third graders at Sir William Van Horne Elementary School, also in Vancouver.

A large body of data shows that mindfulness training helps to reduce stress-related diseases in adults. In children, a smattering of pilot studies indicates that it calms healthy kids and reduces anxiety or anxiety-related academic difficulties in nervous students. In a 2009 study neuroscientist Kirk Warren Brown of Virginia Commonwealth University and his colleagues coached teenagers in an outpatient psychiatric facility to engage in several forms of meditation (sitting, walking and body scan, which involves systematically focusing on and relaxing different body parts while lying down). After eight classes conducted over as many weeks, the teens reported significantly less anxiety, stress, interpersonal problems and symptoms of depression than did those who did not take the classes.

MindUP seems to accomplish something similar. In a study presented in May at the Developmental Contemplative Science meeting in Toronto, Schonert-Reichl and doctoral student Molly Stewart Lawlor and their colleagues measured levels of the stress hormone cortisol in 99 fourth and fifth graders in four local schools in March and again in June, a tumultuous month for students as they wrap up their classes for the year. Initially they saw a healthy hormonal pattern in all the children: cortisol peaked one hour after waking and then declined steeply during the day. For the kids who participated in MindUP, the same rise and fall was recorded in June. In contrast, the cortisol levels of kids in the comparison classrooms were flat throughout the day, a pattern indicative of chronic stress. "Our hypothesis is that MindUP buffered kids from that end-of-year stress," Lawlor says.

The breathing also may burnish executive function more directly. In this meditationlike practice, kids learn to inhibit the urge to elaborate on thoughts and feelings that pop into consciousness. The effort helps them resolve mental conflict induced by competing stimuli, or goals, a skill needed to prioritize. Such conflict monitoring, an ability related to attention, has been linked to better math achievement in school, higher IQ and less antisocial behavior. In a study published in 2007 psychologist Michael Posner of the University of Oregon and his co-workers randomly assigned a group of Chinese college students to five daily 20-minute meditation sessions. Compared with a group taught an exercise involving the relaxation of different body parts, these students showed significantly better scores on a computerized test of attention and conflict monitoring. In 2011 a team led by neuroscientist Amishi Jha at the University of Miami reported similar improvements on this test among 13- to 15-year-olds at a school in India that offered daily transcendental meditation exercises for

Various breathing exercises can train attention, lessen stress and help children regulate their emotions. In one, they close their eyes and tune out all other distractions (*far right* and *far left*). In another, they adjust their puffs to gently shift a cotton ball into a partner's hand (*center*).

PROGRAMS SUCH AS MINDUP WORK AS **SPEED AND AGILITY TRAINING** FOR THE BRAIN. "YOU EXERCISE THE MUSCLE OF THE PREFRONTAL CORTEX—AND GET **SPILLOVER INTO ACADEMICS**."

one to three years, as compared with teens in a school that did not offer this practice.

Does It Feel Rough?

On an overcast morning in late February, Prins dumps a basket of gray stones in the center of a circle of students gathered on the rug. She calls different students to pick from the pile. After everyone has a stone, Prins instructs the students to examine theirs for any special marks, to close their eyes and imagine the rock, and to rub it against their cheeks. "Does it feel rough?" she asks brightly. Mindfulness also means paying close attention to the sensory qualities of things—such as the texture, colors, hollows and ridges of a rock. When all the students put their stone back in the pile, the minerals resembled anonymous bits of gravel. The students' job: to find their stone again. In the first round of this rock game the kids had trouble, but in the second, every student recovered the stone they had inspected. Mindfulness takes practice.

In other venues, these kinds of exercises, in combination with breathing, have had measurable effects on kids' executive function. In 2010 behavioral geneticist Susan L. Smalley of the University of California, Los Angeles, and her colleagues reported providing training in mindfulness to 32 second and third graders twice a week for eight weeks. The training included sitting meditation, along with activities and games that pro-

Your partner takes a deep breath. Can you feel your buddy breathe? Try to breathe with him. Making an effort to adjust your breathing can hone basic self-regulation skills.

Marianne Prins gathers her third graders for a mindfulness lesson (*left*). Each child picks a rock and examines it (*right*). The test: Can you find your rock again after putting it back in the pile with the others?

mote sensory awareness and awareness of others. Teachers and parents completed questionnaires assessing the children's inhibitory skills, control of attention, working memory, and emotional regulation before and after the training. The results indicated that exercising mindfulness significantly improved these aptitudes on the whole, as well as particular skills, compared with 32 children assigned to silent reading. The training gave the biggest boost to those whose capacities were initially weaker, a finding consistent with work by Smalley's team hinting that mindfulness training could benefit adolescents with attention-deficit hyperactivity disorder.

Kids who are naturally more mindful also perform better on tests of inhibitory control. In a study published in 2011 doctoral student Eva Oberle of the University of British Columbia, along with Schonert-Reichl, Lawlor and their colleagues, asked 99 fourth and fifth graders to complete a test that asks questions reflecting mindless states such as: "I do jobs or tasks automatically without being aware of what I am doing" and "I snack without being aware of what I am eating." The higher a kid scored on this test of "mindful attention awareness," the more accurate he or she was on a computerized assessment of inhibitory control.

Of course, ordinary school exercises the brain's executive control centers. You cannot read or do a math problem without tapping your working memory, training your focus or suppressing your wish to chat with a friend instead. Yet school is akin to a team practice that drills sport-related skills but does not maximize an athlete's quadriceps power or smooth out her running stride. Programs such as MindUP work as speed and agility training for the brain. "If you teach explicit ways to self-regulate, you exercise the muscle of the prefrontal cortex—and get spillover into academics," Schonert-Reichl says. In her recent study MindUP participants improved more on computerized tests of attention and inhibitory control than did kids in the comparison classes. They also had higher ratings in math on their end-of-year report cards.

These results are not news to teachers. "I can't stress enough how much this has improved my teaching and the academic skills of the children," says Morris, who began using MindUP three years ago. In 2005, the year MindUP debuted in Vancouver, 17 teachers were trained. That number has ballooned to 1,000. "It kind of went viral," Schonert-Reichl says. "There are wait lists for training. I've never seen anything like it."

Green Means Go

Decades before Hawn became interested in education, developmental psychologist Mark T. Greenberg, then at the University of Washington, made one of the first forays into social-emotional learning. Greenberg had been trying to help deaf individuals with self-regulation deficits control their behavior

(The Author)

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TEACHING CHILDREN TO **PRETEND** THAT A MARSHMALLOW WAS ONLY A PICTURE HELPED THEM RESIST THE TREAT FOR MUCH LONGER. "IF THEY **IMAGINE** A PICTURE, THEY CAN WAIT AS IF IT WERE A PICTURE."

by teaching them words for emotions. He realized that the strategies he was using—having people sign or talk out loud to themselves or exposing them to words as visual aids—also seemed to help hearing children control their behavior. "I was interested in language as a self-regulation mechanism in preschool," Greenberg recalls.

In the 1980s Greenberg and Seattle psychologist Carol A. Kusché created Promoting Alternative Thinking Strategies (PATHS), now used in over 3,000 schools in more than 30 U.S. states and as many foreign countries. In one part of the curriculum, kids receive small labeled cards with faces expressing different feelings. They personalize the cards and use them to communicate their emotions throughout the day. Self-regulation is also taught explicitly with the aid of a traffic signal. If students face a difficult or frustrating situation, they focus on the red light, which means "Stop—Calm Down." They are supposed to describe the problem and their feelings about it. Next comes yellow, "Go Slow—Think," that is, make a plan. Green means "Go—Try My Plan."

In a lesson designed to nurture empathy and compassion, a child reacts to the song and accompanying book, "Don't Laugh at Me," in which people who feel ostracized ask for acceptance from others.

In a study published in 2010 Greenberg, now at Pennsylvania State University, and his colleagues tested these techniques in 2,937 students, many of them disadvantaged, as they advanced from first through third grade in schools in Nashville, Seattle and rural Pennsylvania. According to teacher and peer evaluations, the kids in the 190 classrooms that received the PATHS instruction became less aggressive and more cooperative and helpful, compared with those in 180 classrooms that did not include the intervention. The kids getting PATHS were also more academically engaged—showing more self-control during school-based tasks, teachers said—than those getting instruction as usual.

PATHS may produce these gains by boosting executive function. Several years ago Greenberg, along with Nathaniel R. Riggs of the University of Southern California and their colleagues, tested the inhibitory control of 318 second and third graders from four schools in Seattle. In two of the schools, teachers gave 20 to 30 minutes of PATHS lessons three times a week from October through March. A year later these students had better inhibitory control than did kids in the two other schools.

Red Riding Hood's Problem

In part because of MindUP, Prins presides over a few of the school's most anxious children. Almost as soon as her lesson began one morning, a little boy burst into tears, the reason unclear. "His amygdala is all shook up," Prins says. She picks up a two-liter soda bottle filled with water and sand, turns it upside down and agitates it. "What can we do in our class when our amygdala is shaken up?" she asks. Some of the kids made a "peace" sign with their fingers. The gesture means a child needs to take a walk while his amygdala calms down.

In Prins's class, a diagram of the brain with a labeled prefrontal cortex, amygdala and hippocampus, a storehouse for memories, hangs on the wall. Prins reviews the structures and their roles daily and makes connections to her lessons. "Red Riding Hood had a problem with her amygdala with the wolf," she once told her class. One MindUP lesson for grades three through five centers on the anatomy and function of a neuron; another is a discussion of the brain chemistry of pleasure and reward.

Teachers say their students are fascinated by how their brain works. Yet the main purpose of the lessons is more philosophical than scientific. "It gives kids a certain level of empowerment," Schonert-Reichl says. "They learn they can change their mind." The exercise of thinking about thinking, known as metacognition, is designed to give kids better control over how they think and feel—directing their attention more appropriately or calm-

ing themselves down—in ways that could enhance learning.

