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**MIND**

BEHAVIOR • BRAIN • PET

May/June 2015  
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**When Kids  
Stop Talking:  
How to Relieve  
Their Anxiety**  
*page 50*

**Why  
We  
Love  
Pets  
and Why  
They Love Us**

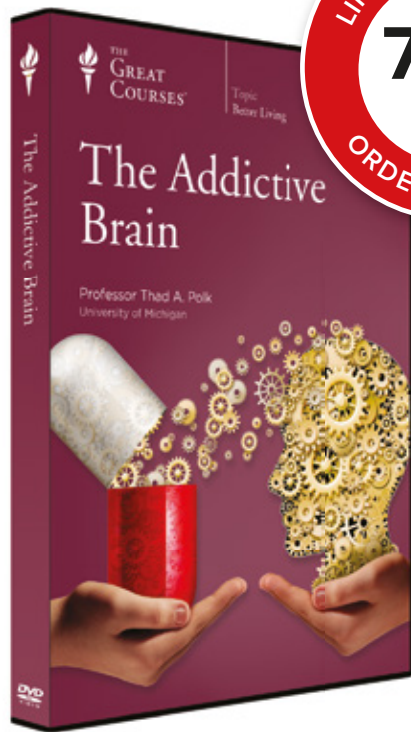
**The Science  
Behind the Bond**

**PLUS**

**Links  
Between  
Depression  
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**Crime  
and  
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## Fins, Feathers and Friends

Ever since I served as the launch editor of *Scientific American Mind*, a little more than a decade ago, our editors have had something of an obsession with relationships. The cover story of the premiere issue, for instance, offered to explain “why we help”—it explored altruism and other socially focused behavior. Through the years the magazine has examined whether men and women can be “just friends,” how certain parenting styles can foster happy and successful children, and why we feel social support from online communities even though there is no in-person contact.

In this edition, we take an expansive look at our close connections to our non-human “family” members. I speak, of course, of our pets: dogs, cats, birds, snakes, turtles, rabbits, fish, horses, and more. We also feature our first nonhuman cover model—a beautiful border collie named Ten, who delighted everyone at the photo shoot. As you will learn in our special report on “The Psychology of Pets,” starting on page 27, we humans share an innate attraction to other species. Pets can provide strong emotional support and give their owners’ lives a greater sense of meaning. Biologist and canine researcher Ádám Miklósi details how dogs in particular have become such an integral part of the human family. Turn to page 37.

Arguably, our most important relationship in life is the one we maintain with ourselves: it is our own consciousness that charts the through line of personal experience. In a provocative article that begins on page 64, the eminent British psychologist Nicholas Humphrey contends that our sense of consciousness is akin to a work of art created by the brain.

Of course, relationships generally rely on some form of communication to share experiences, stories and concerns. In “Beyond Shyness,” starting on page 50, Claudia Wallis describes a childhood anxiety disorder called selective mutism that disrupts social communication. Affected children clam up, especially in school, missing out on early learning and social development. Therapy, she writes, can lead to a happy ending—really a beginning—for such students.

While I’m talking about relationships and connections, I’d like to make an introduction. Wallis not only writes great feature articles for *Scientific American Mind*, she is its new managing editor. She brings a wealth of experience in award-winning journalism and a sure hand in editorial direction. I look forward to seeing how the magazine will continue to grow under her stewardship. And, as always, we welcome feedback from our community of readers every step of the way.

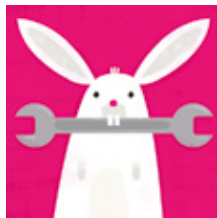
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FEATURES

SPECIAL REPORT

# 27 The Psychology of Pets

BY THE EDITORS

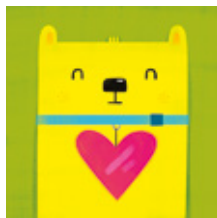


## 28 Pets: Why Do We Have Them?

People have an innate interest in other species, but we like having pets for a variety of social reasons.

BY DAISY YUHAS

**Also:** What Your Pet Reveals about You  
By Karen Schrock Simring

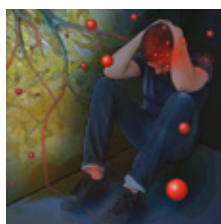


## 37 The Science of a Friendship

How dogs became our closest animal companions.

BY ÁDÁM MIKLÓSI

**Also:** Decoding the Cat  
By Julia Calderone



## 46 Can Infection Give You the Blues?

An overactive immune response can seed psychological illnesses.

BY ERICH KASTEN



## 50 Beyond Shyness

That boy who never speaks in class? Chances are he has an anxiety disorder called selective mutism that demands the one thing he dreads the most: attention.

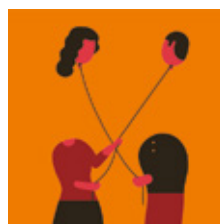
BY CLAUDIA WALLIS



## 56 Women on the Verge

Good news for women in technical fields: by choosing a career that defies gender stereotypes, you can become a more original thinker.

BY LAURA DI BELLA AND RICHARD J. CRISP



## 60 Patients Helping Patients

People who have suffered from mental illness are increasingly recognized as a resource in caring for others.

BY KAREN WEINTRAUB

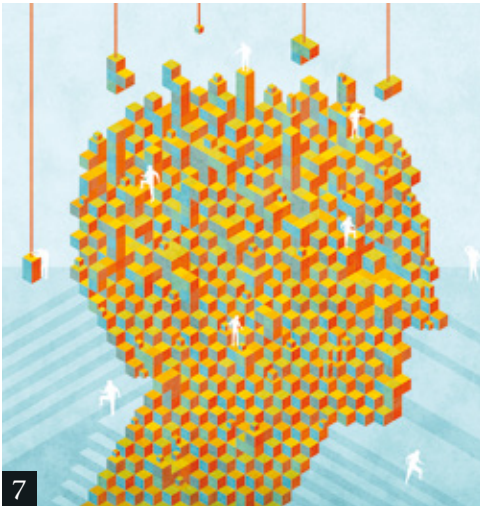


## 64 Consciousness as Art

Our subjective experience of the world may be like a visit to a gallery where the artist is our brain.

BY NICHOLAS HUMPHREY

## DEPARTMENTS



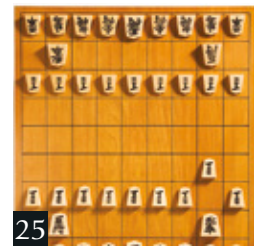
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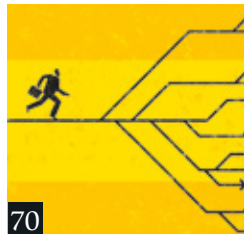
20



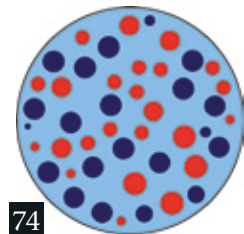
23



25



70



74



76

### 1 From the Editor

### 4 Letters

### 7 Head Lines

Tips for learning and retaining.

Extracting confessions.

How to sleep better.

The brain's sense of direction.

Traces of lost memories.

Two faces of narcissism.

Tiger parenting makes kids anxious.

How we forget presidents.

The rise of moral religions.

### 20 Illusions

Ways the brain can be fooled into perceiving movement.

BY STEPHEN L. MACKNIK AND SUSANA MARTINEZ-CONDE

### 23 Perspectives

**Crime without Punishment?**

Forgiveness can end the cycle of revenge.

BY ORIEL FELDMANHALL AND PETER SOKOL-HESSNER

### 25 Consciousness Redux

The brain has an uncanny ability to rapidly know the answer without knowing why.

BY CHRISTOF KOCH

### 70 Reviews and Recommendations

A comeback for behavioral science. Q&A on the zombie brain. The art and science of tastiness. *Also*: How to make the smartest choice.

### 72 Ask the Brains

Can visualizing your body doing something help you complete the action? Does introversion exist among nonhuman primates?

### 74 Head Games

Match wits with the Mensa puzzlers.

### 76 Mind in Pictures

Flying Blind.

BY DWAYNE GODWIN AND JORGE CHAM

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**WORKERS WITH AUTISM**

It is encouraging to see more discussion, as in the article “Autism Grows Up,” by Jennifer Richler, of the issues surrounding autism in the workplace. Anyone on the spectrum over a certain age will likely not have received any support at any stage of his or her life and may not have school qualifications commensurate with his or her level of intelligence. Assistance in turning a special interest into a career, at any age and with or without a formal qualification, would definitely be useful to such persons.

Although organizations such as Aspire may be doing valuable work in teaching social skills, it must be borne in mind that particularly for those on the higher-functioning end of the spectrum, the issues they face most likely are far more subtle than realizing that it is inappropriate to lie down in a ship bunk on a day out. A far more likely scenario might be not understanding when the boss doesn’t want to be disturbed versus making the judgment call in situations where the boss would indeed want to be interrupted for something important, even if he or she is busy.

In the absence of being able to fully “read” each situation as it occurs, the Aspie would tend to operate off of prior experience or instructions. Having been snapped at a few times for “interrupting,” the next time the person might hesitate to knock on the boss’s door, unless

specifically briefed in advance that the boss was expecting an urgent message. Unfortunately, this uncertainty can easily be interpreted by the boss as a passive or reactive working style and over time can be framed by the organization as a “performance issue.”

The solution is educating organizations in the communication style and preferred working methods of people who are on the spectrum rather than throwing the onus onto the individuals to spell out to their workplace what their needs are—until specific situations arise, they may not actually know or be able to articulate them.

Whereas governments can legislate under disability protection laws to prevent unlawful discrimination, organizations can always find ways around them on the grounds of “cultural fit,” “attitude,” “personality,” and other subjective recruitment or appraisal criteria. It can be very difficult in such circumstances to prove that discrimination has actually taken place.

A better approach would be to educate employers on the strengths of people on the spectrum so that these can be positively sought out by organizations as highly desirable attributes in an employee.

Gwyneth Rolph  
via e-mail

**BE MINDFUL OF EMOTIONS**

“How to Control Your Feelings—And Live Happily Ever After,” by Steve Ayan, sets up a false dichotomy: when a strong emotion arises, we can let it take over and determine our actions, or we can suppress it or distract ourselves from feeling it. Limiting our options to these two sets up a vicious cycle because the more we try to suppress something in us, the more it will tend to pop up again in an extreme manner. A third way will reliably produce a better outcome, which is to fully experience the emotion while understanding that our actions need not be determined by it, an approach that is commonly called mindfulness. Therapies that recognize subpersonalities, such as the Internal Family Systems model, provide a powerful framework for achieving this aim. By



relating to the emotional reaction as a “part,” we provide the witnessing that it needs, avoiding the negative consequences of suppressing feelings while retaining choice over how we act in the world. If we use a car as a metaphor for life, parts such as anger, addictive impulses or fear should not be ejected from the car, nor should they be allowed in the driver’s seat. They can be quite happy riding in the car while the “self” effectively drives.

**Ted Riskin**  
via e-mail

**INSIGHTS FROM ANOMALIES**

I was thrilled by these two articles, back to back: “The Advantages of Dyslexia,” by Matthew H. Schneps [Perspectives], and “The Face as Entryway to the Self,” by Christof Koch [Consciousness Redux].

I have always had difficulties reading with any speed. To survive college, I had to develop a scanning approach to getting enough information out of my textbooks to succeed in my classes. After I became a high school teacher, I worked with one of the leading dyslexia counselors in our district and discovered that I have two predominant anomalies: auditory dyslexia and visual cross dominance. (I found out about the cross dominance from the U.S. Army rifle range. Although I am right-handed, they had me sight the rifle with my left eye. It made the position of my chest perfect for hot shell casings to

go down my shirt: very entertaining for drill sergeants!)

I believe that having these anomalies gave me insight into how to teach kids who were not ideally suited for typical school approaches.

I loved the dyslexia article; I had lots of epiphanies. But here’s a possible epiphany for you: in Koch’s article about faces, I tried doing the 3-D trick on page 27. When I followed the directions correctly, I got Clinton on the right side (instead of the left, as is supposed to happen). I suspect that this picture could be used to determine cross dominance.

**David B. Hanley**  
Bakersfield, Calif.

I have a degree in special education, so when my son was diagnosed as having a learning disability, I started paying attention to the idea that visual-spatial learning can complement more traditional language-based learning. It makes no sense that children who grow up to be the world’s finest artists, authors, entrepreneurs, inventors or scientists are thought to be “slow” and incapable of learning when young. And now it seems we are drugging them and putting them in special classes to a greater degree, which is just scary. How can we move forward with only half of the brain being used? What are the disadvantages of language-based learning that we are glossing over while

making millions of dyslexics miserable? I love the idea of the types of learning being complementary, not antagonistic. We need better teaching methods for all children, not just those with learning disabilities.

**“rosabw”**  
Commenting online at  
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**THAT SEVEN-YEAR ITCH**

Regarding “Is there a biological basis for the famous seven-year itch?” [Ask the Brains], I have a different theory, which also has an evolutionary basis. My belief is that there is an initial “in love” feeling with associated physical passion for four to seven years, which serves to maximize the chances of having children. After that, the “roaring fire” diminishes to a warmly glowing ember that occasionally bursts into flame. The second phase is intended to allow humans to spend their time raising children, a task that takes a lot more time than creating them.

**“rwebber”**  
Commenting online at  
Mind.ScientificAmerican.com

We don’t need to avoid the four- to seven-year itch. We just need to avoid splitting up because of it. My life partner and I hit the four-year-itch mark in 1965, about when our first child was born. Instead of splitting up or forsaking all others, we spent two years talking honestly about what we wanted and adopted what is now called polyamory. We both took other lovers, many of whom became lifelong friends and still play important parts in our lives. Polyamory is growing and becoming more visible. Search online for “polyamory” and your city or state, and you will get a huge number of links.

**“Silenus7”**  
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# Head Lines

THE LATEST RESEARCH IN MIND AND BRAIN

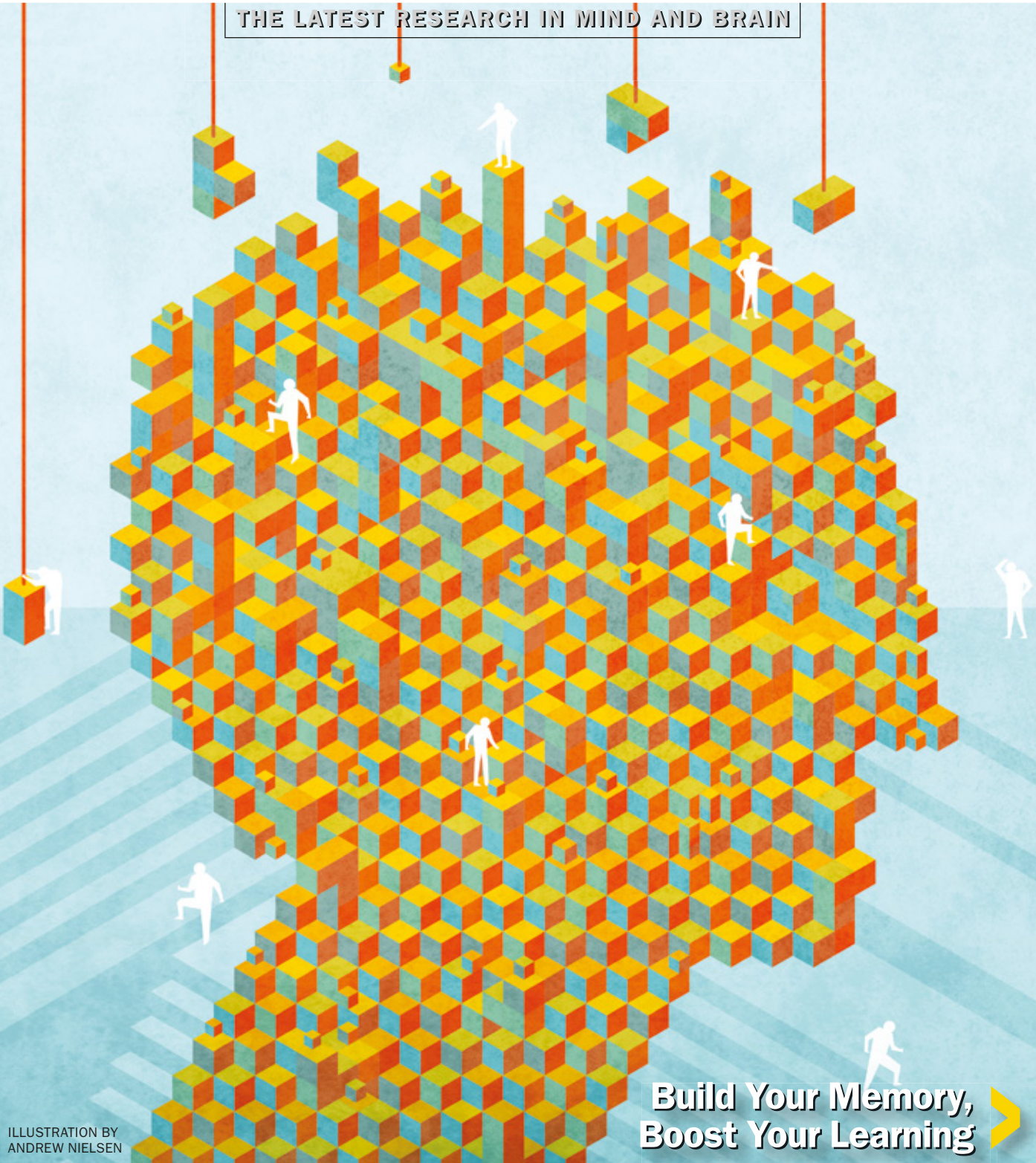


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**Build Your Memory,  
Boost Your Learning** ➤



**NEWS FROM OUR WEB SITE** | Our ability to metabolize alcohol goes back millions of years, according to a genetic study.