Do the neuroanatomy lessons really improve self-control? "I don't think kids need to know about the amygdala," says Adele Diamond, a developmental cognitive neuroscientist at the University of British Columbia. "But kids enjoy learning about the brain." And yet some data hint that Hawn might be on to something.

A girl flips and shakes a bottle filled with sand and water to show the tumult in her brain when she feels stress. When she rights the bottle and the sand settles, she can see how long it takes her brain to revert to a calmer state in which it can make smart decisions.

Keep Away

Mischel and psychologist Angela L. Duckworth of the University of Pennsylvania have found that one of the best ways to summon restraint is to separate yourself from whatever is provoking an emotional response. Kids who covered their cookie, Mischel says, could linger 18 minutes without indulging, whereas those who left the treat exposed bit into it in less than a minute. Teaching children to pretend that a marshmallow was only a picture stretched out their ability to resist from one minute to a quarter of an hour. "If they imagine a picture, they can wait as if it were a picture," Mischel says.

In a study published in 2011 Mischel and Duckworth, along with psychologist Ethan Kross of the University of Michigan, and their colleagues established the power of distancing on cooling hot emotions in children. They asked 110 fifth graders from a public school to recall a personal experience that made them very angry. Some of the kids imagined it was happening to them again. Others were instructed to step back and watch themselves and the event unfold from a distance. All the students then wrote an essay in which they reflected on their experiences. In their essays, students adopting the distant perspective dwelled considerably less on the event's emotional features and included fewer blame statements and more insightful reappraisals of what happened.

Learning about the brain might help kids distance themselves from their emotions by putting them in an abstract context. Mindfulness also involves stepping back from your thoughts and feelings. Moreover, the use of language, as in PATHS, can put space between the impulse to act and the action itself.

Kross and Duckworth are now planning to test the broad applicability of the distancing technique on groups of children in grades five through nine attending Philadelphia charter schools. The psychologists will coach the kids to reflect on their actions during different self-control tasks by encouraging them to either focus on their perspective by talking to themselves using language such as "I" and "my" or cultivate a sense of distance by referring to themselves in the third person. Then the researchers will measure the children's capacity to persevere in a boring work task (sorting chips by color), wait for a delayed reward (seven dollars in a week versus five dollars now) and control their anger related to a recollected experience.

For Good Measure

Tweaking the minds of children can be tricky, however. In as yet unpublished work, Vanderbilt's Farran and her colleagues tested an intervention called Tools of the Mind, which uses self-talk, visual reminders and play to improve executive function in kids. Farran's team randomly assigned the curriculum to 32 prekindergarten classrooms in Tennessee and North Carolina. They measured the students' executive function and achievement before and after eight months of the program. Children did show gains, but no more so than did kids in 28 classrooms that did not offer Tools. "The measures we have, including teacher ratings, did not show that the program was more effective than what they normally do in preschool," Farran says.

Earlier studies had shown benefits from Tools when the pro-

This workout is for the brain, too. While they jump, jog and bring elbow to knee, these kids practice paying attention to signals from their bodies and connecting them to emotions. Monitoring both types of feelings is thought to improve the ability to manage your moods and control your behavior.

gram was simpler, involving 40 activities instead of the 65 now prescribed. Farran believes this proliferation of elements might be diluting the effectiveness of the program. A second issue is that no perfect measure of executive function exists, perhaps because the concept itself is still somewhat ill defined. That ambiguity has not stopped teachers such as Prins, however, who see the positive effects of brain training on a daily basis.

Outside of Prins's class in Vancouver, the slush was melting and water dripped from every branch and gutter. Inside, the kids did "brain exercises." Smiling and panting, they touched their right elbow to left knee. They rubbed their tummies while patting their heads. They did jumping jacks. The choreography was designed to optimally excite the prefrontal cortex. Yet the children's faces indicated that the exact moves might not matter. In Schonert-Reichl's latest investigation, those in the MindUP classes became more optimistic, had more positive emotions and liked school better than other students did. And it is well known that the neurotransmitter dopamine, associated with joy and pleasure, primes the prefrontal cortex for action. "School needs to be more fun," British Columbia's Diamond says. "Kids will buy in. They will learn better." If the grown-ups succeed in making kids better thinkers, the kids should get the last laugh. M

(Further Reading)

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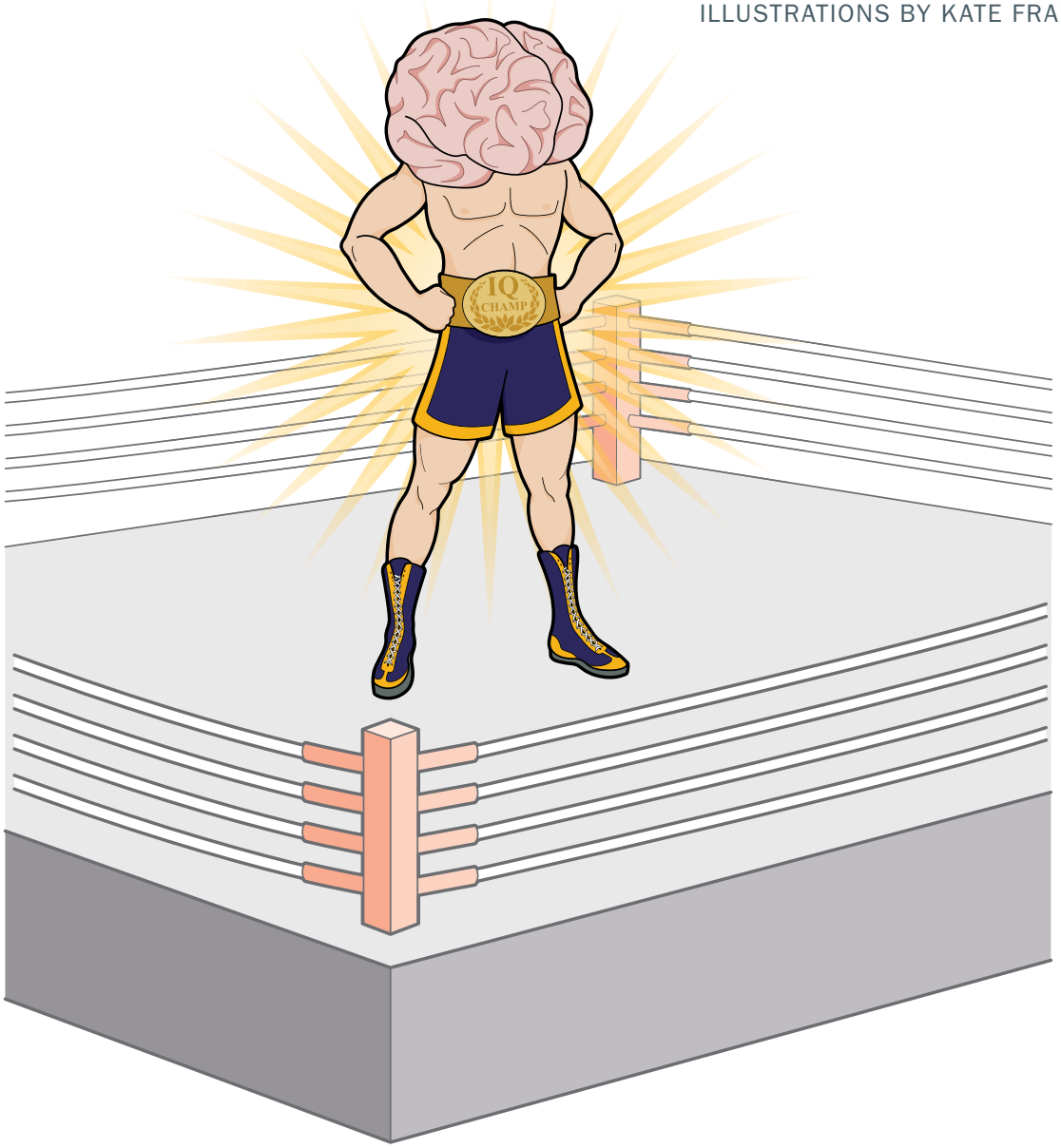
BUILDING BETTER BRAINS

Recent studies indicate that some types of brain training can **make you smarter**

By John Jonides, Susanne M. Jaeggi, Martin Buschkuehl and Priti Shah

ILLUSTRATIONS BY KATE FRANCIS



If you want to strengthen your abdominal muscles, you can do sit-ups. Tone your upper body? Push-ups. To flex your intellectual muscles, however, or boost your children's academic performance, the answer is less clear. An exercise to stretch memory, tighten attention and increase intelligence could improve children's chances of coasting comfortably through life—and give adults a leg up as well.

The very notion flies in the face of conventional wisdom. Most people presume that no matter how hard they work, they are not going to get any smarter. Some subjects in our research laboratory, though, have increased their IQ scores after training their brain for as little as three weeks. The improvement can be significant enough that, anecdotally at least, a few participants noticed a difference in their daily activities. One individual, for example, reported sharper chess skills, stating, "I can plan further ahead." Another said that it felt easier to sight-read music while playing the piano.

How is this possible? Researchers have long believed that fluid intelligence—which reflects how well you tackle a new task rather than what facts you possess—is a fixed attribute, directly inherited or acquired very early in life. Indeed, evidence shows that fluid intelligence, as with height, is highly heritable, by some estimates as much as 50 to 80 percent. Yet intelligence can still be honed. Just as nutrition can influence height, environmental variables can also either brighten or beleaguer minds. Consider the Flynn effect: over at least the past 65 years measured intelligence, such as scores on the SAT, has steadily increased even though the genetic constitution of the population has not changed measurably.