## QUICK TIPS FOR LEARNING

The science of how we learn is thriving. Robust findings suggest that certain strategies—such as reminding students that intelligence is not fixed—work brilliantly for improving learning and performance. The field also occasionally turns out surprising tips that are easy to implement and may lead to big gains. Here are several of the most recent studies to explore such shortcut strategies.

### TRY THIS!

**PUT CRUCIAL INFO IN A HARD-TO-READ FONT.**

*In a 2011 study, people who had to read*

**\* unfamiliar \***

or less legible

*fonts displayed*

**BETTER MEMORY**

for the **INFORMATION**

than those who had

EASILY READABLE

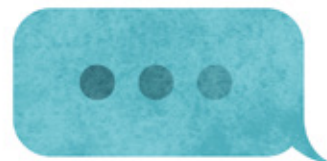
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Font size, however, made no difference.

## Wait for It: Delayed Feedback Enhances Learning—But Only If You're Curious

It may seem that getting instant results would enhance learning, but various studies indicate a benefit to feedback that is delayed. Test takers are more likely to retain the correct answer if they receive it several seconds after providing their answers rather than immediately.

To understand why delayed answers improve learning, researchers at Iowa State University asked college students to give their best guess to trivia questions such as “Who coined the word ‘nerd’?” and “What color is a grasshopper’s blood?” and to rate how curious they were about each answer. For half of the items, participants learned the correct answer immediately after responding to the question. For the remaining items, the answers either followed



a four-second delay or an unpredictable interval of two, four or eight seconds. The students were then tested on the questions after engaging in unrelated distracting tasks.

The results, which were published in the November 2014 issue of *Memory & Cognition*, confirm the benefit of delayed feedback

**Learning often improves when the body cept out loud. Pace and think. Get your**

## Save One File to Remember the Contents of Another

Digital storage of data has become an integral part of our lives, whether in the form of contacts and calendars on smartphones or constant access to the vast stores of knowledge in the cloud. Previous research has suggested that saving information makes us less likely to remember it, presumably because we assume we do not really need to memorize something that is saved. But doing so should also free up mental resources, reasoned cognitive scientists Benjamin Storm and Sean Stone, both at the University of California, Santa Cruz. They found in a new study that saving some information enhances memory for new material.

Storm and Stone ran a series of experiments in which they asked volunteers to study a list of eight words. One group was then told to save the file, whereas the other group was just told to close it. The participants then studied a second list and were later tested on their memory of it.

The researchers found that people who saved the first file remembered more of the list in the second file, according to their paper published in February in *Psychological Science*. This effect was not seen if the saving process was demonstrably unreliable or if the first file consisted of only two words and so was not substantial enough to interfere with memory for the second file. It is almost as if people use digital storage as external capacity to “off-load” memory demands, the researchers posit. They suggest you can take advantage of this memory quirk by saving information you do not need immediately for later reference, thus freeing up resources for the learning task at hand.

—Simon Makin



and show that it hinges on curiosity: in follow-up tests, participants answered more accurately when feedback arrived later but only for items that piqued their interest. The researchers suggest that delayed feedback encourages learners to anticipate the answer, which may increase their level of attention to it when they receive it. The effect was strongest when feedback was presented at unpredictable intervals, which is in line with previous studies showing that attention is enhanced when an upcoming event's timing is uncertain. So if you are studying with a buddy, ask that person to give you the answers after an unpredictable delay of a few seconds. If you are working alone, resist the urge to Google or look up an answer immediately and take a guess first.

By the way, Dr. Seuss coined the word "nerd," and a grasshopper's blood is white. If you were wondering about these answers, that delay may have just sealed them in your memory forever. —Tori Rodriguez

## HIT THE GYM after Studying

Regular exercise boosts brain health, and a fit brain is generally able to learn, think and remember better. But a few recent studies offer an additional exercise-related tip: time your workouts for just after a study session, and you might better retain the information you just learned. In a variety of experiments, people who biked, did leg presses or even simply squeezed a handgrip shortly after or before learning did better on tests of recall in the hours, days or weeks that followed.

Experts think the crucial component is physical arousal. Exercise excites the body in much the same way an emotional experience does—and emotional memories are well known to be the most long lasting. The researchers caution, however, that at most exercise can have a supportive effect—the important thing is to study well first. —T.R.

is involved. Gesture while explaining a con-  
heart rate up. Your brain will thank you.

## Distraction Is Good, Sometimes

Distraction can be a good thing for learning under the right circumstances—namely when you will be tested or have to perform under similarly distracting contexts.

Psychologists know that the things we learn in one context might not be remembered in another. Famously, investigators once showed that words learned while scuba diving are easier to recall underwater than on dry land. Now Brown University psychologists suggest something similar happens with distraction. The researchers trained 48 people to hit a computer-screen target using a wonky touch pad—tracing up, for example, might move the cursor diagonally—and later evaluated them on their ability to quickly hit the mark. During both training and the test, participants were randomly selected to do a distracting second task: counting letters on a screen. Those distracted during just one phase performed poorly when tested, but those who had done the letter-counting task during both training and testing performed just as well as those who had trained and been tested without distractions, according to the results



published in February in *Psychological Science*.

The consensus remains that distraction is typically bad for learning, the scientists explain. But if you anticipate a distracting testing or performance environment, try to mimic those distractions as you study or practice to avoid being caught off guard. —Nathan Collins

## More Quick Tips for Creativity and Focus

### ■ Lie down to spark insight.

One study showed that people who lay on their back solved anagrams significantly faster than those who stood.

### ■ Dress for the occasion.

In one study, people who wore a white lab coat displayed enhanced focus.

### ■ Smile when sad to enhance creativity.

People who exhibited contradictory mental and physical states—they thought of a sad memory while smiling or listened to happy music while frowning—were better able to think outside the box.

—Victoria Stern

players who started the sport before age 12 were found to be more impaired in memory and intelligence than those who started at an older age.



## » How to Extract a Confession ... Ethically

Scientists are using social psychology to enhance interrogation methods without force

Last December a Senate Intelligence Committee report revealed how two psychologists were involved in shaping the CIA's "enhanced interrogation" methods, using psychologist Arthur Seligman's theory of learned helplessness to justify controversial practices such as waterboarding and sleep deprivation—something Seligman himself has repudiated. The problem is that in addition to being morally reprehensible, interrogation methods based on force and intimidation don't work.

"Coercive, confrontational methods actually lead to the detainee shutting down," says psychologist Christian Meissner of Iowa State University, who studies interrogation techniques. "More effective tactics rely on cooperation, which can be facilitated using principles of social influence that we know work very well."

According to the American Psychological Association, if a psychologist meets certain conditions, chief among them "do no harm," it is permissible for him or her to aid in interrogations. So is there an ethical way to extract a confession from someone?

To find out, in 2009 President Barack Obama convened the High Value Detainee Interrogation Group (HIG), made up of cognitive and social psychologists and other experts. This winter the HIG, led by Meissner, released its findings in a special issue of *Applied Cognitive Psychology*. Ethical interrogations are not only possible; their effectiveness is also robustly supported by research.

At the right are some of the HIG's most interesting findings. Though developed for law enforcement, there is no reason to think these strategies will not also work on the mendacious teens, spouses and co-workers in your life if you need to get to the bottom of something.

**1. Build rapport.** Think of it as just "good cop." Researchers have found that coming across as empathetic causes interrogation targets to open up more than when the interrogator is cold and accusatory. Many of the other techniques described in the journal depend on having a cooperative target, making this step all the more important. "The first thing you have to do is develop cooperation, rapport," Meissner says. "Once you have a cooperative person, the question is, How do I get all the info from them that I can?"

**2. Fill in the blank.** To get that info, instead of asking direct questions, tell your target a story about what he or she did, leading the person to believe you already know what happened. As you provide the narrative, the guilty party will then supply details and corrections. This is called the Scharff technique, named for its developer, Hanns Scharff, a German interrogator during World War II. The technique was shown to elicit more information than direct questioning in a 2014 study. People interrogated using this method also tend to underestimate how much they are sharing.

**3. Surprise them.** People who are interrogated often know they are under suspicion, so they practice their answers ahead of time. In addition, liars are under high cognitive strain as they try to keep their story straight and at the same time act calm and collected. If you ask them something unexpected, they often stumble when put on the spot—enabling you to catch them in a lie.

**4. Ask for the story backward.** In contrast to what most people believe, truth tellers are more likely to add details and revise their stories over time, whereas liars tend to keep their stories the same. "Inconsistency is really just a fundamental aspect of the way memory works," Meissner says. A technique that interrogators use to capitalize on that quirk is called reverse telling—asking people to recall events backward rather than forward in time. This strategy has a double effect: For truth tellers, it makes recall easier—in another HIG study, reverse telling produced twice as many details as did recounting chronologically. For liars, the task becomes harder when put in reverse; they become more likely to simplify the story or contradict themselves.

**5. Withhold evidence until the crucial moment.** In a study last March, when people were confronted with potential evidence of their wrongdoing early in the interview, they either clammed up and adopted an extremely hostile posture or immediately spilled their guts, depending on the individual. Rather than risking the former, the researchers advised truth seekers to take a middle path, alluding to evidence without making any direct accusations—at least not right away. —*Roni Jacobson*

## » UNSUPERVISED HABITS

A lack of control in the brain may underlie obsessive-compulsive disorder

An individual with obsessive-compulsive disorder (OCD) is overcome with an urge to engage in unproductive habits, such as excessive hand washing or lock checking. Though recognizing these behaviors as irrational, the person remains trapped in a cycle of life-disrupting compulsions. Previous studies found that OCD patients have abnormalities in two different brain systems—one that creates habits and one that plays a supervisory role. Yet whether the anomalies drive habit formation or are instead a consequence of doing an action over and over remained unclear.

To resolve this question, a team at the University of Cambridge monitored brain activity while people were actually forming new habits. Lapses in supervision are to blame, the researchers reported in a study published online in December 2014 in the *American Journal of Psychiatry*. They scanned 37 people with OCD and 33 healthy control subjects while they learned to avoid a mild shock by pressing on a foot pedal. Pressing the pedal became a habit for everyone, but people with OCD continued to press even when the threat of shock was over. Those with OCD showed abnormal

activity in the supervisory regions important for goal-directed behavior but not in those responsible for habit formation.

The finding suggests that shoring up the goal-directed systems through cognitive training might help people with OCD. The growing understanding of OCD's roots in the brain may also help convince individuals to engage in standard habit-breaking treatments, which expose a person to a trigger but prevent his or her typical response. "It's hard for people to not perform an action that their whole body is telling them to do," says first author Claire Gillan, now at New York University. "So if you have an awareness that the habit is just a biological slip, then it makes OCD a lot less scary and something you can eventually control."

—*Michele Solis*

HENRICK SORESENSEN/Getty Images



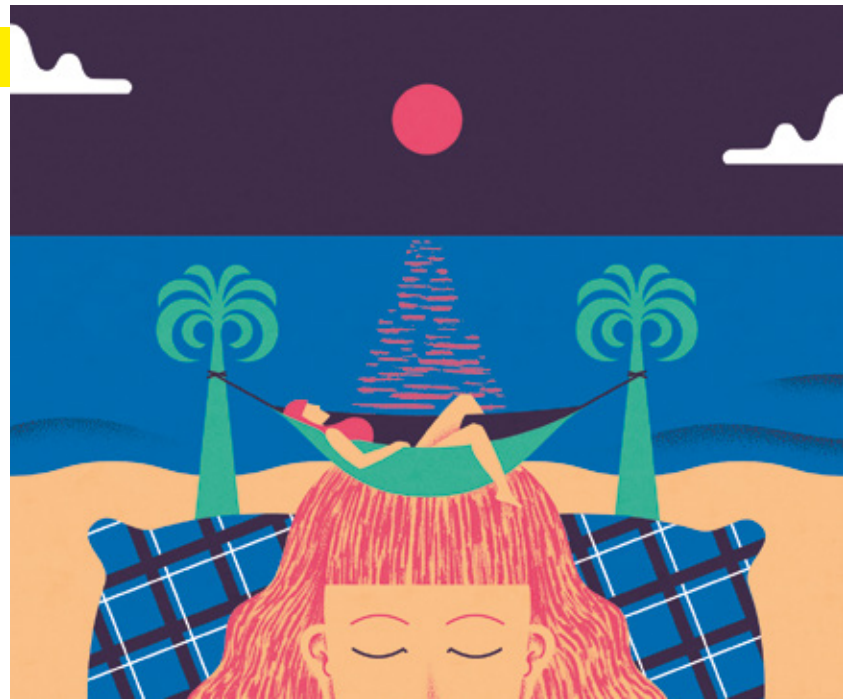
# How to Be a Better **sleeper**

Everyone in my family is sleep-deprived. My wife, who usually writes this column, is so overtaxed this month that she asked me to fill in for her. It's tempting to blame our sleep deprivation on nightly interruptions by our nine-month-old or our toddler. But it's my own fault, too: like 30 percent of my fellow Americans, my sleep habits are fairly wretched. Instead of treating my sleep as a valuable resource, I approach bedtime like folding the laundry: as a regular obligation that I'll get to, eventually.

Decades ago this attitude might have been defensible, but nowadays scientists have linked sleep disruption to accelerated aging, increased risk of obesity, and immune system and cardiovascular dysfunction. The good news is that becoming a better sleeper may be simpler than it seems.

**#1 Take bedtime lighting seriously** (but not too seriously). Recent studies have shown that reading on an electronic screen right before bed can inhibit the production of melatonin, a hormone that helps lull us to sleep. Although it's true that these gadgets can mimic the effect of daylight on the eyes and influence the timing of the body's internal clock, circadian neuroscientist Russell Foster of the University of Oxford says that in the end, quantity of light matters more than quality. "Bright light has a basic alerting effect on the brain, and the amount of light these portable electronic devices give off is pretty low," Foster says. "Ironically, the last thing most of us do before getting in bed is to stand in a massively illuminated bathroom while brushing our teeth." So instead of stressing out about whether you read in bed on a screen or on paper, put your bathroom light switch on a dimmer—or just brush your teeth earlier. However you do it, aim to minimize your exposure to light 30 to 60 minutes before bed.