Because high fluid intelligence typically leads to academic achievement and career success, scientists have long sought to alter it by various means, among them teaching reasoning strategies and test-taking skills. Most of these pursuits have met with limited or no success. More recently, though, in our laboratories and others, researchers have begun exploring the idea that some cognitive training activities—in particular, tasks that exercise working memory—can make a difference. Working memory, also referred to as short-term memory, keeps vital information at the ready so that other parts of the brain can tap it to solve problems. Mental arithmetic, for example, relies on working memory. More broadly, this storage system in the brain appears to be one of the key components of fluid intelligence.

Many studies find that variation in working memory accounts for at least 25 percent of the variation in fluid intelligence among individuals. Our own research confirms that inculcating this skill can lead to higher scores on standard tests of fluid intelligence for children and adults alike. Surprisingly, the training does not appear to expand the capacity of working memory but rather the ability to tune out distracting information. Furthermore, we and other researchers have found that as training progresses, the brain regions taxed by working memory become less active, as if they become more efficient in their functioning. These same areas are more engaged, however, when the brain is at rest. This pattern suggests to us that our program leaves the brain better primed to perform a wide array of tasks.

FAST FACTS

How to Increase Intelligence

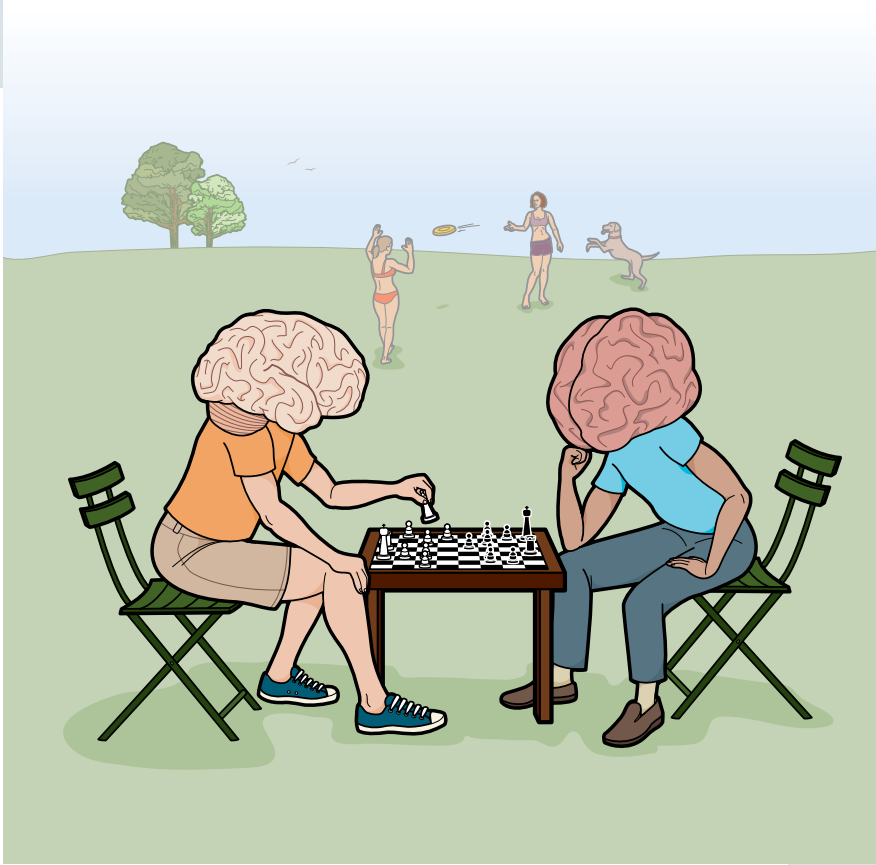
1» **Scientists have long held that fluid intelligence—reflected not by what you know but rather how well you solve novel problems—is largely inherited and relatively impervious to improvement.**

2» **A raft of recent investigations, though, shows that some types of brain training—specifically those that exercise working memory and other so-called executive functions—can raise an individual's fluid intelligence.**

3» **Working memory training appears to boost fluid intelligence in children and adults alike. As training progresses, the brain regions taxed by working memory become less active when called on and more active at rest. This pattern suggests that certain training programs leave the brain better primed to perform a wide array of tasks.**

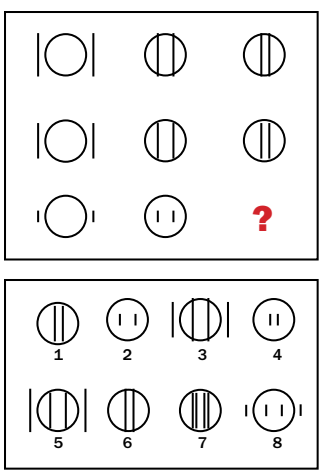
Practice Makes Smarter?

During the 1990s psychologists and neuroscientists made great strides in understanding the basic cognitive processes that underlie fluid intelligence, in particular the importance of the prefrontal cortex, the brain region responsible for so-called ex-



ecutive function. Located just behind the forehead, the prefrontal cortex regulates attention, modulates impulses and coordinates information coming from other brain centers, among other complex tasks. These functions enable you to form plans, make decisions, spot errors and break habits. As scientists gained more insight into these faculties, the question naturally arose: Can any kind of intervention strengthen them and might that lead to greater reasoning abilities?

Torkel Klingberg and his colleagues at Sweden's Karolinska Institute published one of the first studies aimed at this question. In 2002 they developed a specialized computer program to exercise working memory and gave it to seven youths who suffered from attention-deficit hyperactivity disorder (ADHD). They asked another seven children with ADHD to play easier computer games. After five weeks the group who had practiced the working memory–based intervention saw a lessening of some of their symptoms—specifically, they squirmed less. Even more astonishing, they also raised their scores on a well-established measure of fluid intelligence. Klingberg's initial sample was extremely small, but he found the same effect in a later study of 44 children. His findings inspired other cognitive scientists to look more closely at executive function as a way to enhance IQ.



This spatial-reasoning problem resembles those on a well-known test of fluid intelligence often used by us and by others in various studies. Participants must decide which figure best completes the 3 x 3 matrix shown. Note how the two bars change size and position. Only answer 4 follows this pattern.

During the past decade many research groups have produced encouraging results. Training kids' attention has been shown to lead to higher intelligence scores; musical instruction appears to offer benefits, too. Children from a low socioeconomic background have experienced large jumps in IQ scores—on average 13 points—in as little as 20 hours after playing board and card games that exercised their reasoning skills. Older adults improved their fluid intelligence after playing the video game Rise of Nations, as well as after practicing exercises that tax working memory.

To design our own intervention, we wanted a task that would make you juggle several pieces of information in your head, shifting your attention from one to another. We targeted these specific skills by modifying a well-known working memory task, the *n*-back test—so called because participants are asked to keep track of an image, number or letter that appeared *n* positions back in a series.

In a 2-back version of our training task, subjects viewed a series of squares at different locations on an otherwise blank computer screen [*see box on page 63*]. For every square, participants had to decide whether it was positioned in the same spot on the screen as the shape shown before last. A more difficult exercise, a dual *n*-back task, requires participants to match both a visual and auditory cue—locations on the screen, say, and a letter they hear spoken through headphones. One critical feature of our training program is that we can adjust the difficulty by raising the value of *n* in the *n*-back test, just as you might increase the speed of a treadmill to keep yourself challenged while exercising. In this way, we gave our participants' working memory an actual workout, tailoring the training program as their ability changed over time.

(The Authors)

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WE BELIEVE THAT OUR ***N*-BACK TRAINING** IS LIKE A CARDIOVASCULAR ROUTINE, TARGETING MANY ASPECTS OF OUR **REASONING ABILITIES**.

No Pain, No Gain

By varying the difficulty of these tasks, we hoped to exclude the possibility that our subjects might improve simply by virtue of repetition or by developing specific strategies or habits. We wanted them thinking on their feet. Scientists have long debated whether brain training can actually make you smarter or whether it simply makes you better at the particular task you practiced. Consider people who compete in memory competitions, for example. They train to memorize some 200 names of strangers or the exact order of all the cards in a shuffled deck. Although they perform astonishing feats of recall, these tricks do not actually make them more intelligent. Memory training may be a lot like learning to shoot an arrow—although your archery skill improves, your overall fitness stays about the same. Our calibrated *n*-back training, we believe, is more like a cardiovascular routine, targeting many aspects of our reasoning abilities.

In one experiment in 2008 we tested the fluid intelligence of 70 young adults. We then divided them into four groups who trained on the dual *n*-back task for one, two, three or four weeks each. An additional group received no training at all. We then retested all the subjects. The scores of the untrained individuals remained more or less constant. All four groups, however, attained higher scores on the later intelligence test. More training led to greater achievement, so the people who practiced for a month made the most dramatic gains. Another study of 65 older adults produced similar outcomes.

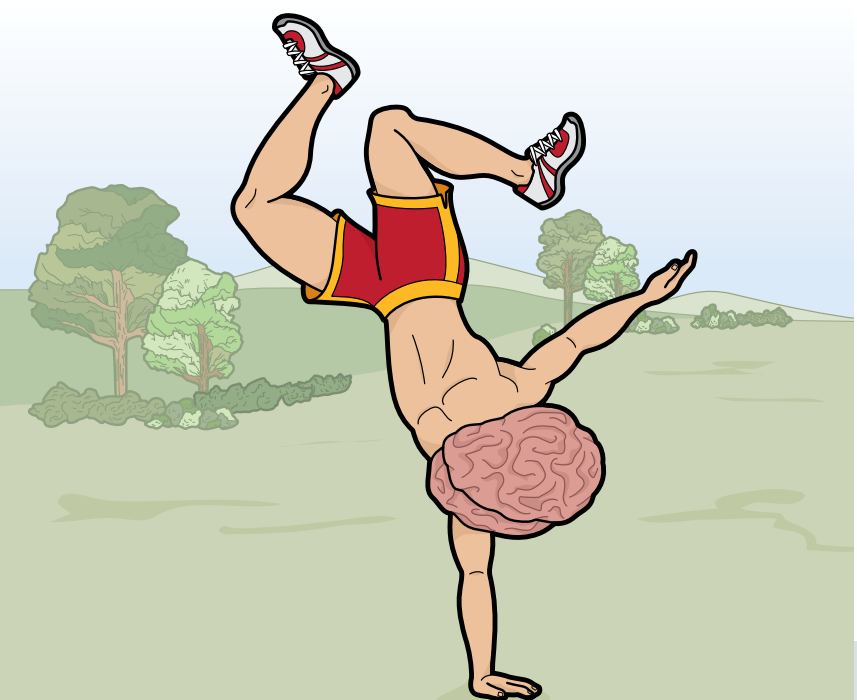
Children displayed greater variability. To test them, we devised a version of the *n*-back task that resembled a video game [*see box on opposite page*]. Participating youth—who were on average nine years old—trained for four weeks. A second group of similarly aged children spent the month using a "knowledge trainer"—software that coached them on general facts and vocabulary items to develop what is known as crystallized intelligence.