**#2 Take a morning "photon shower."** According to Foster, the same eye cells that rely on dim light to ease you into slumber also need a burst of brightness in the morning to resynchronize your circadian rhythm. "The human body clock is slightly longer than 24 hours, so without this stabilizing effect from morning light, the clock starts to drift," Foster says. In other words, you'll start going to bed later and later while waking up at the same time each morning, gradually build-



ing up a sleep deficit. The best medicine is, of course, natural morning light. But if your job, your geography or your kids force you to rise before dawn, grit your teeth and flip those ceiling lights on full blast until you can get some sun. Most indoor lighting has at least the same ambient brightness as a sky at sunrise—between 400 and 1,000 lux (the scientific unit for measuring illuminance). Foster recommends "showering" with 1,000 to 2,000 lux in the morning to ensure alertness and set your body clock up for a proper winding down later in the evening. If you really want to get scientific, you can download light-meter smartphone apps that will tell you exactly how bright any spot in your home is.

**#3 Hack your dreams.** The function of dreaming is still unknown, but a 2011 study done by Robert Stickgold, director of Harvard Medical School's Center for Sleep and Cognition, showed that subjects who were told to solve a maze were able to do so more efficiently if they experienced dreams related to the task prior to doing it. And lucid dreaming—in which the dreamer becomes able to control his or her experience without waking up—may boost dreaming's insight-producing and anxiety-reducing effects. "There are studies showing that people who have one lucid dream per month or more are more resilient in

the face of stressful events," says Tore Nielsen, a sleep researcher at the University of Montreal. You can prime yourself to experience spontaneous lucid dreaming, Nielsen explains, by making it a habit to ask yourself, "Am I dreaming?" throughout the day. Eventually you'll probably ask the question during a dream, realize you're dreaming and take control. "It's been shown that you can fly, you can explore creative ideas, even treat nightmares" with lucid dreams, he says.

**#4 Just do it.** While researching this article, I encountered a seemingly bottomless supply of sleep-hacking tricks, from taking a midday "caffeine nap"—drink a cup of coffee, then sleep for 20 minutes—to keeping one foot outside the covers at night. But at the end of the day, Stickgold says, it's pretty simple: you either choose to get the sleep you need, or you choose not to. "I tell people to do an experiment: go to bed one hour earlier than usual each night for a week," Stickgold says. "And if you find at the end of the week that you're really seven hours 'behind' on everything, then stop doing it! But if you suggest to me that you're not more efficient with that extra seven hours of sleep, you're totally delusional." Challenge accepted, Dr. Stickgold. Just make sure my kids get the memo, too. —John Pavlus

## ▶▶ THE BRAIN'S HOMING SIGNAL

Goal-direction cells tell us which way our destination lies

After wandering around an unfamiliar part of town, can you sense which direction to travel to get back to the subway or your car? If so, you can thank your entorhinal cortex, a brain area recently identified as being responsible for our sense of direction. Variation in the signals in this area might even explain why some people are better navigators than others.

The new work adds to a growing understanding of how our brain knows where we are. Groundbreaking discoveries in this field won last year's Nobel Prize in Physiology or Medicine for John O'Keefe, a neuroscientist at University College London, who discovered "place cells" in the hippocampus, a brain region most associated with memory. These cells activate when we move into a specific location, so that groups of them form a map of the environment.

O'Keefe shared the prize with his former students Edvard Moser and May-Britt Moser, both now at the Kavli Institute for Systems Neuroscience in Norway, who discovered "grid cells" in the entorhinal cortex, a region adjacent to the hippocampus. Grid cells have been called the brain's GPS system. They are thought to tell us where we are relative to where we started.

A third type—head-direction cells, also found in the entorhinal region—fires when we face a certain direction (such as "toward the mountain"). Together these specialized neurons appear to enable navigation, but precisely how is still unclear. For instance, in addition to knowing which direction we are facing, we need to know which direction to travel. Little was known about how or where such a goal-direction signal might be generated in the brain until the new study.

A team of researchers, led by Hugo Spiers of University College London, asked 16 volunteers to familiarize themselves with a virtual environment consisting of a square courtyard with a

landscape (such as a forest or a mountain) on each wall and a unique object in each corner. They then scanned the participants' brains while showing them views from the environment and asking them to indicate in which direction different objects lay.

The entorhinal region displayed a distinct pattern of activity when volunteers faced each direction—consistent with how head-direction cells should behave. The researchers discovered, however, that the same pattern appeared whether the volunteers were *facing* a specific direction or just *thinking* about it. The finding suggests that the same mechanism that signals head direction also simulates goal direction. How, exactly, the brain switches back and forth is unclear, but the researchers think the brain probably signals which direction you are facing until you consciously decide to think about where you want to go, at which point the same cells then run the simulation.

Interestingly, the more consistent the participants' goal-direction signals were, the better they were able to correctly recall in which direction the target objects lay, potentially offering a brain-based explanation for differences in navigational ability. Such results should be interpreted carefully, however. "There are many ways worse performance can lead to weaker effects," cautions Neil Burgess, who heads a different group studying these systems at University College London. For instance, if a participant's attention lapses, she or he will not only perform worse but also produce less relevant brain activity.

The work may have clinical relevance. The ability to navigate is often an early casualty of dementias such as Alzheimer's disease because the entorhinal region is one of the first areas to be affected. Spiers's group is working with doctors to develop tests to help identify deficits and potentially measure disease progression.

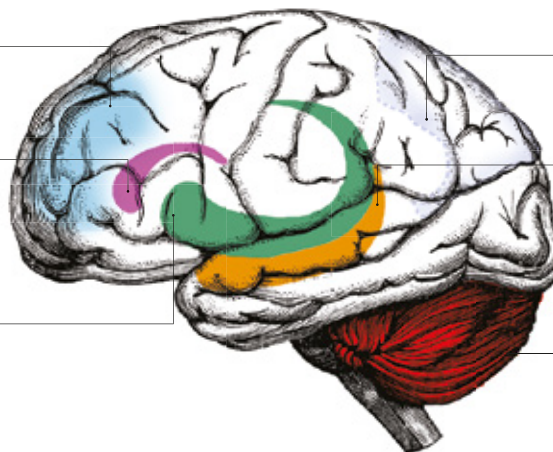
—Simon Makin

### How We Navigate

**Prefrontal cortex** helps us decide on and plan a route and permits us to change navigation strategies.

**Dorsal striatum** stores information required to navigate familiar routes, indicating the direction to proceed and the distance needed to travel to reach the destination.

**Hippocampus** contains place cells, which locate you in space and allow you to store maps of familiar environments.



**Medial parietal cortex** encodes body-centric directions such as left and right, according to the new study described above.

**Entorhinal cortex** houses grid cells, which tell us where we are relative to where we started; this area also contains head-direction cells, which indicate the direction we are facing or thinking about.

**Cerebellum** is involved in motor control; it keeps us aware of our own motion.

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( PHARMA WATCH )

## SIX SYNDROMES WITH SURPRISING PSYCHOTHERAPY SOLUTIONS

Ailments we typically think of as bodily might be improved by thought alone

Most people now acknowledge that the mind and body are inextricably linked, and problems in one are often related to problems in the other. Yet some bodily complaints seem so physically based that it is hard to imagine that any kind of talk therapy could touch them. The six disorders below seem to be such cases—but every one of them can be treated with psychotherapy, according to recent studies. So consider all your options before reaching for a pill.

—The Editors



**HEADACHE** When a headache hits, most of us reach for over-the-counter pain relievers, and in severe cases physicians might prescribe medication. Yet recent research suggests psychotherapy may prevent many headaches from materializing in the

first place. Earlier studies demonstrated that mindfulness-based therapy could ease chronic pain, so researchers at the University of Canberra and elsewhere in Australia investigated whether a brief version of this approach would help people with chronic tension-type headaches (the most common kind). In a pilot study reported last year in *Behavioural and Cognitive Psychotherapy*, the researchers assigned participants to either a control group or to six sessions of mindfulness-based therapy over three weeks. The mindful participants had significantly fewer headaches but not the control group. Another recent study, reported in the *Italian Journal of Pediatrics*, found that a brief course of psychodynamic psychotherapy might be more effective than standard care in treating migraines and tension headaches in children.

—Tori Rodriguez



**INSOMNIA** People who have trouble falling asleep or remaining asleep long enough to feel rested are typically treated with sedatives. Most popular are benzodiazepines, such as Valium and Xanax, or Z-drugs, such as Lunesta and Ambien. Evidence suggests that cognitive-behavior therapy (CBT) may work just as well, if not better, than these drugs at managing insomnia, especially in the long term. A 2005 randomized controlled trial found that insomniacs receiving CBT fell asleep faster and slept more soundly than those taking sedatives and that participants receiving both interventions did no better than those who underwent only therapy. In a 2012 review of five randomized controlled trials, researchers concluded that insomniacs who received CBT were more satisfied with their sleep and slept better than those who took sleep medications.

—Victoria Stern



**FIBROMYALGIA** Intense pain in joints and muscles, fatigue and depression characterize fibromyalgia, which is routinely treated with pain medications and antidepressants. Popular drugs Lyrica, Savella and Cymbalta are all approved to treat fibromyalgia pain and depression, but they vary in their success and can come with significant side effects. A growing body of research suggests that CBT can also help. A 2011 randomized controlled trial found that in patients with fibromyalgia, CBT reduced pain just as well as a standard drug regimen of Cymbalta or Lyrica, and it enhanced quality of life and perceptions of pain more dramatically. Other analyses concur, finding that psychological interventions, especially CBT, have a small but noticeable effect on reducing pain in patients with fibromyalgia, similar to that observed for drug therapy.

—V.S.



**IBS** Irritable bowel syndrome (IBS) is a chronic gastrointestinal disorder that often includes symptoms of abdominal pain, bloating and diarrhea, and constipation. Medications for IBS can help people with constipation or diarrhea. Diet and lifestyle changes

are an essential part of treatment, and many experts recognize the importance of addressing psychological symptoms because 50 to 90 percent of patients have co-occurring mental disorders such as anxiety, depression or social phobia. A new meta-analysis published online in December 2014 in the *Journal of Psychosomatic Research* examined data from 48 randomized controlled trials investigating psychological interventions for IBS. They found that symptoms improved when psychological distress diminished. The approaches that worked best were those that emphasized the link between symptoms and thoughts, incorporated self-monitoring and coping strategies, and provided feedback and general empathetic support.

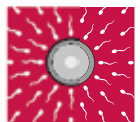
—T.R.



**FSD** Female sexual dysfunction (FSD) is a broad term that includes issues pertaining to sexual arousal or desire, orgasm or sex-related pain. Low desire is the most common sexual complaint among women and can affect quality of life. Pharmaceutical companies continue to hunt for a “female Viagra” with little success, although some compounds are in the early stages of clinical trials now.

Meanwhile researchers have found a promising psychological approach. In a study published last year in *Behaviour Research and Therapy*, 68 women attended four 90-minute sessions of mindfulness-based group therapy consisting of meditation, cognitive therapy and education, whereas 49 women were assigned to a delayed-treatment group. Results show that the mindful group had significant improvements in sexual desire, arousal, lubrication and satisfaction, along with fewer symptoms of depression, which also predicted sexual improvements.

—T.R.



**INFERTILITY** Fertility drugs, such as Clomid or Sero-phene, tend to be the first course of action to help women become pregnant. About half of women will get pregnant after taking these drugs, but for those who do not, doctors often recommend other medications—

such as injectable hormones—or in vitro fertilization. Yet given the role stress can play in becoming pregnant, it makes sense that psychological treatments may also be an effective way to enhance fertility. A 2005 review found that 45 percent of participants who underwent psychotherapy became pregnant compared with only 14 percent of control subjects who received no intervention. The study also found that women who had psychotherapy alone versus psychotherapy paired with in vitro fertilization had identical pregnancy rates. A smattering of more recent studies have found similar results, but the idea of using psychotherapy for infertility remains on the fringe.

—V.S.

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choose higher-paying and more prestigious jobs than extremely gifted girls do, according to research that has been following child prodigies since the 1970s.



## »» When Doctors Say, “Let’s Wait and See”

Treating the inherent anxiety might help patients make better choices

Imagine being told you have cancer or a potentially dangerous aneurysm—and then being told the best course of action might be to do nothing. This approach, dubbed “watchful waiting,” is the reality for an increasing number of patients, thanks to powerful new scanning tools. Yet coping with such uncertainty is difficult for most people.

“As the technology gets better and better, we’re picking up more of these conditions way earlier than the disease would be symptomatic or dangerous,” says Shelley Hwang, a breast surgeon at Duke University Medical Center, whose practice includes some women who choose surveillance for a precancerous but risky breast condition. Prostate cancer patients represent another large group for whom watchful waiting is often the medically sound choice because the disease may progress very slowly and surgery can lead to incontinence, impotence and other side effects. Smokers and ex-smokers often present with worrisome lung nodules—but only five out of 100 patients will go on to develop cancer.

Despite the favorable odds, many people experience anxiety and distress after such diagnoses. A National Institutes of Health report found in 2011 that just 10 percent of the 100,000-plus men with prostate cancer who are medically eligible for surveillance choose that route every year, and a quarter of those who initially choose to wait and see end up defaulting to treatment within three years. “From a health psychology perspective, there are less invasive ways to treat anxiety than through a surgical intervention,” says David Victorson, a health psychologist at Northwestern University—yet patients often think surgery is their only other option.

Scientists are investigating how best to help struggling patients. One recent study suggests that having faith in your ability to cope is key. Researchers asked 71 watchful waiters with prostate cancer to rate themselves on a series of statements about stress management, such as “Whenever I get negative, I reexamine my thoughts to gain a new perspective” or “I am confident about being able to choose the best cop-

ing responses for hard situations.” Men who saw themselves as good at coping suffered less cancer-related distress than those who felt less well equipped, according to the findings published in 2014 in the *Journal of Behavioral Medicine*. Relaxation skills did not appear to similarly ease negative thoughts. Health care practitioners may therefore want to survey their patients about their coping confidence before sending them off to try and wait patiently. Those who score low may need extra help.

## Ten to 20 percent of people react to medical surveillance with an extreme emotional or lifestyle change, such as drastically altering physical activity.

Another promising intervention, once the anxious patients have been identified, may be mindful meditation, which tames worrying by helping people focus on the present. Victorson led a study of prostate cancer patients, currently submitted for publication. He found that the 23 men who completed an eight-week meditation class experienced significantly greater post-traumatic growth—meaning the crisis of their diagnosis became a catalyst for positive psychological change—compared with the 18 men who were given a meditation book only. That psychological payoff persisted at least a full year.

These studies are preliminary—the most effective treatment for medical anxiety is not yet clear. But an important takeaway for patients has emerged: You do not have to face a choice between angst-ridden waiting and risky treatment. Treating the anxiety might be a safer and happier middle ground. —Charlotte Huff

## »» Where Memories Live

The long-held belief that memories are stored in synapses may not be the full story

**Once a memory is lost, is it gone forever? Most research points to yes. Yet a study published in the online journal eLife now suggests that traces of a lost memory might remain in a cell’s nucleus, perhaps enabling future recall or at least the easy formation of a new, related memory.**

The current theory accepted by neurobiologists is that long-term memories live at synapses, which are the spaces where impulses pass from one nerve cell to another. Lasting memories are dependent on a strong network of such neural connections; memories weaken or fade if the synapses degrade.

In the new study, researchers at the University of California, Los Angeles, studied sea slugs’ neurons in a cell culture dish. Over several days the neurons spontaneously formed a number of synapses. The scientists then administered the neurotransmitter serotonin to the neurons, causing them to create many more synapses—the same process by which a living creature would form a long-term memory. When they inhibited a memory-forming enzyme and checked the neurons after 48 hours, the number of synapses had returned to the initial number—but they were not the same individual synapses as before. Some of the original and some of the new synapses retracted to create the exact number the cells started with.

The finding is surprising because it suggests that a nerve cell body “knows” how many synapses it is supposed to form, meaning it is encoding a crucial part of memory. The researchers also ran a similar experiment on live sea slugs, in which they found that a long-term memory could be totally erased (as gauged by its synapses being destroyed) and then re-formed with only a small reminder stimulus—again suggesting that some information was being stored in a neuron’s body.

Synapses may be like a concert pianist’s fingers, explains principal investigator David Glanzman, a neurologist at U.C.L.A. Even if Chopin did not have his fingers, he would still know how to play his sonatas. “This is a radical idea, and I don’t deny it: memory really isn’t stored in synapses,” Glanzman says.