Not all the children who trained on the *n*-back task succeeded in building working memory skills. Some showed little interest in it, whereas others seemed to grow overly frustrated as the difficulty increased. Children who showed the most improvement, however, also earned higher scores on intelligence tests after the program. Even three months later, with no further training, these children preserved a good deal of their increases in fluid intelligence. The young people who used the knowledge trainer saw no such benefits.

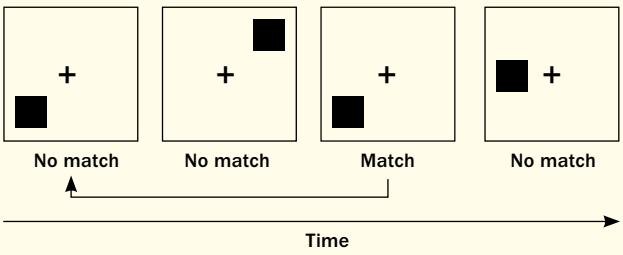
Mental Conditioning

When we looked more closely at what might be changing as a result of this intervention, we found that the *n*-back training renders people psychologically more conservative over time. In other words, those who practiced the task learned to resist the impulse to respond automatically to a stimulus. One recent study demonstrates this effect: children who become more cautious over time on *n*-back tests also show greater reservation in a related exercise, in which they are told to say "yes" to any letter except X. About 90 percent of the letters presented were not Xs, and the children quickly got into the habit of saying "yes," producing quite a few errors as a result. After a course of *n*-back training, though, the children became slower to respond, and the number of incorrect "yeses" dropped considerably.

We also wanted to know what underlying brain differences might explain the changes we were observing. Using functional MRI, we scanned 26 participants as they performed *n*-back tasks and during a rest period when they simply lay awake with their eyes open. Every day for a week the subjects used our *n*-back training exercise, and then we scanned them again. Initially we found the greatest activation in parts of the prefrontal and parietal cortex, just behind the frontal cortex—a pattern that is quite stan-



A Working Memory Workout



In a visual 2-back working memory task for adults, participants watch a series of squares that appear in different locations on a computer screen. They must press a key whenever the square lands in the same position it was in two spots back in the series. Thus, in the sequence shown above, test subjects would respond to the third square. Children can train their working memories using programs that present *n*-back tasks in the form of video games. In the example at the right, a frog jumps from one lily pad to another; the children must press a key when the frog lands on the same pad as the one he was on *n* jumps before. To make the program more appealing for youngsters, we present it within a story about a magic frog prince.

dard for tasks that involve working memory. After training, however, we saw less activation in these regions. Despite improved performance, the *n*-back test elicited less neural activity after a week of practice. Working memory training, it seems, leads to more efficient brain activation, somewhat like a car engine that no longer needs to work as hard once it has kicked into a higher gear. This drop in activity as proficiency grows has solid support—psychologist Richard Haier of the University of California, Irvine, for example, has shown that people use less brainpower to play Tetris as they become increasingly adept at the game.

Yet our study produced another intriguing result. When we looked at the scans of our subjects' resting brains, we saw higher levels of blood flow after training than before in selected regions that largely overlapped the ones mentioned above. We surmise that the parts of the brain that become more efficient through training are left better prepared for the task while at rest; that is, they are more fit. This conditioning may help explain how *n*-back training leads to improvements on different working memory tasks and general intelligence tests. It might also account for how the effects induced by these activities can outlast the training period itself.

Of course, the training and transfer effects we have documented vary from person to person, for reasons that are yet to be fully explored. For example, we have found that an individual's beliefs about the malleability of intelligence can affect how much they improve. Subjects who have some intrinsic motivation to train also find the endeavor more effective.

We are at the opening bell in investigations of cognitive training and its benefits. We have yet to learn how long the effects last and how to make the activities suitable for educational settings. More important, we do not yet know to what extent the improvements we see affect academic achievement and other real-life consequences. Still, we have every reason to believe that making people smarter might help them to lead happier, healthier lives. M

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TREATING A TOXIN TO LEARNING

Stress may be silently sabotaging success in school. Its effects are especially potent for children in poverty

By Clancy Blair

FAST FACTS

Relax to Learn

1» **Psychological stress affects even very young children and can substantially shape the course of their cognitive, social and emotional development.**

2» **Stresses that accompany low income directly impair specific learning abilities in children, potentially setting them back in many domains of life.**

3» **Children from more affluent backgrounds can also encounter stressful situations that weaken their capacity to learn. Reducing stress in young people could improve the well-being and cognitive performance of large numbers of schoolchildren.**

Stress can be toxic at any age. It rattles us when it strikes, shaking up our relationships and narrowing our focus. When it becomes chronic, it ravages our health. Physically, emotionally and intellectually, stress can drag us down.

An even more insidious effect is the assault it can launch on a child's brain, impeding the development of critical cognitive skills. A number of researchers, including myself, have discovered that psychological stress affects the thinking skills and brain development of even very young children, likely beginning prenatally. It is no mystery that stress thrives in difficult situations, but research is now showing that a disadvantaged upbringing may set back children in profound, lasting ways. In fact, stress may be one important mechanism through which poverty adversely affects children's ability to perform well in school.

Although children differ in their susceptibility to the problems of poverty, data show that youngsters from lower-income homes are very likely to start school behind their more affluent peers. This socioeconomic gap persists throughout the school years and is difficult to close. People have long argued that disadvantaged homes tend to offer an impoverished learning environment that does not sufficiently prepare children for the rigors of school. This theory is, at best, only half of the story. My work suggests that the stresses that accompany low income—such as crowded conditions, noise, financial worries and an inability to provide adequate child care—directly impair specific learning abilities in children.

A stressful childhood may emerge from conditions other than poverty, whether from challenging family circumstances such as a divorce

SALLY ANSCOMBE *Getty Images*

or death, overbearing or distracted parents, or learning disabilities that create anxiety about school. A focus on reducing stress through changes in home or in school could improve the well-being of large numbers of schoolchildren and set them up for greater success throughout life.

Flooding the Engines

Stress hormones can shape the developing circuitry of the brain. Most notably, they influence the neural connections in the prefrontal cortex, located behind the forehead, that buttress what are known as executive functions. These include the ability to hold information in mind (working memory) and to inhibit automatic or impulsive responses to stimulation. Executive functions are critical for reasoning, planning and problem solving and for regulating emotions and attention. They are essential to academic success. [For more on training executive function, see "The Education of Character," on page 48, and "Building Better Brains," on page 59.]

The effects of stress on the brain depend on how much of it is present. A little stress heightens alertness; it *improves* people's performance on complex tasks. But as the dose exceeds a certain level, stress starts to erode performance. This relation between arousal and performance can be expressed as an inverted U-shaped curve, first identified by psychologists Robert Yerkes and John Dodson in 1908. In the brain, moderate amounts of stress hormones such as cortisol and noradrenaline boost activity in prefrontal areas that underlie executive functions. At high levels, however, they flood this engine of self-regulation, shutting it down. Over time the brain circuits that control stress hormone levels are shaped by experience toward a tendency to unleash either very large or very small amounts of these hormones onto the prefrontal cortex in response to stress or to maintain a more optimal level of arousal.

In 2001 I began to wonder how this physiology played out in the brains of young children and whether it might explain how poverty "gets under the skin." I set out to explore whether the chronic stress of poverty might be impairing the developing executive function of children enough to set them back at school.

My graduate student at the time, Rachel Peters, and I, then at Pennsylvania State University, gave two tests to 170 four-year-olds in central Pennsylvania enrolled in Head Start, the federal preschool program for children in poverty. We measured mental flexibility by asking children to identify different ways in which small groups of objects were similar. We examined working memory and inhibitory control by asking them to tap a peg twice when the experimenter tapped it once, and vice versa. Here the child has to remember the rule and control the impulse to copy the experimenter. We also asked teachers to rate each child's behavior and academic abilities. And in collaboration with neuroendocrinologist Douglas Granger, also then at Penn State, we took samples of the children's saliva to determine levels of cortisol at the beginning, middle and end of our experimental session.

A LITTLE STRESS **HEIGHTENS ALERTNESS**; IT *IMPROVES* PEOPLE'S PERFORMANCE ON **COMPLEX TASKS**. BUT AS THE DOSE EXCEEDS A CERTAIN LEVEL, STRESS STARTS TO ERODE PERFORMANCE.

The children with better executive function and behavior had low cortisol at the beginning of the session that rose and then returned to baseline, as expected, in response to the mild stress of meeting one of us and participating in our tasks. Those who showed either a sustained high level of cortisol or a blunted response—high initial levels, which then dropped, indicating a shutting down of the process—tended to have low executive function; their teachers also rated them as more aggressive and lacking in self-control. We published these results in 2005.