Other memory experts are intrigued by the findings but cautious about interpreting the results. Even if neurons retain information about how many synapses to form, it is unclear how the cells could know where to put the synapses or how strong they should be—which are crucial components of memory storage. Yet the work indeed suggests that synapses might not be set in stone as they encode memory: they may wither and re-form as a memory waxes and wanes. “The results are really just kind of surprising,” says Todd Sacktor, a neurologist at SUNY Downstate Medical Center. “It has always been this assumption that it’s the same synapses that are storing the memory,” he says. “And the essence of what [Glanzman] is saying is that it’s far more dynamic.” —Susan Cosler

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## A MAGNETIC ZAP THAT STRENGTHENS MEMORY

Imagine you are enjoying your golden years, driving to your daily appointment for some painless brain zapping that is helping to stave off memory loss. That's the hope of a new study, in which people who learned associations (such as a random word and an image) after transcranial magnetic stimulation (TMS) were better able to learn more pairings days and weeks later—with no further stimulation needed. TMS uses a magnetic coil placed on the head to increase electrical signaling a few centimeters into the brain. Past studies have found that TMS can boost cognition and memory during stimulation, but this is the first to show that such gains can last even after the TMS regimen is completed.

In the new study, which was published in *Science*, neuroscientists first used brain imaging to identify the associative memory network of 16 young, healthy participants. This network, based around the hippocampus, glues together things such as sights, places, sounds and time to form a memory, explains neuroscientist Joel Voss of Northwestern University, a senior author of the paper.

Next, the researchers applied TMS behind the left ear of each participant for 20 minutes for five consecutive days to stimulate this memory network.

To see if participants' associative memory improved, one day after the stimulation regimen finished they were tested for their ability to learn random words paired with faces. Subjects who had had TMS performed 33 percent better, compared with those who received placebo treatments, such as sham stimulation.

"Twenty-four hours may not sound like a long time, but in fact that's quite long in terms of affecting the brain," Voss says. His team followed up with the participants about 15 days later and found the benefit remained, according to another paper in press at *Hippocampus*. The team also imaged the subjects' brains one and 15 days after stimulation, finding increases in neural connectivity in their associative memory network.

Voss now plans to test whether this method works on individuals who have disorders in which the memory association network is weak, such as Alzheimer's disease, traumatic brain injury and schizophrenia. —Esther Hsieh



IAN MCKINNELL/Getty Images (masks); SCOTT DUNLOP/iStockphoto (sun icon); ISTOCKPHOTO (lightbulb)



## ▶ The Two Faces of Narcissism

The personality trait has two facets, and not everyone we think of as a narcissist shows both

In the past two years the study of narcissism has gotten a face-lift. The trait is now considered to have two distinct dimensions: admiration seeking and rivalry. Subsequent studies, including a recent look at actors, revealed a more nuanced picture of personality than did past work. The actors, for instance, want admiration more than most people but tend to be less competitive than the average Joe—they may crave the spotlight, but they will not necessarily push others out of the way to get it.

The new understanding of narcissism started with a 2013 paper in the *Journal of Personality and Social Psychology* that identified narcissism's two dimensions. "Previous theories and measures of narcissism dealt with this trait as a unitary construct, mixing up agentic aspects—assertiveness, dominance, charm—with antagonistic aspects—aggressiveness and devaluation of others," says Mitja Back of the University of Münster in Germany, the study's primary author. Lumping both aspects together made narcissistic behavior confounding.

Studying hundreds of healthy subjects, Back's team found that traits related to narcissism clustered into two categories, with both facets of narcissism serving to maintain a positive self-image. Self-promotion draws praise, whereas self-defense demeans others to fend off criticism. Admiration seeking and rivalry each have different effects on body language, relationship health and personality.

In the latest paper to build on these findings, in press in *Social Psychological and Personality Science*, actors and acting students were rated by themselves and others as more hung up on admiration than nonactors. But although winning plum roles requires competing with fellow thespians, working with others demands collaboration, and this aspect also attracts actors: the actors were found to be less rivalrous than the nonactors. Hollywood, then, may be predictably full of egotists but not jerks. The research was led by Michael Dufner of Leipzig University in Germany, who collaborated with Back on both papers.

It pays to be aware of narcissism's duality. "What attracts us in social partners at first sight is not necessarily what makes us happy in long-term relations," Back says. Even if narcissists have that bright, charming side, it is often simply a matter of time before the clouds come out. Except, perhaps, on Broadway. —Matthew Hutson

## ▶▶ Treating Depression Early May Protect the Heart

The link between cardiovascular problems and depression starts young



Heart disease and depression often go hand in hand. Long-term studies have found that people with depression have a significantly higher risk of subsequent heart disease, and vice versa.

Recent research has revealed that the link begins at an early age and is probably caused by chronic inflammation.

A new study in the November 2014 issue of *Psychosomatic Medicine* by researchers in the U.S., Australia and China examined data from an ongoing study of health among Australians. The researchers looked at the scores of 865 young adults on a questionnaire that assesses depression symptoms and other measures of mental health. They also examined measurements of the internal diameter of the blood vessels of the retina, a possible marker of early cardiovascular disease.

After controlling for sex, age, smoking status and body mass index, the investigators found that participants with more symptoms of depression and anxiety had wider retinal arterioles than others, which could reflect the quality of blood vessels in their heart and brain. “We don’t know if the association is causal,” explains study co-author Madeline Meier, a psychology professor at Arizona State University. “But our findings suggest that symptoms of depression and anxiety may identify youth at risk for cardiovascular disease.”

Other research shows that people with depression have more inflammation throughout their body and nervous system. “One theory is that stress and inflammation could play a causal role in depression,” Meier says. [For more on how inflammation may underlie depression, see page 46.] Such chronic inflammation is also a risk factor for cardiovascular disease. The relationship is complex: in some people, inflammation

seems to precede depression and heart disease; in others, the disorders seem to cause or exacerbate the inflammation.

A study published last year suggests that atypical depression, one particular type of the disorder, may be more strongly associated with inflammation—and thus with cardiovascular problems. Atypical depression accounts for 15 to 40 percent of depression cases. It is characterized by more flexibility in mood than is found in typical depression—for instance, mood might improve in response to positive events—along with symptoms such as increased appetite, feelings of heaviness in the limbs and sensitivity to interpersonal rejection.

In the study, which was reported in the *Journal of Behavioral Medicine*, researchers found that blood levels of a telltale immune protein in young adults with atypical depression were at least 55 percent higher than in those with other types of depression or no depression. The number of participants with atypical depression who had readings that indicated high cardiovascular risk was almost double that of the others.

The good news is that treating depression symptoms may indeed help prevent heart disease, according to a trial reported in 2013 in *Psychosomatic Medicine*. Patients with depression—some with and some without heart disease—either got 12 months of treatment with antidepressants and psychotherapy, or they were simply advised to follow up with their primary care provider. Over eight years the patients without heart disease whose depression was treated had a 48 percent lower risk of heart attack and stroke than those who were not treated. There was no change in risk for patients who already had heart disease at the start of the study, further underscoring the need for timely intervention. —Tori Rodriguez



## ▶▶ Tiger Parents Rear Anxious Cubs

Harsh, critical parenting may drive kids’ brains to overreact to errors

In an age when the formula for success seems infinitely regressive—when having a good career means going to a good college, which requires acing your way through a top high school, middle school and even preschool—the onus is on the parent to push, push, push. We want our children to get a foot in the door before they even know how to tie the shoe that’s on it. But should we

encourage our children through tender praise, or do we embrace the “tiger mom” strategy of punishment and criticism?

New research suggests that parents who stoke their children with harsh scolding may also be saddling them with anxieties that last a lifetime. In a survey published last November, researchers collected childhood memories from more than 4,000 adults of all ages and correlated them with the participants’ self-reported mental health. The findings suggest that children with authoritarian parents will have a harder time adapting to adversity later in life.

According to recent work by Greg Hajcak Proudfit, a clinical psychologist at Stony Brook University, punitive parenting has

LYNNE CAMERON AP Photo (tigers); ISTOCKPHOTO (heart icon)

## ➤ Once Famous, Now Forgotten

A study of how well we recall past U.S. presidents reveals a clear pattern of what we remember and forget

As President Barack Obama approaches the end of his second term, he must find himself wondering (along with countless pundits) about his legacy. The results of a recent study suggest that the question of how long he will be remembered can be addressed scientifically. The rate at which the majority of the population forgets about presidents—and other cultural icons and events—follows a predictable pattern, according to Henry Roediger, principal investigator of the Memory Lab at Washington University in St. Louis.

Roediger and fellow Washington psychologist Andrew DeSoto studied the results of a presidential recall test issued to a total of 415 undergraduate students in 1974, 1991 and 2009, as well as a similar online test given to 497 adults, aged 18 to 69, in 2014. Participants attempted to recall as many U.S. presidents as possible and place them in the correct order.

Roediger found that people's patterns of forgetting were remarkably similar, regardless of their age or when they took the test. In general, people tend to remember the first few presidents, along with the most recent eight or nine presidents, and one or two presidents in the middle, such as Abraham Lincoln, who governed during distinctive events.

Even more surprising, Roediger says, is the fact that our memories tend to follow the same pattern for all information, not just presidents. One can draw a "forgetting curve" that applies equally to historical events, television shows and even personal memories.

"There's no reason that forgetting presidents should follow the same curve as forgetting a list of words," Roediger says, "but that's what we see in the data." As for Obama, the fact that he is the first African-American president means he will probably be remembered



long past the 100 years or so that it will take for Bush and Clinton to become as obscure as Fillmore and Harrison seem today. —*Ajai Raj*

### How Does Your Memory for Presidents Stack Up?

The test is simple: Write down as many presidents as you can name, in the order you believe to be correct. Then visit [ScientificAmerican.com/Mind/presidents](http://ScientificAmerican.com/Mind/presidents) to see how your memory compares with that of other people today and in the past.

MICHAEL CHO

such a powerful and persistent effect because it trains a child's brain to overly emphasize mistakes.

When we goof up, our medial prefrontal cortex—just behind the center of the forehead—produces a predictable electrical pattern called the error-related negativity, or ERN. The ERN is thought to be the brain's way of pulling us back on track so that we won't make further careless mistakes. Evidence suggests that genetics can account for variations in the strength of the ERN among individuals, but Proudfit's work indicates that exposure to harsh criticism also comes into play.

In a study co-authored by his graduate student Alex Meyer, Proudfit measured the

ERN of nearly 300 children at age three and again at age six while giving them puzzles to work on in the company of their parents. The interactions that he observed varied greatly on a scale that most would consider normal; none of the parents were abusive. The parents were rated on how controlling they were (for example, stepping in immediately if a child made a mistake) and how warm they were when they gave feedback.

Proudfit also asked the parents to describe their feedback strategies, whether they were more likely to offer encouragement when the child made a mistake or to come down hard. A group of punitive parents emerged who were high in control and low in warmth—a critical, hostile style.

Both the self-reported and observed critical, hostile parenting predicted larger ERNs three years later. Furthermore, the children with punitive parents and high ERNs were more likely to show signs of anxiety disorders on their second visit.

According to Proudfit, children who are exposed to harsh criticism learn to internalize parental feedback until the ERN, normally a convenient caution sign, instead becomes a trigger for anxiety.

"Of course, everybody makes mistakes," Proudfit says. "But if you're punishing yourself more or responding to your mistakes more than the next kid, then that may be the trajectory of risk that leads you into an anxiety disorder." —*Morgen E. Peck*

be better at metacognition, the ability to reflect on one's own thoughts. | Crows may understand analogies and the concept of "same" versus "different."

## » Did Affluence Spur the Rise of Modern Religions?

Reliable food and energy may have freed up time to think about the purpose of life

About 2,500 years ago something changed the way humans think. Within the span of two centuries, in three separate regions of Eurasia, spiritual movements emerged that would give rise to the world's major moral religions, those preaching some combination of compassion, humility and asceticism. Scholars often attribute the rise of these moral religions—Buddhism, Judaism, Islam, Hinduism and Christianity included—to population growth, seeing morality as a necessary social stabilizer in increasingly large and volatile human communities. Yet findings from a recent study published in *Current Biology* point to a different factor: rising affluence.

The authors investigated variables relating to political complexity and living standards. Affluence emerged as a major force in the rise of moral religion, in particular, access to energy. Across cultures moral religions abruptly emerged when members of a population could reliably source 20,000 calories of energy a day, including food (for humans and livestock), fuel and raw materials.

“This number appears to correspond with a certain peace of mind,” says lead author Nicolas Baumard, a research scientist at École Normale Supérieure in Paris. “Having a roof over your head, not feeling like the world is full of predators and enemies, knowing that you’ll have enough to eat tomorrow.” As Baumard points out, psychology research shows that affluence appears to influence our motivations and reward circuitry away from short-term gain to also considering the benefits of long-term strategy. In other words, with a steady energy supply, we had more time to cooperate, cultivate skills and consider consequences. Affluence also allowed more time for existential pondering: maybe we have some greater moral responsibility; perhaps life has a purpose.



Baumard acknowledges that moral and ascetic qualities probably existed in humans before the major religions emphasizing them. Other experts believe that the paper may not consider these inherent qualities seriously enough. Barbara King, an anthropologist at the College of William & Mary, argues that the study exaggerates the sharp transition to the moral belief systems. She suggests that a more gradual transition may have taken place—one that was perhaps nudged over the line by a reliable calorie count. “Anthropologists and psychologists have found deep roots of morality and compassion in other primates,” King explains. “I don’t see any reason to assume that cosmological morality and compassion were not important to

earlier hunter-gatherer groups.”

Bernard J. Crespi, an evolutionary biologist at Simon Fraser University in British Columbia, also cautions against Baumard’s claim: “The main idea in the article is fascinating, but the causal link between increasing affluence and religion remains to be established. Our work actually suggests that the authors might have their causality reversed—that religion itself drives increases in affluence via its effects on increased cooperation.”

Still, Baumard’s findings point to a strong association between affluence and the emergence of moral religion, specifically. Plenty of ancient societies cooperated and had religious beliefs—the Maya, Sumerians and Egyptians among them. For the most part, however, none of these societies’ belief systems emphasized morality or material and visceral restraint. And according to Baumard, members of these societies never had access to more than 15,000 calories a day. Whether cause or effect, morality, it seems, takes energy. —Bret Stetka

### The Beginnings of Moral Religion

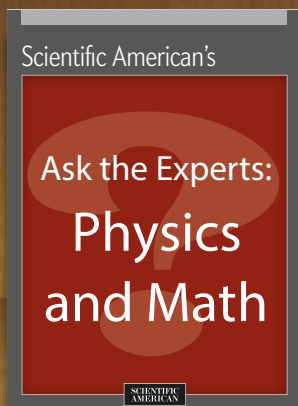
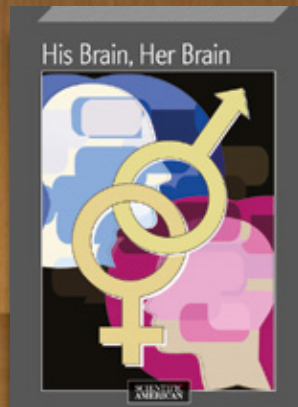
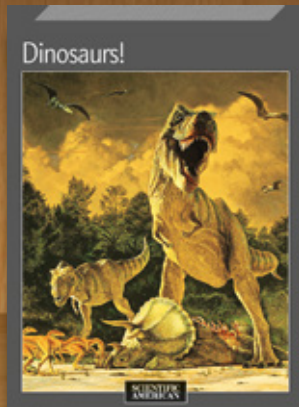
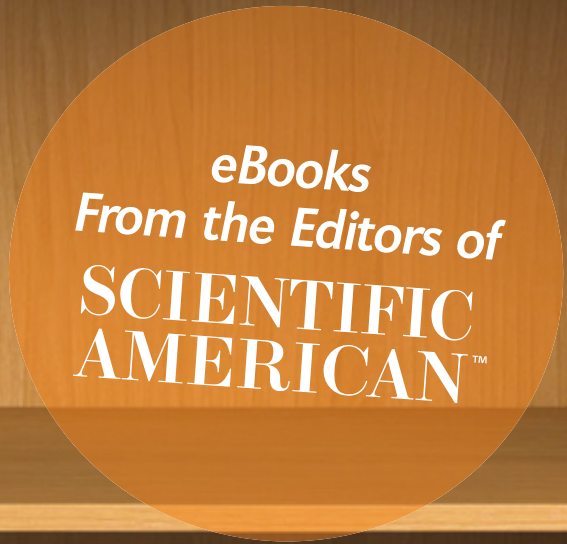
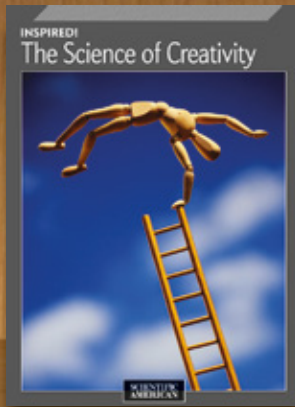
These five major movements mark the beginning of humanity’s turn toward religions that emphasize personal morality and asceticism, according to a new study.