As we followed these children into kindergarten, we observed that executive function matters for achievement: this suite of mental skills was the main determinant of math proficiency, far outweighing other aspects of intelligence. And in an analysis published this year our team, led by postdoctoral researcher Daniel Berry, found that elevated cortisol in children directly predicts academic difficulties, as indicated by their knowledge of math, letters and words. A statistical analysis also backs up our hypothesis that detriments to executive function—as opposed to, say, low general mental ability—are the critical link tying high cortisol to low academic ability.

Positive Parenting

Meanwhile my colleagues and I also set out to determine what aspects of poverty might contribute most to children's

(The Author)

CLANCY BLAIR is professor of applied psychology at New York University, where he studies the development of self-regulation in early childhood. He earned his Ph.D. in 1996 from the University of Alabama at Birmingham. His research is supported by the National Institutes of Health.

Children whose parents encourage them to learn by doing are calmer and more attentive than those whose mothers and fathers typically restrict them or do things for them.

stress. We focused on parenting style. Impoverished parents tend to elicit obedience through discipline rather than encouraging exploration and learning by doing. The latter approach, known as scaffolding, is essential to sensitive parenting. In this type of parenting, mothers and fathers interact with their children during play and create opportunities for them to accomplish small tasks, such as stacking blocks. Although poor parents can and do provide sensitive care, they are less likely to do so, given the realities of their situation and, potentially, their own high stress levels.

To investigate further, we have been following 1,292 children, starting at birth, and their families, most of whom live in poverty in rural communities in Appalachia and the Deep South. For about seven years now our team has been visiting these homes annually to collect data on family and economic conditions as well as on executive function and cortisol levels. My colleagues Martha Cox and Roger Mills-Koonce of the University of North Carolina at Chapel Hill analyzed video recordings of mothers interacting with their children in free play. In our first analysis, published in 2008, we found that infants whose mothers displayed the sensitive, scaffolding parenting style had lower cortisol levels and were calmer and more attentive than those whose mothers either completed the activity for them or restricted their attempts to do so.

Furthermore, at age seven months the children whose parents displayed the positive parenting style were more likely to exhibit a healthy cortisol response—a rise and fall—to fear (triggered by an experimenter in a mask) and frustration from a toy placed just out of reach. At age 15 months these children again had lower cortisol levels and were more likely to respond appropriately to the emotional challenges. We now had evidence that parenting style shapes the developing stress response system.

We next sought to sketch the complete path from poverty to parenting to increased stress and diminished executive function in the same group of children. Most recently, we found that the more severely impoverished the family, the less likely parents were to be sensitive and responsive. As expected, the children in such homes had elevated cortisol, which was, in turn, associated with lower executive function. We also saw that less positive parenting went hand in hand with poorer executive function in children, indicating that mothers and fathers can directly stimulate the development of important mental skills.

Creating Capable Kids

Research indicates that stress from a variety of sources—chaotic and poorly run classrooms, for example, or problems with family or peers—impedes learning. The potential good news: knowing that stress is a malevolent force means that finding ways to thwart it could boost children's learning capacity.

In that vein, my collaborators and I are testing a program that teaches parents how to be more sensitive and how to structure opportunities for their children to learn while providing warm and loving care. We are also trying out a new curriculum that gives kindergarteners and preschoolers more control over their learning activities. After a year we will see whether the children's stress regulation and executive function improve. Although this work is in its early stages, we are encouraged by the possibility that informed changes to environments can boost children's self-control and academic competence, giving many of our youth a far greater chance of succeeding in life. M

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ROSEMARIE GEARHAR *Getty Images*

Are All Psychotherapies Created Equal?

Certain core benefits cut across methods, but some differences in effectiveness remain

BY SCOTT O. LILIENFELD AND HAL ARKOWITZ

AS A PROSPECTIVE client searches for a psychotherapist, numerous questions may spring to mind. How experienced is the therapist? Has he helped people with problems like mine? Is she someone I can relate to? Yet it may not occur to clients to ask another one: What type of therapy does the clinician deliver? People often assume that the brand of therapy offered is irrelevant to the effectiveness of treatment. Is this assumption correct?

Psychologists do not agree on whether the "school" of therapy predicts its effectiveness. In a survey in 2006 by psychologists Charles Boisvert of Rhode Island College and David Faust of the University of Rhode Island, psychotherapy researchers responded to the statement that "in general, therapies achieve similar outcomes" with an average score of 6 on a 7-point scale, indicating strong agreement. In contrast, psychologists in practice averaged a rating of 4.5, signifying that they agreed only moderately with that position.

As we will discover, both camps can justify their point of view. Although a number of commonly used psychotherapies are broadly comparable in their effects, some options are less well suited to certain conditions, and a few may even be harmful. In addition, the differences among therapies in their effectiveness may depend partly on the kinds of psychological problems that clients are experiencing.

Tale of the Dodo Bird

At least 500 different types of psychotherapy exist, according to one estimate by University of Scranton psychologist John Norcross. Given that researchers cannot investigate all of them, they have generally concentrated on the most frequently used approaches. These include behavior therapy (altering unhealthy behaviors), cognitive-behavior therapy (altering maladaptive ways of thinking), psychodynamic therapy (resolving unconscious conflicts and adverse childhood experiences), interpersonal therapy (remedying unhealthy ways of interacting with others), and person-centered therapy (helping clients to find their own solutions to life problems).

As early as 1936, Washington University psychologist Saul Rosenzweig concluded after perusing the literature that one therapy works about as well as any other. At the time, many of the principal treatments fell roughly into the psychodynamic and behavioral categories, which are still widely used today. Rosenzweig introduced the metaphor of the Dodo Bird, after the feathered creature in Lewis Carroll's *Alice in Wonderland,* who declared following a race that "everyone has won, and all must have prizes." The "Dodo Bird verdict" has since come to refer to the claim that all therapies are equivalent in their effects.

This verdict gained traction in 1975, when University of Pennsylvania psychologist Lester Luborsky and his colleagues published a review of relevant research suggesting that all therapies work equally well. It gathered more momentum in 1997, when University of Wisconsin–Madison psychologist Bruce E. Wampold and his co-authors published a meta-analysis (quantitative review) of more than 200 scientific studies in which "bona fide" therapies were compared with no treatment. By bona fide, they meant treatments delivered by trained therapists, based on sound psychological principles and described in publications. Wampold's team found the differences in the treatments' effectiveness to be minimal (and

COURTESY OF SCOTT O. LILIENFELD (*Lilienfeld*); COURTESY OF HAL ARKOWITZ (*Arkowitz*); MARIO WAGNER (*illustration*)

they were all better than no treatment).

One explanation for the Dodo Bird effect is that virtually all types of psychotherapy share certain core features. In a classic 1961 book the late psychiatrist Jerome Frank of the Johns Hopkins University argued that all effective therapies consist of clearly prescribed roles for healer and client. They present clients with a plausible theoretical rationale and provide them with specific therapeutic rituals, he wrote. They also take place in a setting, usually a comfortable office, associated with the alleviation of distress. Later writers elaborated on Frank's thinking, contending that effective therapies require empathy on the part of the clinician, close rapport between practitioner and client, and shared therapeutic goals.

Today many authors argue that these and other common elements are even more powerful than the features that distinguish one therapy from another. To take just one example, Wampold concluded in a 2001 analysis that the therapeutic alliance—the strength of the bond between a therapist and his or her client—accounts for about 7 percent of therapeutic effectiveness but that the school of the therapy accounts for only about 1 percent. Most of the remaining 92 percent is presumably caused by other factors, such as the personalities of the therapist and client.

Is the Dodo Bird Extinct?

Although most researchers agree that common factors play key roles in psychotherapy, some doubt that all methods are equally effective. Even Wampold has been careful to note that his conclusion holds for only bona fide treatments; it does not extend to all 500 or so therapies. For example, few experts would contend that rebirthing therapy, premised on the dubious idea that we must "relive" the trauma of our birth to cure neurosis, works as well as cognitive-behavior therapy for most psychological conditions.

Moreover, research suggests that even among accepted therapies, the type of treatment does matter under certain circumstances. A 2001 review by University of Pennsylvania psychologist Dianne Chambless and Virginia Polytechnic Institute psychologist Thomas Ollendick revealed that behavior therapy and cognitive-behavior therapy are more effective than many, and probably most, other treatments for anxiety disorders and for childhood and adolescent depression and behavioral problems. In addition, in a 2010 meta-analysis psychologist David Tolin of the Institute of Living in Hartford, Conn., found that these same two therapy types produce better results than psychodynamic therapy for anxiety and mood disorders.

The Dodo Bird verdict must also be qualified by evidence indicating that several widely used therapies do not work and may actually harm. For example, in a 2003 review psychologist Richard McNally of Harvard University and his colleagues evaluated crisis debriefing. In this treatment for warding off post-traumatic stress symptoms, therapists urge those exposed to emotionally fraught events such as shootings or earthquakes to try to reexperience the feelings they had during the event soon after it. McNally's team concluded that this treatment is inert at best and possibly damaging, perhaps because it interferes with natural coping mechanisms.

In light of such findings, a search for a therapist should at least sometimes involve a consideration of the type of treatment he or she practices. It is true that ingredients, such as empathy, that cut across effective therapies are potent and that various established techniques are roughly equivalent for a broad range of difficulties. Yet under certain circumstances, the therapeutic method can matter. For example, if a clinician espouses an approach outside the scientific mainstream—one that does not fall under the broad categories we have listed here—you should not assume that this treatment will be as helpful as others. If you suffer from an anxiety disorder or one of the other conditions for which behavior and cognitive-behavior interventions work well, then someone who practices one of those two types is probably a good bet.

Of course, scientists have systematically assessed only a minority of the psychotherapies invented so far for their efficacy in treating the numerous psychological difficulties that afflict humankind. In the coming decade, we hope that further research clarifies whether the brand of therapy makes a difference in an individual's recovery from psychological distress. M

> All effective therapies take place in a setting, often a comfortable office, associated with **the alleviation of distress**.