—Victoria Stern



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## And Yet It Doesn't Move

How the brain can be fooled into perceiving movement

In August 2014 Nanami “Seven Seas” Nagura walked onto a stage in Oulu, Finland, for what looked like a martial arts demonstration. Flinging her hooded robe to the ground to reveal her kimono, she reached her arm around and prepared to unsheathe her sword. Then she swept a pointed finger out across the crowd and screamed, “I will kill you!”

Explosive light and sound followed. Foo Fighters’ hard-driving “Bridge Burning” started cranking while Nagura’s blade changed into a hard-rocking guitar. Nagura’s left hand fingered the frets as her right arm windmilled Towns-

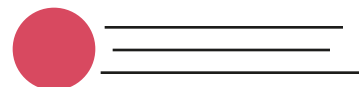


hend-style. Channeling Hendrix, Nagura ran across the stage as if pulled by her instrument, black tresses whipping back and forth. Bent over backward, toward the audience, she then played the guitar behind her head. The performance was exhausting but worth it: Nagura won the coveted 2014 Air Guitar World Championship. The 19-year-old had achieved air immortality.

But how did we perceive that Nagura wielded a sword and then a guitar, given that neither actually existed? The illusion might have been even stronger had she opted for a more traditional approach, such as sitting on a chair, one foot on a step, hands poised à la Spanish classical guitarist Andrés Segovia. Yet her offbeat performance offered multiple clues that enabled the audience to imagine a solid,

moving guitar in Nagura’s hands. Put simply: Nagura acted like a rock star, with all the fixings—stage, lighting, music—except the guitar itself.

The brain can derive a lot of information about an object from just a few cues. Implied motion, which is the perception of movement when none is there, is among the most famous examples of this ability. For instance, a drawing of a ball with three horizontal lines just to the right of the ball’s edge (*below*) looks like it is flying through the air. Read on to see other examples of the brain’s remarkable ability to recognize motion from a few simple clues. **M**



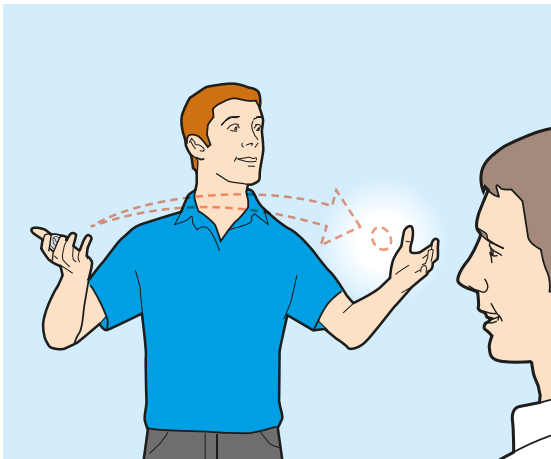
**BY STEPHEN L. MACKNIK  
AND SUSANA MARTINEZ-CONDE**



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



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## MAGIC MOTION

A few magic tricks take advantage of our brain's propensity to perceive motion based on a handful of implicit cues. Psychologist and magician Gustav Kuhn, then at Durham University in England, studied a magic illusion known as the vanishing ball trick in which a ball thrown in the air disappears in midflight. To achieve this effect, the magician first tosses the ball straight up and then catches it as it drops into his hand several times. On the final pitch, the magician only pretends to throw the ball but in reality keeps it hidden in his hand. Many people see the nonexistent ball ascend and then—alakazam!—vanish in midair.

Kuhn and his colleague Michael F. Land of the University of Sussex in England found that the illusion works in part because the magician's head and eyes follow the imaginary ball during the fake toss. The spectators do not direct their gaze along the ball's path, however. The researchers concluded that observers may follow the implied trajectory with their peripheral attention rather than their direct gaze.

In 2011 we and our colleagues Jie Cui and Jorge Otero-Millan, all then at the Barrow Neurological Institute in Phoenix, teamed up with Mac King, champion comedy magician and headliner at Harrah's Las Vegas, to study a coin-vanishing act. King's sleight of hand technique is the stuff of magic legend. After flipping the coin up and down a couple of times, King then pretends to lob it from right to left while keeping it hidden in his right hand to stop it from flying [see *illustrations at left*]. At the same time, he closes his left hand as if to "catch" the imaginary flying coin. A few breaths later he opens his left hand, and—poof!—the coin, which spectators had just perceived as soaring through the air, is gone.

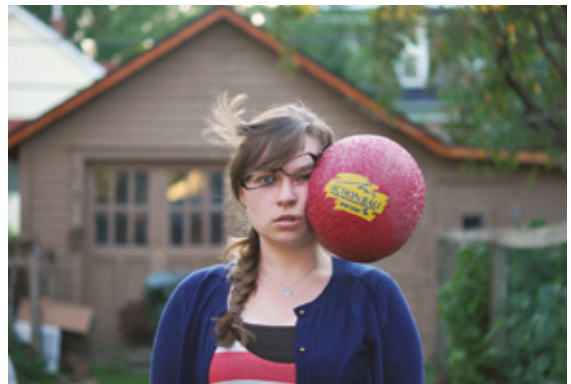
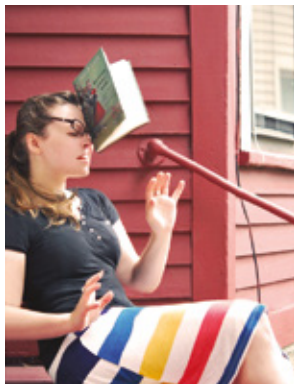
One reason the implied-motion cues overpower our visual system is that the kinematics of King's simulated throw and catch are very close to the real thing. His timing is perfect: videos that we presented to experimental subjects in the laboratory showed that King grabbed the coin 235 milliseconds after the fake toss and 269 milliseconds after the real toss (the 34-millisecond difference is negligible to our visual system).

In addition, the illusion was equally powerful whether King's face was visible or invisible to observers during the toss, which means that social cues, such as the magician's gaze direction, were less important in this illusion than in Kuhn's vanishing ball trick. The implied action, suggested by the gestures of King's hands, was all that a viewer's brain needed to supply the coin.

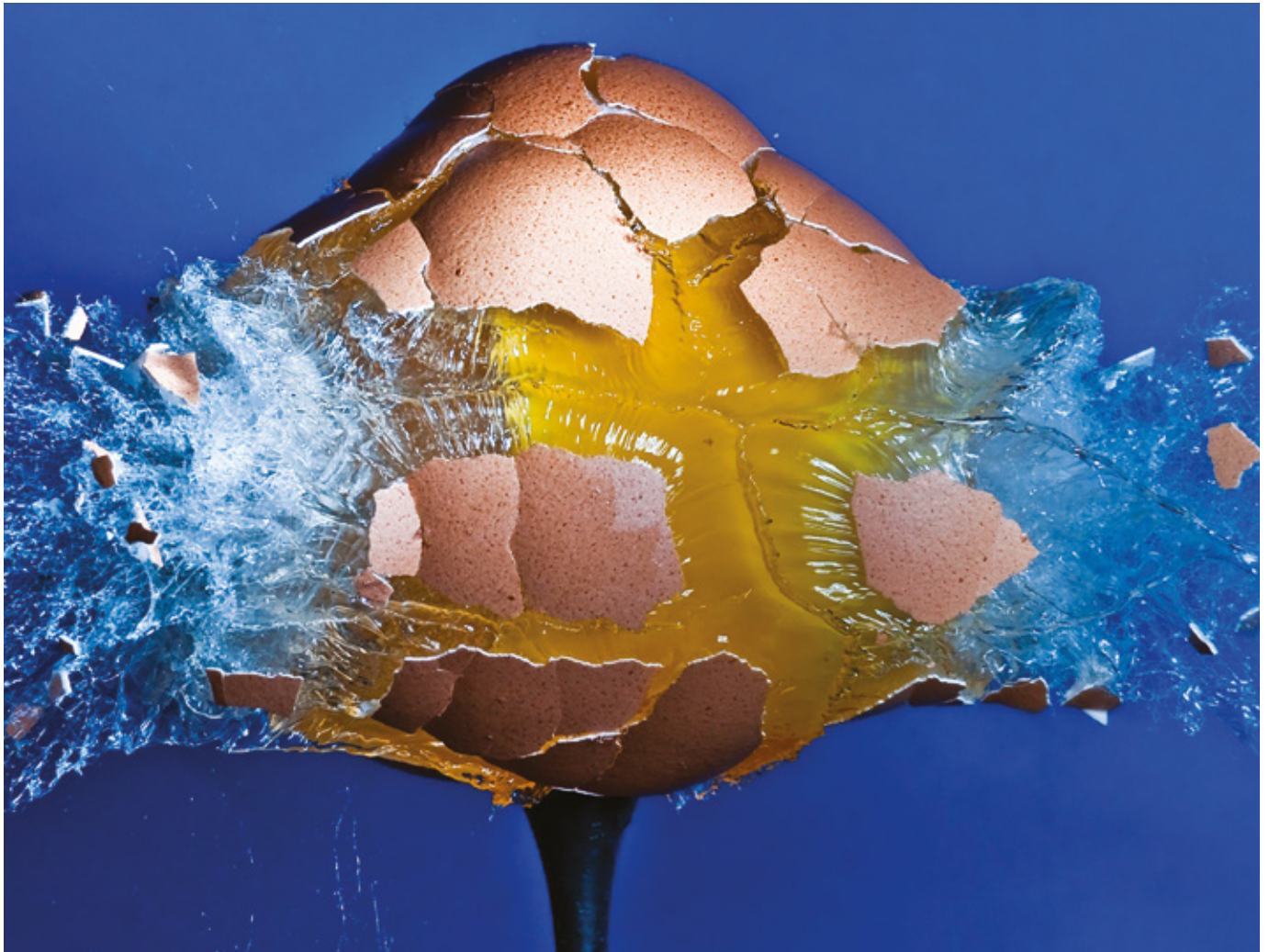
## FAKED COLLISIONS

Air guitarists and magicians use the shifts of their bodies to create the illusion of imaginary moving objects. But as any reader of superhero comic books knows, a completely still image can convey forceful action. Kaija Straumanis, a photographer and editor at Open Letter Books in Rochester, N.Y., decided to produce 365 photographs of herself getting clocked in the noggin with assorted objects. She cleverly staged implied collisions by taking a series of photographs, including shots in which she held an object against her head, then used photo editing to combine her images. The finished pictures, which she posted to Flickr, show the young woman, sometimes shocked, occasionally unperturbed, at the moment of apparent impact.

The images include many clues that signal motion to our visual system. For instance, Straumanis's left cheek deforms as her face absorbs the crash of a red rubber ball. Straumanis's ash-blonde bangs fly up and her black-frame glasses are knocked askew by the



implied impact. The effect activates not only neural circuits that we use to perceive motion but also our mirror neuron system, which allows us to imagine another person's experience [see "A Revealing Reflection," by David Dobbs; *SCIENTIFIC AMERICAN MIND*, April/May 2006]. Although we know that the photographer suffered no harm, it is hard to repress a visceral "ouch" when seeing the images.



## FAST AND FURIOUS

Neuroscience has begun to show how implied motion is processed in the brain. Groups of neurons in specific areas encode certain perceptions. When one group of neurons becomes active, we have a certain experience, whereas when a different population of neurons fire, we feel something else. This system allows the brain to assign meaning to objects and events, even when that concept is only suggested by a few sparse cues.

In 2000 neuroscientist Carl Senior, then at King's College London, and his colleagues showed what happens in the brain when we view actual moving objects versus static representations of moving objects. Area MT, a brain region that processes the direction of objects in real motion, responded to both explicit and implicit representations of mobility. That is, neurons in this region reacted not only to an actual ball moving to the left but also to the representation of a static ball with adjacent lines drawn to represent motion and even to a verbal statement that a ball was going along.

The brain sorts out—based on previous experience with this type of representation—that the lines indicate the retinal smearing caused by a rapid advance. Blur in a photograph, as in the exploding egg above, creates the same effect. This knowledge activates a constellation of neurons in the brain, including those that respond to actual moving objects.

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JUSTICE FOR ALL

## Crime without Punishment?

*Focusing on forgiveness and a victim's needs may more effectively heal emotional wounds*

By Oriel FeldmanHall and Peter Sokol-Hessner

**Twenty-one years ago** Rwanda was torn apart by violence. Members of the Hutu majority slaughtered their Tutsi neighbors, killing hundreds of thousands of Tutsi minorities in only four months. Once the massacre finally stopped, a difficult question arose: Was there a way to right these monstrous wrongs without igniting a murderous cycle of revenge and retribution?

Such a cycle would be the epitome of the ancient “eye for an eye” notion of justice, in which punishment is commensurate with the crime, an approach that still underlies most modern legal systems, including that of the U.S. Decades of research have demonstrated that people have a strong proclivity to punish

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transgressors. The practice can serve other functions, such as deterrence, but retribution is arguably a central goal. In fact, we as individuals punish even when it costs us to do so. One 1995 study found that if treated very unfairly, some people were willing to forgo up to three month's salary if it meant they could punish the perpetrator.

But would our desire for punishment persist if we had other options to restore justice? Aside from simply accepting the transgression, some form of reprimand is typically the only option available for righting a wrong. For that reason, we did not know—until now—how other options might stack up. Recent research from our laboratory suggests that tactics such as compensating the victim have significant advantages in their ability to amicably reconcile differences.

### How Justice Is Served

In a set of studies published in 2014 we asked more than 1,000 participants to play a game in which one participant had

to split a sum of money between himself or herself and another participant. Often the first participant chose to keep most of the money. After receiving an unfair split, the second participant was then asked how he or she would like to redistribute the money. One option for restoring justice was to punish the culprit for unfair treatment by reducing that individual's monetary payout—a response commonly observed both in the lab and in the real world. But we also gave participants other options, including the ability to rebalance the scales by increasing their own monetary payout. We found that around nine out of 10 victims preferred to compensate themselves rather than exact punishment, even after a wildly unfair split. Although that result is not particularly surprising (who doesn't like money?), participants also felt that this result was enough to right the wrong: they generally did not decide to also punish the transgressor—even when it was easy to do.

Evidence from actual legal situations supports the idea that for some crimes

victims will choose a different path to justice if it is available. Restorative justice programs, such as the commission established in South Africa to respond to apartheid-era violations of human rights, typically prioritize victims' needs and enable the perpetrator to tell his or her story. These elements foster a dialogue between victim and criminal that results in two important consequences: victims report high rates of satisfaction with the process, and offenders are more likely to take responsibility for their crimes.

These programs are not the norm, however. Victims do not typically decide the fate of their assailers. Judges and juries do because they are considered to be impartial and can thus more objectively mete out justice.

As part of our 2014 studies of punishment, we also examined whether third parties such as juries actually do handle social transgressions differently than victims do. In another series of games, we asked participants to act like juries—neutral third parties doling out punishment to the wrongdoer and compensation to the afflicted. First, participants observed an individual make a very uneven split of money with another person. After observing this unfair treatment, participants had to decide how to reapportion the money between the individual who had divided the money and the person who received an unjust portion. More often than not, the third parties chose the most retributive option, where the victim was monetarily compensated *and* the transgressor was punished by having his or her payout decreased.