SCOTT O. LILIENFELD and HAL ARKOWITZ serve on the board of advisers for *Scientific American Mind*. Lilienfeld is a psychology professor at Emory University, and Arkowitz is a psychology professor at the University of Arizona.

Send suggestions for column topics to editors@SciAmMind.com

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How to Spot a Scoundrel

Certain types of fidgeting give away a person's trustworthiness

BY WRAY HERBERT

IMAGINE the original job interview. The first one ever, back on the prehistoric savannas of eastern Africa or maybe in an early agrarian society in the Fertile Crescent. A member of an unknown settlement may have wandered in and offered some irresistible service—lion-wrangling expertise, perhaps, or Herculean strength in the field. Unlike in a modern job interview, early humans had no résumés, LinkedIn profiles or letters of recommendation to guide them. The fundamental idea, however, was the same: somehow the interviewer had to judge, in a brief interval, whether the applicant—a complete stranger—was trustworthy. Bringing on a sordid character as a business partner or as a steward of your goods could endanger your livelihood or even your personal safety.

To boost the odds of choosing a solid relationship and rejecting a dicey one, our ancestors might have learned to detect subtle, unintended signs in that initial, face-to-face interaction. Indeed, how do we make these judgments nowadays? Discerning the motives of strangers is a skill we rely on all the time. Every time you walk into a used-car lot or shop around for a home contractor or financial adviser, you are using your wits to pick someone trustworthy—and to avoid scoundrels.

Because trust and cooperation are so essential to the smooth working of human society, it makes sense that people would have learned over thousands of years both to send signals of trustworthiness and to pick up signs of malicious intent. Yet scientists have searched in vain for that single "golden cue" that predicts future cooperation or opportunism. Now a growing consensus rejects the idea of a single, isolated nonverbal signal of trustworthiness—or deceit—as simplistic. Rather than a certain grimace or gesture giving intentions away, a subtle constellation of clues may emerge dynamically during brief encounters. We sense this cluster of behaviors without realizing it and use them to judge a person's integrity.

New research from psychological scientist David DeSteno of Northeastern University explored this idea with a fresh technological approach. Working with a large team of collaborators at the Massa-

(The more often the participants used this **set of gestures**, the less trustworthy they were in the financial exchange.)

MATT MENDELSON (*Herbert*); DAVID POHL (*Illustration*)

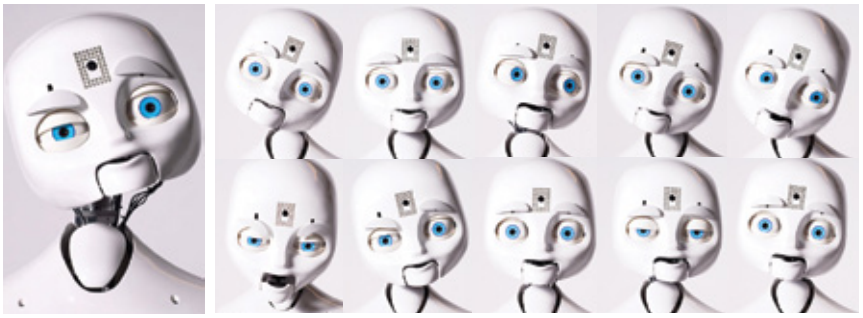
The opportunists displayed a **cluster of four cues**: hand touching, face touching, crossing arms and leaning away.

chusetts Institute of Technology, Cornell University and his own institution, DeSteno ran a two-part experiment to identify the intertwined nonverbal cues that warn of opportunism in others. In the first part of the study, the scientists videotaped strangers conducting their first conversation together, either face-to-face or in a typed Web chat. The researchers guessed that if a set of nonverbal cues can indeed convey trustworthiness consistently, people should be better at judging others' intentions face-to-face.

Giveaway Gestures

The pairs of unacquainted students chatted for five minutes about ordinary topics such as spring break, life in Boston, and so forth. Other students had similar chats via the Internet, the only restriction being that they could not use emoticons, those symbols that convey emotion in online conversations. Then all the pairs played a game that measures cooperative and self-interested economic behavior. As expected, those who had chatted face-to-face beforehand were more accurate in predicting the trustworthiness or sleaziness of the stranger. Something in the interaction—some nonverbal information that was missing from the text-only Web chat—had given away their opponents' intentions.

But what? To find out, the scientists asked two independent judges to analyze the videotaped interactions and identify all the possibly meaningful cues: smiling, laughing, leaning, looking away, crossing the arms, nodding, head shaking, and touching. Next they isolated the specific cluster of cues that were present when volunteers successfully detected others' self-serving intentions. Again and again, the opportunists displayed a cluster of four cues: hand touching, face touching, crossing arms and leaning away. None of these cues foretold deceit by itself, but together they transformed into a highly accurate signal. And the more often the



COURTESY OF FARDAD FARIDI *Massachusetts Institute of Technology*

Researchers used Nexi, a robot designed to emote with humanlike facial expressions and body language, to show that specific motions and positions communicate self-interest.

participants used this particular set of gestures, the less trustworthy they were in the subsequent financial exchange.

This finding was intriguing but inconclusive. After all, people are constantly twitching and shifting, so it is difficult to know if this specific cluster of cues—and only these cues—are the ones involved in signaling duplicity. To test this more rigorously, the scientists needed to experimentally manipulate the suspect motions and then see if they did indeed inspire feelings of distrust.

Virtual Trust

Enter Nexi, a robot especially designed to mimic human expressiveness. In the second phase of the study, it replaced one of the partners in each pair. The human partner had a 10-minute "conversation" with Nexi, again about mundane topics. The scientists meanwhile operated Nexi in Wizard of Oz fashion, making it lean back, touch its face and hands, and cross its arms. All Nexi's cues were derived from examples of human motion to make them as authentic as possible. The order varied, with some cues repeated, to simulate human fidgeting.

Other volunteers also chatted with Nexi for 10 minutes, but during these conversations Nexi used gestures other than the target movements. As reported in a forthcoming issue of the journal *Psychological Science*, when Nexi used the target gestures—but not when it made other humanlike movements—the volunteers reported feelings of distrust toward the robot. What's more, when they played the economic exchange game with Nexi, these volunteers expected to be treated poorly and behaved less cooperatively with the robot.

Interestingly, these results were narrowly focused on trust. That is, even when Nexi's body language made people skeptical of its motives, the study participants did not necessarily dislike it, according to their subsequent reports of their feelings toward it. This is a familiar human experience: many of us know individuals whom we like well enough but would never, ever trust with our money. M

For more insights into the quirks of human nature, visit the "We're Only Human. . ." blog and podcasts at www.psychologicalscience.org/onlyhuman

WRAY HERBERT is writer in residence at the Association for Psychological Science.

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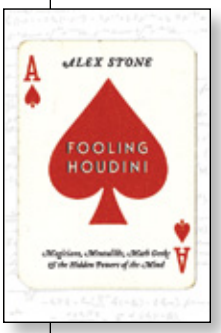
books

TRICKS OF THE TRADE

Fooling Houdini: Magicians, Mentalists, Math Geeks, and the Hidden Powers of the Mind

by Alex Stone. HarperCollins, 2012 ($26.99)



A magician's psychological subterfuge requires years to master, as Stone writes in *Fooling Houdini,* a foray into the underbelly of the magic culture.

As an aspiring magician, Stone quickly realizes he needs to do more than practice tricks. He has to penetrate this unique subculture, in which apprentices seek out masters to hone their performance and learn codes of conduct. Magicians once relied on a vow of secrecy: never tell the audience *how* you performed a trick. This discretion was born in part of magic's seedy roots in a time when a card cheat could wipe out the house and the slightest slipup might lead to a severe beating or worse.

Magic is much safer today, and secrets are no longer so closely guarded. The celebrity illusionist duo Penn and Teller discovered, for example, that even when they explained a trick to an audience, people were still fooled—and all the more impressed at the feat.

As magic grew more sophisticated, practitioners turned to behavioral science and mathematics for fresh ideas on how to exploit our perceptions. For example, in Daniel Simons's famous "invisible gorilla" experiment, subjects were asked to watch a video of people passing a basketball and tally the number of passes that occurred. Subjects who counted correctly tended to completely miss the appearance of a person in a gorilla suit. Called inattentional blindness, this phenomenon enables many illusory feats.

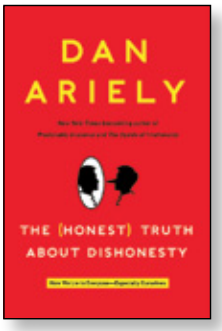
Stone discovers that as magicians perfect their trade, fewer tricks catch them off guard; however, he finds that even the experts can be deceived. Everyone, especially magicians, yearns for the thrill of being fooled.

Using vibrant, clear examples, Stone reveals that magic is not just shakedowns and con games. Rather the art of deception allows us to peek into our subconscious and understand the mathematical and psychological gears that make it turn. *—Brian Mossop*

DECEITFUL SELF

The (Honest) Truth about Dishonesty: How We Lie to Everyone—Especially Ourselves

by Dan Ariely. HarperCollins, 2012 ($26.99)



Liars: they populate our news feeds, perform evil deeds on our favorite television shows and infuse drama into our daily lives. The psychological origins of both Bernard Madoff–scale Ponzi schemes and the mundane dishonesties most of us partake in—filching office pens, padding expense reports or secretly toting a counterfeit designer purse—are the subject of Ariely's *The (Honest) Truth about Dishonesty.*

Ariely, a professor of psychology and behavioral economics, suggests that a moral sweet spot guides our decisions, so that we "benefit from dishonesty without destroying our own self-image." We dial up our lies when we perceive them as benefiting a friend (that's altruism!) and tend to exaggerate more liberally when we're sporting fake designer sunglasses (hey, we're already fudging our fashion, why not push a few more boundaries?). Rather than applying a cost-benefit analysis—will I get away with it?—Ariely argues that we decide whether to behave truthfully by considering complex internal and environmental influences.

Many of the factors he cites are social. Social contagion may facilitate deceit: just as a virus spreads by proximity to an infectious person, Ariely argues, dishonesty in one's social group can be catching. Although skeptics have challenged theories of social contagion, he cites real-life examples in politics, finance and his own research on cheating, which shows that dishonesty can become the norm when a group practices it openly. Creativity, too, is linked to dishonesty—not because creative people are more likely to be dishonest but because they are probably better at convincing themselves of their own lies.

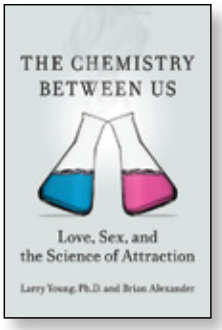
So what holds us in check? "Moral prophylactics" such as the presence of Bibles and locks are associated with honesty, probably by acting as reminders of a social contract. Similarly, even suggested surveillance, such as decorating a communal coffee kitty with a pair of eyes, can promote honesty. Seeing a person outside one's social circle breaking the rules also seems to discourage bad behavior—most likely, Ariely posits, because we want to distance ourselves from people we perceive as "other."

It is slightly dissatisfying that Ariely does not consider the potential benefits of dishonesty beyond those of white lies, perhaps overlooking other reasons why we fudge the truth. Second, he touches on the neurological underpinnings of only pathological liars, leaving the rest of us with little biological insight into our transgressions. Yet *(Honest) Truth* contains a wealth of fascinating findings about what makes us garden-variety fibbers do what we do and why certain moral reminders may make us think twice. *—Jordan Lite*

LOVE POTIONS

The Chemistry between Us: Love, Sex, and the Science of Attraction

by Larry Young and Brian Alexander. Penguin Group USA, 2012 ($26.95)



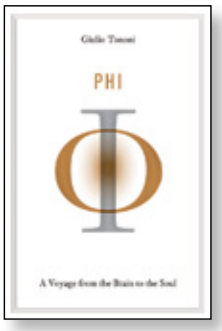
How do I love thee? When neuroscientist Young and journalist Alexander started counting, they found many molecular ways. In *The Chemistry between Us,* the writers highlight the complex chemical processes that create love in the brain and bolster the argument that love is an addiction.

Young has devoted his career to studying the behaviors and neural circuitry of love in the prairie vole, a rodent whose monogamous tendencies resemble our own. Once a prairie vole has found "the one," the pair will most likely remain companions for life. Young's research has implicated a range of chemical activities—mainly during sex—that build this lifelong bond. In particular, he uncovered how two hormones in the brain, vasopressin in male voles and oxytocin in female voles, regulate social behavior and memory—promoting the recognition of a loved one and the urge to cuddle or defend. In addition, the circulation of dopamine and opioids allows the vole to associate his or her partner with pleasure, thus strengthening

SOUL SEARCH

Phi: A Voyage from the Brain to the Soul

by Giulio Tononi. Pantheon Books, 2012 ($30)



In his book *Phi,* neuroscientist Tononi imagines Galileo Galilei, the 16th-century astronomer, drifting into a dream that takes him on a journey to understand consciousness. Part fantasy novel, part scientific expedition, *Phi* follows Galileo as he puzzles over what consciousness is, where it comes from and what beings can possess it.

Tononi invokes Dante's *Divine Comedy* by having guides, all groundbreaking scientists, introduce Galileo to different facets of consciousness. The first guide is the sharp-tongued biologist Francis Crick, who reveals the parts of the brain that contribute to consciousness. The two men visit mathematician and astronomer Nicolaus Copernicus, who has suffered a cerebral hemorrhage and fallen into a vegetative state. His misfortune illustrates how damage to the corticothalamic system can destroy consciousness. In a healthy individual, this system regulates functions such as sleep, awareness, memory and thought.

Alan Turing, the mathematician, becomes Galileo's second guide and challenges him to define consciousness. Turing suggests that even simple machines can produce a conscious experience. Galileo disagrees, arguing that although a digital camera has the capacity to store tremendous amounts of information, a brain can handle more. Communication among neurons allows the brain to generate knowledge; this integration of ideas is what creates consciousness. Galileo dubs this concept of consciousness "phi."

Finally, Charles Darwin walks Galileo through the implications of phi—what expands consciousness, for example, and how phi can diminish with time. In the library of poet and essayist Jorge Luis Borges, they observe how imagination enhances the quality of our conscious experience. In a Kafkaesque incident, however, the dark side of phi emerges: manipulation of our neural circuitry is shown to elicit the most excruciating pain. Galileo also learns how consciousness can be nurtured or extinguished and how it evolved, having surfaced in other animals and in humans before birth.

Along the way, a mysterious notetaker reflects on each chapter, identifying the artistic, scientific and historical references that inform Galileo's journey. Although these notes allow the reader to identify Tononi's allusions, they also compound the confusion, adding one more voice to the cacophony. It is possible that his ambitious approach is intended as a metaphor: as with the dialogue among neurons, the conversation among ideas in the book shapes our conscious experience. The reliance on metaphor, however, gives Tononi's explanations an oblique, hazy quality. *Phi,* like Galileo's wending path, remains unwieldy and mysterious. *—Daisy Yuhas*

their bond. Many of these molecules are identical to those activated in human bonding.

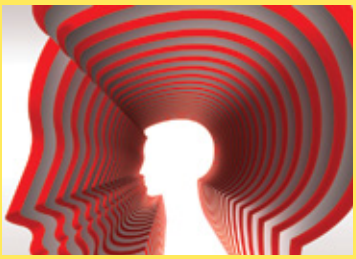
That loving feeling comes at a price. A hormone called corticotropin-releasing factor, or CRF, builds up in the brains of paramours and parents alike. The CRF system activates a stress response, and this system elicits the painful sensations you feel when your baby cries or your boyfriend dumps you. The system may seem like a nasty trick, but it has its uses. Even when passion fades or a diaper needs changing, the sharp pangs of the CRF system keep families and loved ones together. The CRF system also contributes to the agony an addict feels after the elation wears off. Thus, the authors argue, the highs of intimacy and withdrawals of separation parallel the highs and lows that drug addicts experience.

The Chemistry between Us playfully integrates anecdotes and research, bouncing from bizarre experiments examining how rodents can develop fetishes to real-life stories, such as a woman unable to develop loving bonds because of her lack of human contact in an orphanage as a child. Though occasionally too quick, the book's pace makes it feel like a light read. Understanding love's neurochemistry can't compare with the actual experience, but learning the science can certainly make us appreciate our heritage as loving, social beings.

—Daisy Yuhas

ISTOCKPHOTO

ROUNDUP



Private Lives

Three new books reveal how our inner worlds influence our behaviors.

Our unconscious mind is more in control than we might think, argues theoretical physicist Leonard Mlodinow in **Subliminal: How Your Unconscious Mind Rules Your Behavior** (Pantheon, 2012). Imaging shows that unconscious thought requires substantially more brain activity than conscious reasoning. Our unconscious has evolved to help us act on information quickly. It dictates our choices of friends and forms our biases.

What we eat doesn't just satiate our bellies, it affects our behavior and molds our brains. In **The Omnivorous Mind: Our Evolving Relationship with Food** (Harvard University Press, 2012), neuroscientist John S. Allen explores why our specific food preferences evolved. For instance, Allen traces our love of crispy foods back to insect-munching primates who lived millions of years ago, suggesting "the appeal of crispy foods is ancient and cognitively deep-seated."

Getting a poor night's sleep does more than leave you groggy the next morning. Our sleep patterns have a strong influence on our mental and physical health. In **Internal Time: Chronotypes, Social Jet Lag, and Why You're So Tired** (Harvard University Press, 2012), Till Roenneberg reveals that chronically sleep-deprived people are more likely to smoke, gain weight and become sick. The reason, he explains, is that our largely indoor and sedentary lives confuse our internal clocks. To combat the malaise, he recommends spending more time in the sun by walking to work or eating lunch outdoors. *—Victoria Stern*

askthe**Brains**

Why do children generally forget all their memories from before the age of three or four?

—E. Lawrence Langan III, *Wynnewood, Pa.*

Paul Reber, *a psychology professor at Northwestern University, answers:*

OUR INABILITY to remember many of our early experiences is a phenomenon known as childhood (or infantile) amnesia. Exactly why we forget these memories remains a mystery, although two hypotheses put forth possible explanations.

The brain systems that support our memory of experiences—the hippocampus and medial temporal lobe—appear to function reasonably well by the end of the first year of life. Infants and toddlers can remember such things as receiving a gift from a favorite uncle or breaking a beloved toy. After early childhood, however, these memories fade or disappear.

One idea is that the brain's prefrontal cortex may not contribute adequately to memory formation at young ages. A recollection of an event consists of a number of pieces of information that, when tied together, create a full picture. Across all ages, we try to summon a memory by using an initial bit of information (a "retrieval cue") that helps to initiate recall.

Some parts of the memory are not really central to an event, such as where you were standing when you took your first step, but are important for recall. Remembering such contextual information invokes the prefrontal cortex, which develops throughout childhood and even into adulthood. If this part of the brain is not assisting in memory formation early in life, then children may not form vivid, lasting recollections until they are a little bit older.

Another possibility is that our mental representations of the world—the elements from which we form thoughts and memories—change during the first few years of life. For example, it is very likely that learning language during these young years dramatically alters how children see the world. Very early memories from our prelanguage mental representations might become harder and harder to remember as we mature.

Early memories from our pre-language mental representations might become harder to remember as we mature.

Our brain's flexibility and capacity to learn new information and adapt to new experiences are extremely valuable to our survival. It appears that an accidental consequence of this trait is amnesia regarding our early lives. Maturing—putting our childish ways behind us—may cost us our young memories.