The findings from this part of our experiment starkly contrast with the decisions that participants made after they directly experienced being treated unfairly (that is, when they were the victim). Thus, a gap seems to exist between what we as victims want and what third parties decide for us. When we have been slighted, we tend to our own needs rather than pursuing punishment, but when we make decisions on behalf of someone else, we prefer an eye-for-an-eye strategy. This finding calls into question our

reliance on the putative impartiality of juries and judges.

### Reconciliation

Our data also offer hope for our overburdened and underfunded justice system. By emphasizing restorative justice for the victim rather than punishment of the offender, we could reduce some of the need for long prison sentences—a potential boon given how packed and expensive the prison systems are in the U.S. In fact, an emerging literature has begun to shift the emphasis away from punishment toward other ways of restoring justice. In 2009 psychologist David Rand, then at Harvard University, and his colleagues reported findings from a game in which players could encourage one another to contribute to a common pool by rewarding donations or punishing stinginess. Over multiple rounds of play, Rand and his colleagues found that rewards, unlike punishment, boost total giving. In a paper published in 2014 economist Nikos Nikiforakis, now at New York University Abu Dhabi, and Helen Mitchell, policy officer in the Australian Department of Foreign Affairs and Trade, revealed that people exhibit an increased desire to punish if it is the only available option to restore justice.

Essentially the growing literature suggests that the motivation to punish appears to be a function of the landscape of choices presented. Giving people more ways to restore justice, whether it involves a guided reconciliation process between victim and perpetrator or simply focusing on compensation for the wronged party, could actually change how people feel about punishing a crime. Altogether these

studies suggest that punishment—which is certainly desirable in some instances—should not always be considered the gold standard for justice.

Though less often employed, reconciliatory nonpunitive approaches toward restoring justice have proved successful in the real world. These approaches can work for even the most egregious crimes against humanity. In Rwanda, the nonprofit organization Association Modeste et Innocent (AMI) is bringing together Hutus and Tutsis to reconcile one of the most horrific genocides in history. Through different programs, AMI teaches both the perpetrators and the victims about trauma healing, civic participation and peace education.

After receiving reconciliation counseling over many months, in which both sides are pushed to express their painful emotions, a Hutu perpetrator asks a Tutsi survivor of his crime—for example, a mother who survived the murder of her entire family—for forgiveness. Many Tutsi survivors have shown an impressive ability to forgive and thus have become reconciled with their Hutu perpetrators. With an aim to heal ties between neighbors, this initiative emphasizes restoration and forgiveness, not punishment. In doing so, it has the potential to curb the hate and violence that fuels a cycle of revenge and retribution. **M**

**MIND  
MATTERS**



Each week in **Mind Matters**, [www.ScientificAmerican.com/mind-matters](http://www.ScientificAmerican.com/mind-matters), researchers explain their disciplines' most notable recent findings. **Mind Matters** is edited by Gareth Cook, a Pulitzer Prize-winning journalist in Boston.

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## COGNITIVE NEUROSCIENCE

## Without a Thought

*Intuition is rooted in the brain's uncanny ability to rapidly know the answer without knowing why*

*In the instant before he drove Kuang's sting through the base of the first tower, he attained a level of proficiency exceeding anything he'd known or imagined. Beyond ego, beyond personality, beyond awareness, he moved, Kuang moving with him, evading his attackers with an ancient dance, Hideo's dance, grace of the mind-body interface granted him, in that second, by the clarity and singleness of his wish to die.*

—William Gibson, *Neuromancer*, 1984

**Sometimes a solution** just appears out of nowhere. You bring your multipage spreadsheet to the finance department, and within seconds the accountant tells you something isn't quite right without being able to say what. You're perched on a narrow ledge halfway up Half Dome in Yosemite Valley, 1,000 feet above deck, searching for the continuation of the climb on the granite wall that appears featureless, when your senior climbing partner quickly points to a tiny series of flakes: "Trust me, this is it."

Understanding computer code, deci-

### BY CHRISTOF KOCH



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



A traditional Japanese shogi board with its pieces. Shogi is a strategy game related to chess but is considerably more intricate.

phering a differential equation, diagnosing a tumor from the shadowy patterns on an x-ray image, telling a fake from an authentic painting, knowing when to hold and when to fold in poker. Experts decide in a flash, without thought. Intuition is the name we give to the uncanny ability to quickly and effortlessly know the answer, unconsciously, either without or well before knowing why. The conscious explanation comes later, if at all, and involves a much more deliberate process.

Intuition arises within a circumscribed cognitive domain. It may take years of training to develop, and it does not easily transfer from one domain of expertise to another. Chess mastery is useless when playing bridge. Professionals, who may spend a lifetime honing their skills, are much in demand for their proficiency.

Let us consider a series of elegant experiments in functional brain imaging that finger one brain structure as being centrally involved in intuition. Shogi is a Japanese strategy game played on a nine-by-nine board, with two sets of 20 distinct pieces facing each other. It is much more

complex than chess, given that captured pieces can be dropped into an empty position anywhere on the board at the discretion of the capturer. This rule multiplies the number of possible moves available at any point in the game and prevents the steady attrition of the two opposing armies that face off in a chess match.

Keiji Tanaka of the RIKEN Brain Science Institute outside Tokyo led a group of cognitive neuroscientists who studied the brains of shogi players, using functional MRI to search for the neural signatures of proficiency. First, subjects inside the scanner looked at drawings of shogi boards taken either from tournament games or from randomly shuffled board positions. They also looked at sketches that had nothing to do with shogi: games of chess and Chinese chess, as well as pictures of faces and houses.

In professional players, pictures of board positions taken from real shogi games activated a piece of cortex, the precuneus in the parietal lobe (located at the top of the brain toward the back), much more strongly than any of the other cate-

gories of pictures. That is, a region of their parietal cortex read out certain perceptual features associated with shogi games and distinguished them from random board positions. Experts see configurations of pieces, lines of control, a weakened defense or an imminent attack—patterns that amateurs do not notice.

In a second experiment, Tanaka and his group presented players with checkmatelike shogi puzzles while they lay in the scanner. Subjects had to find the next move that would lead, inexorably, to the capture of the king. They had to do this within one second, pushing them to rely on their intuition because there was no time to analyze the various moves, countermoves, countercountermoves, and so on. When they controlled for confounding cognitive factors, the scientists found nothing activated in the cortex. They did, however, isolate a small region in the front of the caudate nucleus, under the cortex, that reliably and very distinctly turned on in professional shogi players. The caudate was less reliably and less prominently activated when amateur players tried to find the correct move. And when subjects had up to eight seconds to more deliberately search for the best solution, this subcortical region remained silent.

### Special-Purpose Hardware

This elegant finding links intuition with the caudate nucleus, which is part of the basal ganglia—a set of interlinked brain areas responsible for learning, executing habits and automatic behaviors. The basal ganglia receive massive input from the cortex, the outer, rindlike surface of the brain. Ultimately these structures project back to the cortex, creating a series of cortical–basal ganglia loops. In one interpretation, the cortex is associated with conscious perception and the deliberate and conscious analysis of any given situation, novel or familiar, whereas the caudate nucleus is the site where highly specialized expertise resides that allows you to come up with an appropriate answer

without conscious thought. In computer engineering parlance, a constantly used class of computations (namely those associated with playing a strategy game) is downloaded into special-purpose hardware, the caudate, to lighten the burden of the main processor, the cortex.

So far these experiments relate the task of generating shogi moves to brain activi-

ty that activity did not change over the training period, nor did it correlate with the fraction of correct responses. In contrast, changes in blood flow in the front of the caudate nucleus evolved over the course of training in parallel with better performance. Furthermore, the strength of the caudate signal at the end of the training correlated with how much subjects im-



Brain activity in 17 professional shogi players who had to decide on the next best move without lengthy deliberation was averaged into a single brain image. The most active area, the caudate nucleus, is shown in color from different angles.

ty. Of course, we are not allowed to infer causation from correlation. Just because two things are associated does not imply that one causes the other. As research progresses, the causal structure of intuition and brain activity could be probed by inhibiting or blocking the caudate nucleus to see whether doing so prevents the rapid generation of correct shogi moves. Regrettably there are no reliable technologies to turn bits of brain deep inside the skull on and off in a way conducive to the long-term health of the subject.

Instead Tanaka and his collaborators wondered whether novices who learn to play shogi wire up their caudate nucleus in a similar manner to that of experts. They recruited naive volunteers and subjected them to an intensive 15-week regime of daily play on a simplified computer version of the game. Motivated by prize money, the subjects improved over the approximately 100 days of training, during which they accumulated total practice time ranging from 37 to 107 hours.

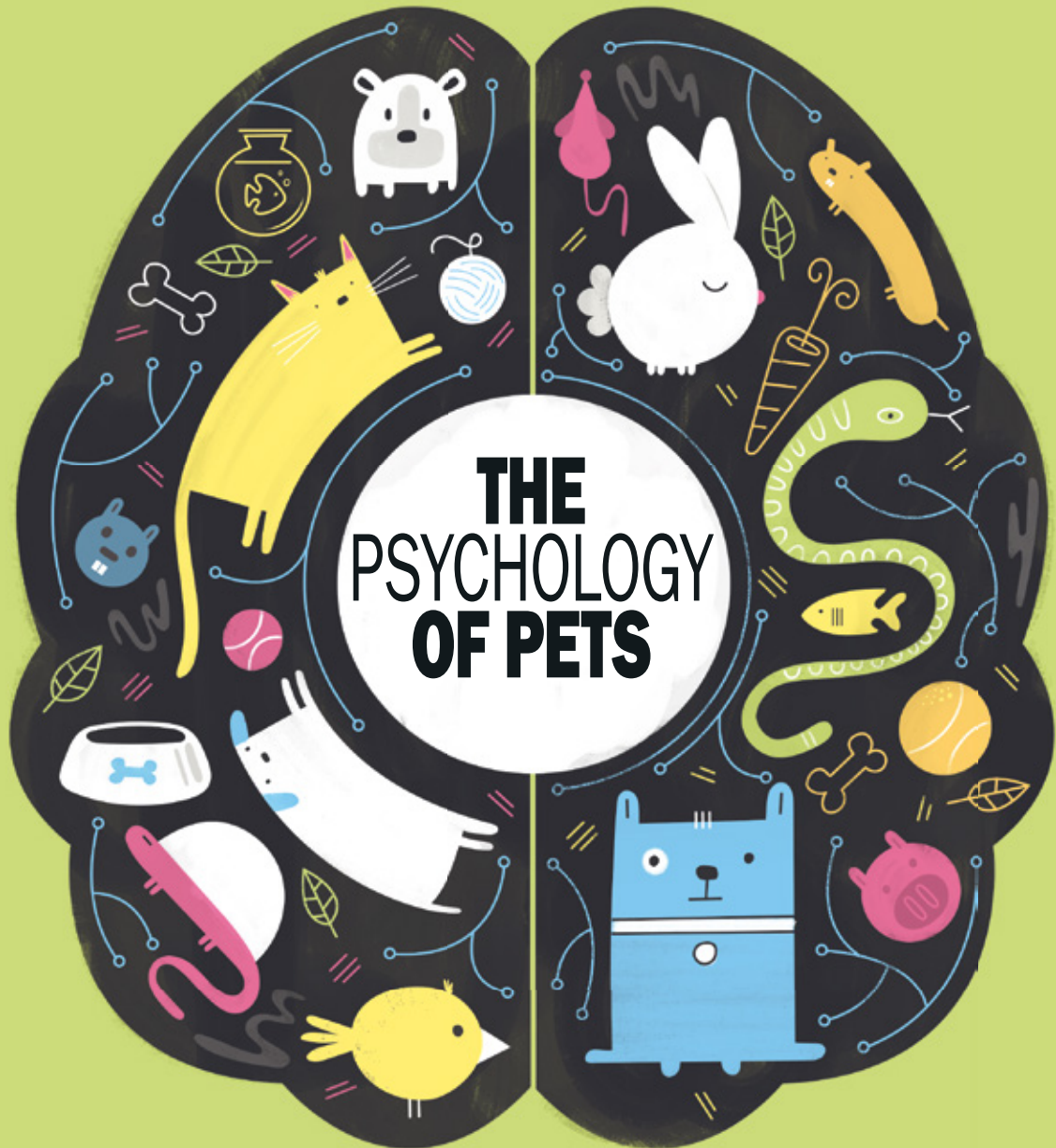
Asking subjects in these experiments to quickly come up with the best next move led to increased cortical activity, but

proved over time. The more the subject learned, the larger the caudate signal.

It appears that the site of fast, automatic, unconscious cognitive operations—from where a solution materializes all of a sudden—lies in the basal ganglia, linked to but apart from the cortex. These studies provide a telling hint of what happens when the brain brings the output of unconscious processing into awareness. What remains unclear is why furious activity in the caudate should remain unconscious while exertions in some part of the cortex give rise to conscious sensation. Finding an answer may illuminate the central challenge—why excitable matter produces feelings at all. **M**

#### FURTHER READING

- **The Neural Basis of Intuitive Best Next-Move Generation in Board Game Experts.** Xiaohong Wan et al. in *Science*, Vol. 331, pages 341–346; January 21, 2011.
- **Developing Intuition: Neural Correlates of Cognitive-Skill Learning in Caudate Nucleus.** Xiaohong Wan et al. in *Journal of Neuroscience*, Vol. 32, pages 17,492–17,501; November 28, 2012.



## THE PSYCHOLOGY OF PETS

In 1961 a child psychologist proposed a radical idea to the American Psychological Association: What if dogs could help therapists connect to troubled patients? Perhaps the animals would help soothe anxiety and help people open up. When Boris Levinson of Yeshiva University presented this idea, many of his colleagues thought it was laughable. Yet the idea that humans might derive therapeutic effects from animals would go on to capture the attention of many future researchers.

In recent years scientists have started investigating our attachment to creatures great and small. Although various types of pets and non-Western cultural dynamics remain largely unexplored, research has begun to examine how the animals that surround us affect our mood and mental states. New work has, for example, revealed how just think-

ing of a beloved pet may help us stay calm under pressure.

Most of the research thus far has focused on dogs, a fact that is reflected in these pages. But we also present some surprising data on other pets and their owners, including information gathered from you, our readers.

Our hope in assembling these stories is to inspire readers and researchers alike to ponder recent findings and the deeper questions that they may provoke. How are we like our animal friends, and how do we differ? What makes these relationships so appealing—and what qualities lead one person to adopt a cocker spaniel and another to take in a cobra? Ultimately, if we want to understand the human mind in all its contexts, we must consider our connections not merely with one another but across the divide of species.

—The Editors

ILLUSTRATIONS BY  
SHAW NIELSEN

## PETS



**People have an innate interest in other species, but we like having pets for a variety of social reasons**  
By Daisy Yuhas

# WHY DO WE HAVE THEM?

**On my 10th birthday, I got a puppy.** I was so shocked—I had wanted a dog for as long as I could remember—and so overwhelmed with happiness that I burst into tears. For the next 14 years, Happy, a beagle, charmed everyone he met. And when he passed, all of us who had known him mourned, as we would for any loved one.

More than half of American households have a pet—that is, an animal kept primarily for companionship. And despite the fact that these housemates may bear scales, fur, fins or feathers, people often view their animals as family members. In 2014 we spent an estimated \$58 billion on our animal companions and untold hours caring for them.

For 50 years psychologists have been trying to unravel the appeals of animal companionship in hopes of deciphering just why we invest so much in these creatures. In the process, anthrozoologists—scientists who study human-animal relationships—have discovered a window into human sociality more broadly. Our interactions with animals can be useful models for understanding how issues of identity, nurturing, support and attachment play out in a relationship. “It’s all about human psychology,” says anthrozoologist Pauleen Bennett of La Trobe University in Australia. “Pets help us fill our need for social connectedness.”

Although the motivations for pet ownership may vary as much as a gold-



en retriever and a goldfish, scientists are finding that some common threads tie humans to their household animals. Some of our attraction to animals may be subconscious, driven by biological and social forces that we do not fully acknowledge. In addition, the emotional bond between pets and their owners can bring varied benefits, from lowered stress to novel adventures. The more we uncover about our companion animals, the more we may learn about our human attachments as well.

### Inborn Attraction?

Part of our attraction to animal companionship is innate. In 2013 psychologist Vanessa LoBue of Rutgers University and her colleagues revealed that toddlers one to three years old spend more time interacting with live animals—whether fish, hamsters, snakes, spiders or geckos—than they do with inanimate toys when given a choice between the two.

Humans even have specialized brain cells for recognizing animal life. Researchers led by Christof Koch of the Allen Institute for Brain Science in Seattle (he also serves on *Scientific American Mind*'s board of advisers) have found neurons in the amygdala, an area involved in emotions, that respond preferentially to animal images. The 2011 finding hints at a neural basis for the powerful emotional reactions animals elicit from us.



Some researchers think we are drawn to cute animals because aspects of their appearance, such as large eyes and soft contours, somewhat resemble a human infant's features.

#### FAST FACTS

##### THE ANIMALS AMONG US

- 1 Both innate fascination and cultural norms influence the human tendency to adopt companion animals.
- 2 Human-animal bonds can be powerful sources of social support, although the extent of that support depends on the strength of the bond with the animal.
- 3 Reports from owners suggest that having pets makes people happier and gives their lives meaning.



Our interest in other animals may be partially innate. Children are fascinated by diverse creatures from a young age.

Many animals seem to tap into humans' attraction to the adorable, a drive that also may motivate good parenting. Behavioral researchers have long noticed that humans seem to have inborn, positive responses to beings with characteristics typical of human infants—such as wide eyes, broad foreheads and large head-to-body ratios.

To better understand the responses that cuteness can elicit, psychologist Hiroshi Nittono and his colleagues at Hiroshima University in Japan published a series of experiments in 2012 in which college students, 132 in all, searched for a digit in numerical matrices or lifted tiny objects from small holes using tweezers. Afterward, participants viewed a series of photographs before attempting the attention or motor task for a second time.

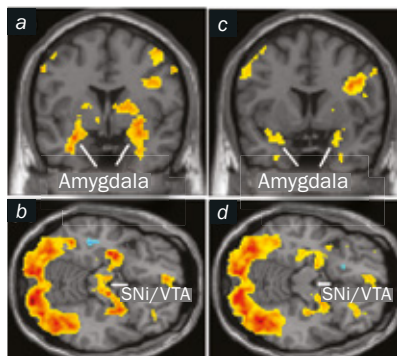
Nittono and his colleagues found that students who viewed adult animals or food—stimuli they had rated as pleasant but not cute—did not improve between trials. But the students who saw cute baby animals did the tweezer task faster and more dexterously and performed the visual search task faster the second time, suggesting that being exposed to such creatures motivates focused, attentive behavior. This finding suggests that humans are primed to attend to fragile, young infants, who may require greater care than other beings. Clearly, baby animals exploit the same instinctive responses in us that human infants elicit.

Such findings lend credence to the idea that our interest in pets stems from what biologist E. O. Wilson has called “biophilia,” or an inherent tendency to focus on life and lifelike processes. Our fascination with all manner of fauna might explain why people adopt such a wide range of animal life, from tarantulas to salamanders.



Yet Wilson has also acknowledged that our interest in animals depends on personal and cultural experience. For example, dogs are popular in many Western countries but are considered unclean in traditional Islamic communities. Indeed, psychologist Harold A. Herzog of West Carolina University has argued that pet keeping is driven principally by culture. In a paper published in 2013 Herzog and his colleagues assessed the fluctuating popularity of dog breeds using the American Kennel Club's registry from 1926 to 2005. They found no relationship between a breed's health, longevity or behavioral traits such as aggressiveness or trainability and its popularity. Instead, they argued, the trends in top dogs were erratic and seemed to shift suddenly, as if driven by fashion. In 2014 three of the authors, including Herzog, further discovered that movies featuring specific dog breeds would boost that pooch's popularity for up to a decade. In the 10 years following the 1963 release of *The Incredible Journey*, starring a Labrador retriever, people registered Labs in the kennel club at a rate of 2,223 dogs a year, in contrast to 452 dogs a year in the previous decade.

Extending these findings to other species, Herzog posited that people may keep pets simply because other people keep



Massachusetts General Hospital researchers discovered that similar brain regions, including the amygdala, engage when women view their own children (a, b) and dogs (c, d). The overlap is not absolute, however. Certain midbrain areas (SNi/VTA) activate only when mothers see their kids.

pets, reflecting our penchant for social imitation. He pointed to a brief craze in the U.S. for turtle keeping, a koi fish fad in Japan and what he jokingly identified as a brief “epidemic of Irish setters” as further evidence.

### Friends with Benefits

But even if imitation plays a role in their choices, most people profess to wanting pets for companionship. This friendship then sustains the connection despite the costs of ownership. Indeed, some animal-human relationships feel similar in certain ways to human relationships. In a study published in 2014 Massachusetts General Hospital veterinarian Lori Palley and her colleagues used functional magnetic resonance imaging to measure brain activity in 14 mothers while they were looking at pictures of their children or their dogs or at pictures of other people's children or unfamiliar dogs. The researchers found that the brain activation patterns

## In one study, subjects who saw photographs of cute baby animals performed better on tasks involving focused, attentive behavior.

evoked by images of the women's own children and dogs were very similar and that those patterns were distinct from those elicited by unknown children and canines, suggesting that maternal feelings may extend to animals. Pets may thus help fill a human need to nurture other living beings.

An animal also can be on the flip side of this relationship, serving as a source of comfort. In the 1960s Yeshiva University child psychologist Boris Levinson observed that troubled, socially withdrawn children became talkative and enthusiastic about therapy when his dog, Jingles, was present during a session. This observation spurred a series of investigations into whether or not keeping pets could improve well-being. In a 1980 study of 92 people, biologist Erika Friedmann of the University of Pennsylvania reported that pet owners were more likely to be alive a year after a heart attack than were people who did not have a companion animal—possibly because the animals afforded some form of stress relief. Yet efforts to replicate such findings have had mixed results, and animal-assisted therapy, the field that Levinson's work inspired, has been criticized for overstating the ability of animals to ameliorate mental illness.

Nevertheless, some people may gain psychological support from their pets and keep them for exactly this reason. In a study published in 2012 psychologist Sigal Zilcha-Mano, then at the Baruch Iver School of Psychology at the Interdisciplinary Center Herzliya in Israel, and her colleagues asked 285 cat or dog owners to answer a questionnaire assessing their emotional connection with their pet. Then the researchers asked 120 of these pet owners to take a challenging word test. By recording her subjects' blood pressure—a measure of stress—during the test, Zilcha-Mano found that individuals who had their pet present or thought about the pet before taking the test had lower stress than people who had no contact with the pet. Yet the strength of this benefit depended on how attached the owner

THE AUTHOR

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## The researchers found that people who frequently kissed their dogs had higher levels of the bonding hormone oxytocin.

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was to his or her pet. In other words, the level of emotional sustenance a pet owner receives depends on how close he or she feels to the animal.

Different hormonal cocktails seem to underpin various degrees of animal-human attachment. In a study published in 2012 biologist Linda Handlin of the University of Skövde in Sweden and her colleagues measured levels of the bonding hormone oxytocin and stress hormone cortisol in 10 owners of female Labrador retrievers and correlated the results with self-reported data about the owners' relationships with their dogs. Owners who had high oxytocin levels and lower cortisol levels when interacting with their dogs tended to have closer bonds with their pets. People who frequently kissed their dogs, for example, had higher levels of oxytocin, and women who reported that they dreaded their dog's death had



lower cortisol levels, perhaps because they rely on their animals for stress relief.

A person's social orientation could also factor into the strength of the pet-person tie. In a study published in 2012 psychologist Andrea Beetz of the University of Rostock in Germany and her colleagues asked 47 seven- to 11-year-old boys who had difficulties forming social attachments to present a story before a committee of unfamiliar adults and then take a math test. During this ordeal, 24 of the children were accompanied by a dog, 10 had a friendly human by their side and the others had a toy dog nearby.

Beetz found that children accompanied by a real dog had the lowest cortisol levels and that those with human company had the highest, probably because people made these boys nervous. Furthermore, among those boys who benefited from the dog, those who engaged in the most petting and other physical contact with the dog during the test showed the least stress, as measured by salivary cortisol. Thus, interacting with animals may be an especially good buffer against stress for those who find human social interaction difficult. "Some things are much easier with animals," Beetz says. "They are easier to forgive, don't talk back, and there's less inhibition when it comes to physical contact."

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### FURTHER READING

- **Pets in the Family: An Evolutionary Perspective.** James A. Serpell and Elizabeth S. Paul in *The Oxford Handbook of Evolutionary Family Psychology*. Edited by Todd K. Shackelford and Catherine A. Salmon. Oxford University Press, 2011.
  - **Biology, Culture, and the Origins of Pet-Keeping.** Harold A. Herzog in *Animal Behavior and Cognition*, Vol. 1, No. 3, pages 269–308; August 2014.
  - **Toward a Psychology of Human-Animal Relations.** Catherine E. Amiot and Brock Bastian in *Psychological Bulletin*, Vol. 141, No. 1, pages 6–47; January 2015.
- From Our Archives*
- **Can Animals Aid Therapy?** Scott O. Lilienfeld and Hal Arkowitz, *Facts and Fictions in Mental Health*; June/July 2008.
  - **The Social Genius of Animals.** Katherine Harmon; November/December 2012.

## Animal Antics

Yet pets are much more than human substitutes. Many people with no obvious social deficits reap varied psychological benefits from owning a pet. In 2012 Bennett presented preliminary findings from a student, psychologist Jordan Schaan, then at Monash University in Australia, who had interviewed 37 dog owners who were personally and professionally successful and had an above-average connection to their animals. (The subjects were educated, affluent and had fulfilling romantic partnerships, for instance.) Among the benefits of dog ownership that these individuals reported were amusement—the animals' antics made their owners laugh—a sense of meaning from having responsibility for the welfare of another living thing, and an entrée into new experiences and relationships: a puppy can be a great way to meet neighbors.

Furthermore, many pet owners described their companion animals as instructors in a simpler, more virtuous lifestyle. Bennett and Schaan discovered that their highly successful subjects actually looked to their dogs as role models for a better life. People felt they could derive unconditional love and forgiveness from their dogs, whereas human beings seemed more likely to disappoint one another. "There's something about animals that's very genuine and honest," Bennett says. "We miss that in our human interactions."

Bennett and other anthrozoologists acknowledge that owners project some of this dynamic onto their animals. A pet owner can "read" a response into an animal companion's behavior regardless of the animal's intentions. Yet such projections are precisely what make this field ripe for psychology: they reveal our own social needs and desires. Animal relationships may someday provide useful comparison points to human connections—a benchmark for investigating empathy, caring and even decision making. That these creatures can fit many molds while being so different from us makes these friendships uniquely valuable.

The study of animal companionship is still in its infancy. But without this research, we could not begin to fathom the rich and varied range of relationships that make up human experience. **M**

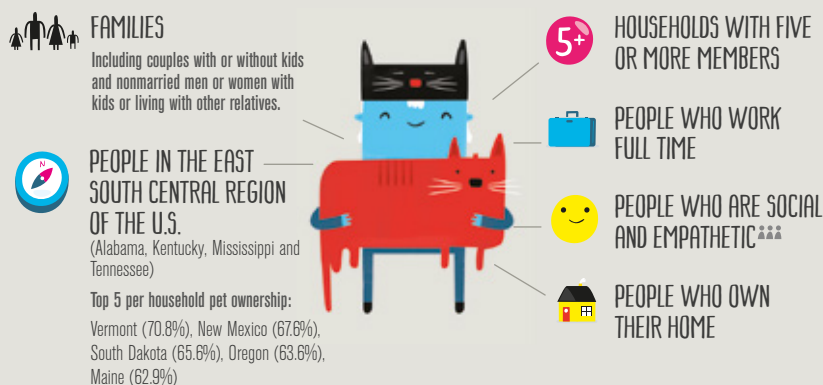
# What Your Pet Reveals about You

Is there a typical cat person or snake owner? The jury is still out

By Karen Schrock Simring

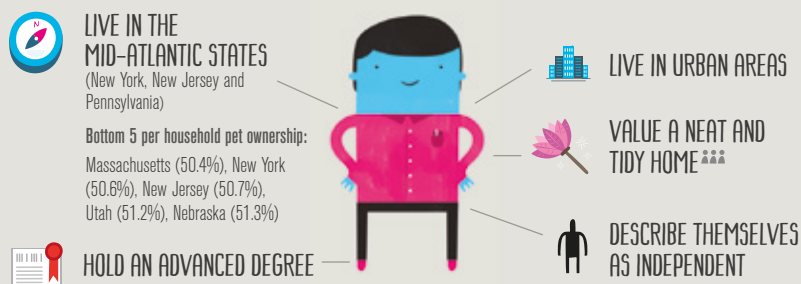
Most of us think our pets say a lot about who we are. Why else would we proudly proclaim our loyalty on T-shirts and in online profile pictures? Yet few scientists have rigorously investigated whether our choice of pet reveals anything about our personality, beliefs or lifestyle. We rounded up the smattering of available research and highlighted some of the more interesting findings in the infographic that starts below and continues on the next pages. Some information comes from peer-reviewed studies, but the bulk of our data derives from huge market surveys undertaken by interested parties in the pet industry, such as the American Veterinary Medical Association, which tracks pet populations, owner demographics and expenditures to follow how pet ownership in the U.S. changes over time. As you will see, these surveys reveal interesting things about people and the pets they love.

## PET OWNERSHIP IS HIGHEST AMONG:



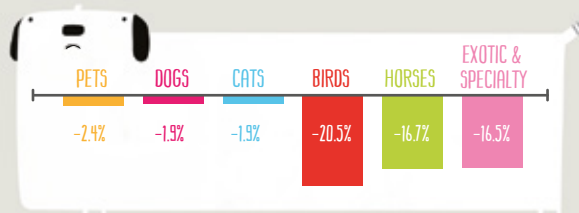
**FUN STAT:** For every type of pet, in 8 out of 10 households the primary caretaker of the pet is female.

## PEOPLE WHO DO NOT OWN PETS ARE MORE LIKELY THAN PET OWNERS TO:



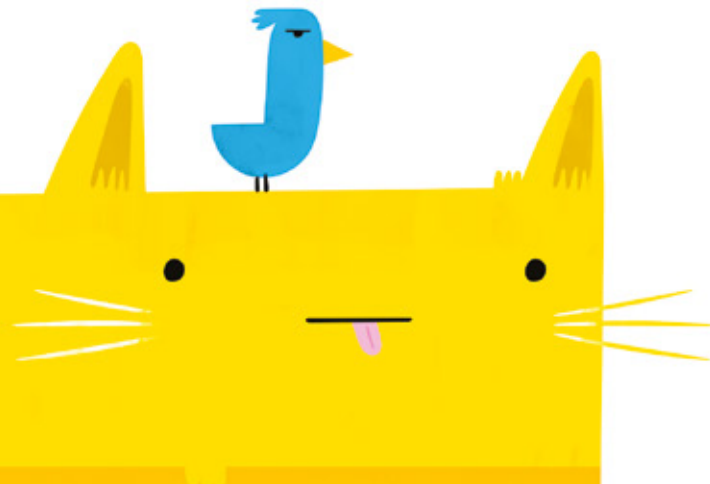
## PET OWNERSHIP IS DECREASING

Since 2006, the percentage of U.S. households that own a pet has declined by 2.4 percent; experts blame the recession.



Indicates a finding from a peer-reviewed paper.