Can you make a sociopath—either through brain injury or other types of trauma?

—Chris Daly, *via e-mail*

Jeannine Stamatakis, *an instructor at various colleges in the San Francisco Bay Area, explains:*

PSYCHOLOGIST John Watson, the founder of behaviorism, once said, "Give me a dozen healthy infants, well formed, and my own specified world to bring them up in, and I'll guarantee to take any one at random and train him to become any type of specialist I might select."

If we take Watson's logic one step further, it may be possible to mold someone into a psychopath. Psychopathy, also called sociopathy, is defined by a lack of empathy, deceitfulness and complete selfishness. Current thinking is that although certain genes may predispose people toward psychopathy, their environment seems to provide the ultimate catalyst. Thus, a person who possesses the particular genes associated with this malady and is brought up in an abusive or neglectful household will be at a higher risk of exhibiting the traits associated with this disorder.

Severe trauma to specific regions of the brain can cause a person to undergo marked personality changes, such as in the famous case of Phineas Gage. While working as a railroad construction foreman in Vermont in 1848, he survived an accident in which a large iron rod was driven through his head, damaging much of his brain's left frontal lobe. Although he did not become a sociopath, the reported effects on his personality and behavior were so profound that friends saw him as "no longer Gage."

An incident two decades ago supports the idea that brain trauma can lead to psychopathic behaviors. In 1991 convicted sex offender Phillip Garrido kidnapped 11-year-old Jaycee Dugard and kept her as a prisoner in his home for 18 years. Experts believe that Garrido experienced severe brain damage after a serious motorcycle accident as a teenager, which was compounded by intense drug use. Garrido's father said that his son had been a "good boy" as a child but that he had changed radically after the accident and had become unstable.

Recently neuroscientists have identified areas of the brain related to psychopathic behaviors. Subtle damage to the amygdala, a brain region that helps us process our emotions, may explain why psychopaths act so cruelly and cannot express emotions properly. Psychopathic behaviors are also associated with injury to the cerebral cortex, which regulates memory and self-awareness, and the frontal lobe, which is responsible for self-control and judgment. M

Have a question? Send it to editors@SciAmMind.com

JAMIE CARROLL *iStockphoto*

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Head Games

Match wits with the Mensa puzzlers

1 YYMTSR TLRT

The following words have had a certain letter removed, and the remaining letters have been scrambled. The missing letter appears at least three times in each of the words. What are the words?

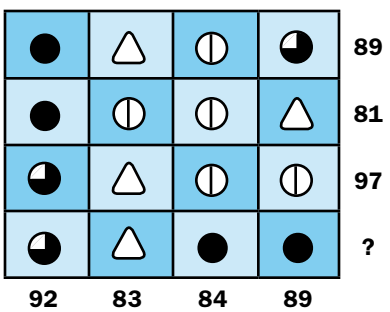
LILRV RSPIL PRSTN SYSL

2 NO ACCOUNTING FOR TASTE

A boy likes beets but not spinach. He likes apples but not pears. He likes Sally but not Susie. Will he like Jimmy or Joe?

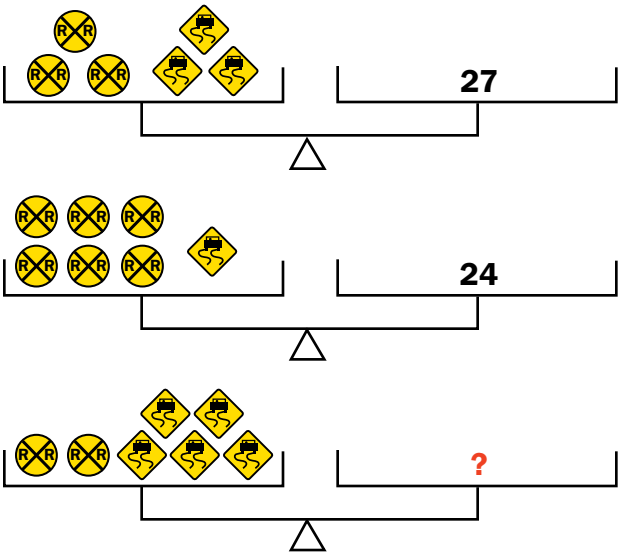
3 SYMBOLIC SUM

In the figure below, each symbol has a numerical value. The rows and columns add up to their adjacent number. Figure out the values and fill in the missing number.



4 HIDDEN COSTS

If Susannah is worth 97, Archimedes is worth 85 and Ulysses is worth 120, what is Agamemnon worth?



5 SIGN WEIGHT

The scales shown at the left are balanced. Figure out how much each traffic sign is worth and provide the missing amount.

6 GOOD ADVICE

In the following cryptogram, each number stands for a certain letter. The slashes indicate spaces between words. Crack the code and find the message.

18 7 / 23 12 22 8 13 ' 7 / 14 26 7 7 22 9 / 18 21 / 2 12 6 / 4 18 13 / 12 9 / 15 12 8 22 / 26 8 / 15 12 13 20 / 26 8 / 2 12 6 / 4 18 13

7 MATHLETICS

What number is one third of the square root of the product of XXIV and the number of sides on a cube?

8 SHORTCUT

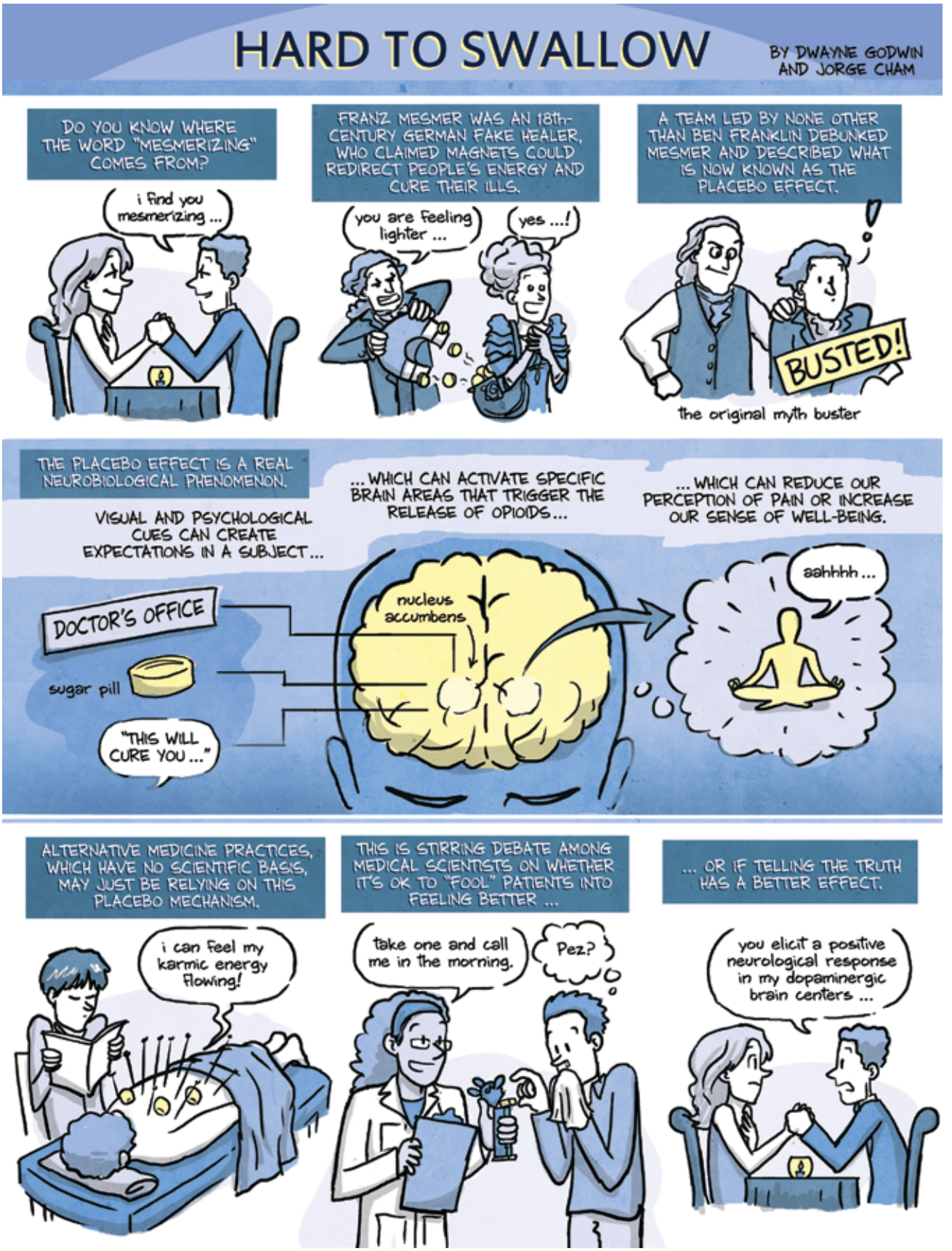
What five-letter English word can have four letters removed and still be pronounced exactly the same?

9 DIVIDE AND ANSWER

Using only four lines, divide this diagram into six sections. One of the sections should contain one telephone, another section two phones, another section three phones, and so on (up to six phones in the sixth section).

Answers

1. REVEILLE, SLEEPIER, PRETENSE, EYELESS.
2. Jimmy. (He likes words with double letters.)
3. 81. ◐ = 23, ● = 15, ◕ = 31, △ = 20.
4. 83. Each letter is worth its numbered position in the alphabet, for example, A = 1, T = 20, so AT = 21.
5. 36. ⊗ = 6; ⊕ = 3.
6. IT DOESN'T MATTER IF YOU WIN OR LOSE AS LONG AS YOU WIN. (A = 26, Z = 1, and so on.)
7. 4.
8. Queue.
9. One possibility:



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.*