# What Your Pet Reveals about You



## IF YOU HAVE A DOG, YOU'RE MORE LIKELY TO:



### BE IN SENIOR MANAGEMENT

(COMPARED WITH OTHER PET OWNERS)



### CONSIDER YOUR PET PART OF THE FAMILY

(COMPARED WITH OTHER PET OWNERS)



#### Live with family members

(COMPARED WITH THE GENERAL POPULATION)



#### Not have a college degree

(COMPARED WITH PEOPLE WHO DO NOT OWN DOGS)



#### Be a professor, nurse, information technology professional, military professional or entertainer

(COMPARED WITH OTHER PET OWNERS WHO WORK FULL TIME)



#### Be extroverted, agreeable and conscientious<sup>\*\*\*</sup>

(COMPARED WITH CAT OWNERS)



#### Have gotten the dog from a shelter or rescue group

(COMPARED WITH ANY OTHER SOURCE)



#### Live in Arkansas, New Mexico, Kentucky, Missouri or West Virginia than in other states

(BASED ON PER HOUSEHOLD OWNERSHIP)



## IF YOU HAVE A CAT, YOU'RE MORE LIKELY TO:



### BE DIVORCED, WIDOWED OR SEPARATED

(COMPARED WITH OTHER PET OWNERS)



### LIVE IN AN APARTMENT

(COMPARED WITH OTHER PET OWNERS)



#### Be neurotic and open to new experiences<sup>\*\*\*</sup>

(COMPARED WITH DOG OWNERS)



#### Be college educated<sup>\*\*\*</sup>

(COMPARED WITH PEOPLE WHO DO NOT OWN CATS)



#### Be less socially dominant<sup>\*\*\*</sup>

(COMPARED WITH OTHER PET OWNERS)



#### Live in Vermont, Maine, Oregon, South Dakota, or Washington than in other states

(BASED ON PER HOUSEHOLD OWNERSHIP)



#### Be a physician, real estate agent, science or medical lab technician, machine operator or personal caretaker

(COMPARED WITH OTHER PET OWNERS WHO WORK FULL TIME)



RABBIT OWNERS ARE THE MOST INTROVERTED AND NEUROTIC OF ALL PET OWNERS, ACCORDING TO ONE STUDY<sup>\*\*\*</sup>



\*\*\* Indicates a finding from a peer-reviewed paper.



## IF YOU HAVE A BIRD, YOU'RE MORE LIKELY TO:



### BE UNEMPLOYED

(COMPARED WITH OTHER PET OWNERS)



### DESCRIBE YOURSELF AS POLITE AND CARING<sup>\*\*\*</sup>

(COMPARED WITH HORSE, TURTLE AND SNAKE OWNERS)



### Live in the Pacific region (California, Oregon, Washington and Nevada)

(BASED ON PER HOUSEHOLD OWNERSHIP)



### Be socially dominant if you're female<sup>\*\*\*</sup>

(COMPARED WITH HORSE, TURTLE AND SNAKE OWNERS)



### Be socially outgoing and expressive<sup>\*\*\*</sup>

(COMPARED WITH HORSE, TURTLE AND SNAKE OWNERS)

## IF YOU HAVE A HORSE, YOU'RE MORE LIKELY TO:



### Hold an advanced degree

(COMPARED WITH OTHER PET OWNERS)



### Be a homeowner

(COMPARED WITH OTHER PET OWNERS)



### Be more assertive and introspective and less warm and nurturing<sup>\*\*\*</sup>

(COMPARED WITH TURTLE, SNAKE AND BIRD OWNERS)



### Live in Texas, Oklahoma, Arkansas or Louisiana

(BASED ON PER HOUSEHOLD OWNERSHIP)



### Be aggressive and socially dominant if you're male and nonaggressive and easygoing if you're female<sup>\*\*\*</sup>

(COMPARED WITH TURTLE, SNAKE AND BIRD OWNERS)



### Live in a rural area

(COMPARED WITH OTHER PET OWNERS)



## BE MARRIED

(COMPARED WITH OTHER PET OWNERS)

## IF YOU HAVE A COLD-BLOODED EXOTIC PET:



And are male, you are much less agreeable  
than female owners or male owners of  
traditional pets<sup>\*\*\*</sup>



And are female, you are much more open to  
experience than male owners or female owners  
of traditional pets<sup>\*\*\*</sup>

And it is a snake, you're more likely to ...



Describe yourself as more relaxed and unpredictable<sup>\*\*\*</sup>

(COMPARED WITH HORSE, TURTLE AND BIRD OWNERS)



Be unconventional and novelty-seeking<sup>\*\*\*</sup>

(COMPARED WITH HORSE, TURTLE AND BIRD OWNERS)

And it is a turtle, you're more likely to ...



Be hardworking, reliable and<sup>\*\*\*</sup>  
upwardly mobile

(COMPARED WITH HORSE, SNAKE AND BIRD OWNERS)



Describe yourself as more rational and goal-oriented<sup>\*\*\*</sup>

(COMPARED WITH HORSE, SNAKE AND BIRD OWNERS)

## And Now a Few Words from Our Readers


In anticipation of our special report, we asked our readers to weigh in on their own pet predilections. More than 2,000 people responded to our online survey, and some results differed quite a bit from the data shown on the preceding pages. This is not surprising. Big surveys of many thousands of pet owners will show, for instance, that dog owners (on average) are somewhat more extroverted than cat owners (on average), but the individual differences within each group are greater than the differences between them. Thus, there are plenty of boisterous cat owners and reserved dog owners. In addition, many people have more than one type of pet and cannot be strictly labeled as partial to one particular creature.


Our survey drives home the fact—supported by several studies—that our animal companions are integral to how we see ourselves. For instance, men who like being seen


as tough may get a tough-looking dog to help them project that image. Some people are proud rabbit or poodle owners because having those pets is a family tradition. Other folks might keep less popular critters, such as spiders or snakes, because they feel these animals are misunderstood, much like themselves.


Below, at the left, we provide some intriguing findings from readers who admire or have more than one type of pet and some data on how owners of specific animals describe themselves. At the right is a sampling of the hundreds of passionate responses we got to the question: What makes you a dog person, a cat person, neither or both? Visit our Web site ([www.ScientificAmerican.com/Mind/pet-survey](http://www.ScientificAmerican.com/Mind/pet-survey)) for more survey results.


### SURVEY FINDINGS:


 **Snake owners** were the most likely of all pet owners to describe themselves as “neat and tidy” and, surprisingly, to consider their pet “part of the family.”


 **Fish owners** were the most likely to describe themselves as calm and emotionally stable.


 **Rabbit owners** were the most likely to describe themselves as sympathetic and warm and open to new experiences.


 **Horse owners** were the most likely to describe themselves as dependable and self-disciplined.

 **Hamster owners** were the most likely to have an advanced degree.

 **Guinea pig owners** were the least likely to describe themselves as extroverted.

 **Owners of unusual pets** were more likely to have a menagerie. For instance, more than half of **ferret owners** said they had six or more pets. **Dog owners**, on the other hand, were the most likely to have just one animal.

 More than half of **cat owners** described themselves as fond of both cats and dogs. But more than half of **dog owners** said they preferred only canines.

Beyond the 12 popular pets we asked about in our survey, our respondents reported keeping an astonishing variety of species, from **chickens** to **exotic insects** to **sugar gliders**, which are small possums (*right*). ▶ 

“I started life as a dog person. Then later in life a cat corrected my error.”

“Dogs are living Buddhas—compassionate beings who live completely in the present moment.”

“Even my pet rock is part of the family. We don’t discriminate.”

“I am impressed by how nearly wild—still functionally in touch with their instincts—cats are.”

“My dogs and cats each feed a different part of my soul.”

“When you finally win over a cat, it’s so worth it.”

“All single moms need a giant bearlike protector dog who is both ‘scary’ and loves to cuddle.”

“I have PTSD. Cats help me with my hypervigilance because they pick up on things first. Petting them puts me at peace.”

“Both dogs and cats are preferable to most humans.”



**PETS**



# **THE SCIENCE OF A FRIENDSHIP**

How dogs became our closest animal companions by **Ádám Miklósi**



The sensitivity of dogs to human emotions means they might also experience stress when their owner is crying.

**A**t a research institute in Hungary not far from the banks of the Danube, an emotional bond began to grow between an elderly night janitor and an old watchdog living there named Balthasar. The dog would sometimes spend the day at the janitor's home. "Unfortunately, this relationship lasted only a few months, because the janitor became ill ... and eventually died," writes animal behaviorist Vilmos Csányi, founder of the department of ethology at Eötvös Loránd University in Budapest, in his book *If Dogs Could Talk*. Shortly after the janitor's death, researchers at the institute noticed that Balthasar would disappear from time to time, particularly in the mornings. "We tracked down what he was doing during his absences," Csányi reports, "and found that he would cross the busy highway, go to his adoptive master's old house in the village, and sit in front of it for hours."

Relationships between people and dogs have spawned a myriad of fascinating stories, not least because the association is so improbable. Just take a look at your dog or at any dog in your

neighborhood. Would you expect these creatures to be humanity's best friends? They look very different from us. They behave very differently. They do not seem to have an affinity for culture. And they cannot speak a single word. Yet most people in Western cultures regard dogs as members of the family in the truest sense. And now behavioral science is starting to reveal how this friendship came to be.

Fewer than 20 years have passed since scientific teams led by psychologist Michael Tomasello of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and Csányi in Budapest independently published research papers on how family dogs can follow human pointing gestures to find hidden food. That work marked the birth of a flourishing field of investigation into the biological foundations of the human-dog bond. Since then, researchers have learned that

#### FAST FACTS

##### FRIENDS FOR LIFE

- 1 Dogs' social competence has helped them join the human family. Domestication has shaped their communication and learning skills, making them sensitive to human behavior if they grow up in an appropriate social environment.
- 2 An attachment relationship forms the social basis of human-dog collaborations. The strong bond also facilitates behavioral and emotional synchronization.
- 3 Dogs excel in their flexible social behavior but only if humans invest the necessary time and effort in their relationship.





Today people own dogs just for the pleasure of it, but in earlier times, dogs had to earn their keep by doing jobs such as helping with the hunt.

humans and their dog companions live in an attachment relationship, just like mothers and infants. They enjoy one another's company and find mutual support in potentially challenging circumstances. Attachment relationships also provide the foundation of cooper-

ation: humans help dogs navigate modern society; dogs, in return, help us when we lack a specific ability, such as sight. And when dogs are treated poorly, they sometimes show the same psychological symptoms of an attachment gone wrong that children do.

Research has also shown that dogs have been able to adjust smoothly to family life because of their attentiveness and their sensitivity to human modes of communication and emotional behavior. Dogs tend to express their emotions through vocalization, just as humans do, and they seem to react to the emotional nuances of human speech and cries. Dogs can put on displays of behavior with the canniness of any adolescent to elicit a desired response from their owner. They also excel in learning from humans through observation, which allows them to follow the rules of the family.

Now modern technology is extending the human-dog relationship, both by helping us to understand it better and by enabling different forms of interaction. Images of brain activity in humans and dogs show striking parallels in how each species encodes the emotional content of the other's vocalizations. And devices ranging from state-of-the-art sensors to interactive robots may one day let dogs participate in new cooperative tasks with humans. As we move into an ever more complex future, the ability of dogs to attach and adapt should keep them close by our side.

### Fitting In

Dogs are unique in the animal kingdom because they have figured out how to join the community of an entirely alien spe-

cies—evidence of sophisticated social competence. Psychologists define social competence as the ability of individuals to harmonize their needs and expectations with those of the collective, letting them fit in with the group. Social competence depends on mastering a set of skills, including the abilities to form attachments, regulate aggression, learn and follow rules, provide assistance and participate in various group activities.

Social competence also comes into play when members of a nonhuman species join our social units. So when I design studies of the human-dog relationship with my group at Eötvös Loránd, we focus on the ability of dogs to exhibit each of the components of social competence. In this way, we come to understand their compatibility with us. But a noteworthy question is how dogs were able to develop this competence in the first place.

Anybody who has had the luck or misfortune to raise wolves and dogs at home would agree that the difference between the two is a big one. Wolves do not easily become members of the family, despite all efforts to socialize them to human life. Dogs have been able to bridge the divide because of significant changes in their genes over centuries of domestication, marked by the selection of genetic components that support the development of humanlike social competence when dogs are raised among people.

### Attachment for Life

A crucial component of social competence is the ability to form an attachment. Most researchers agree that the attachment between juvenile and adult dogs and their owners closely

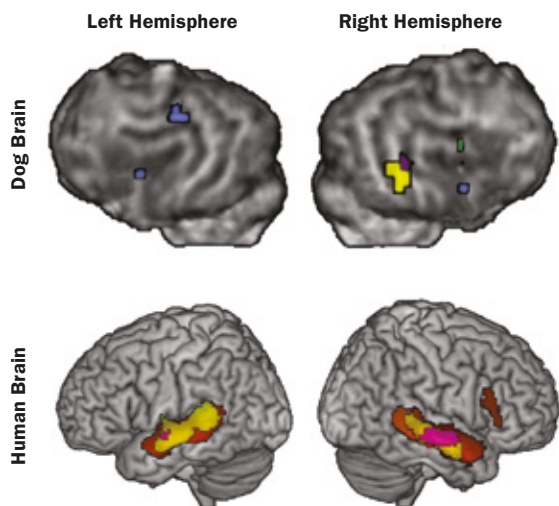
## Dogs have figured out how to join the community of an entirely alien species—evidence of sophisticated social competence.

resembles the bond that exists between mothers and very young children. In the 1960s psychologists John Bowlby of the Tavistock Clinic in London and Mary Ainsworth, then at Johns Hopkins University, developed an intriguing theory to explain the strong tie between mothers and their babies. They argued that this bond, known as attachment, ensures that the baby develops in a safe environment with opportunities to explore and learn about the complexities of human life. Ainsworth

## Parallel Brains

Researchers of the human-canine bond have long wanted to see how a dog's brain reacts to human emotional signals. But the main tool for investigating neural activity—functional magnetic resonance imaging—requires a subject to lie completely still for several minutes. Within the past several years dogs became the first nonhuman species to learn to lie motionless in the apparatus without being physically restrained. On the strength of this breakthrough, last year neurobiologist Attila Andics of the MTA-ELTE Comparative Ethology Research Group in Budapest and his colleagues performed a comparative imaging study of humans and dogs to investigate whether canine and human brains process nonlinguistic acoustic stimuli in a similar way.

Andics's team recorded more than 100 vocalizations by humans and dogs and asked humans to judge the negative or positive emotional content of the sounds. Twenty-two people and 11 specially trained dogs listened to a long sequence of excerpts from these recordings while their brain activity was recorded. Even though the canine brain is much smaller than the human one, the researchers were able to locate



Imaging studies have shown that, like humans, dogs have specialized brain regions that process sounds of their own species (shown as red in humans and blue in dogs). We also both have regions that process sounds with positive emotional content (yellow for humans; purple for dogs). Note the overlap of yellow and purple regions, showing that in each brain, the same region lights up in response to positive vocalizations of either species.



two neural areas that performed similar functions in both species. One area was mostly active when the subjects listened to vocalizations of their own species independent of the emotional content of the voice, showing that dogs and humans each have a brain area in about the same location dedicated to this function.

Even more intriguing was the finding on the processing of emotional information—that human and canine brains have analogous regions where activity correlates with increasingly positive emotional content regardless of the species that produces the sounds. Although these brain areas process acoustic stimuli at a relatively basic level (related, for example, to the length and frequency of the vocalizations), the results provide a preliminary hint of the existence of a neural basis for why family dogs (and sensitive owners) may react so strongly to their companion's emotions. —A.M.

and her colleagues introduced a simple test that is now the standard method for measuring the quality of this bond in everyday life. Mothers and babies of around 12 to 18 months in age were observed in a series of settings in which the baby was exposed to a strange female or separated from the mother for short periods. The study showed that the babies regarded their mother as a safe base, returning to her from time to time. They

also approached her for consolation after being left alone.

It took ethologists many years to recognize that dogs and their owners show this attachment pattern, too. In 1998 animal behaviorist József Topál and his colleagues at Eötvös Loránd asked 51 dog owners to participate in an experiment much like the study of mothers and their babies. The owner and dog were brought to an unfamiliar room and spent some time playing together, first

FROM "VOICE-SENSITIVE REGIONS IN THE DOG AND HUMAN BRAIN ARE REVEALED BY COMPARATIVE fMRI," BY ATTILA ANDICS ET AL., IN *CURRENT BIOLOGY*, VOL. 24, NO. 5, MARCH 3, 2014 (brain imaging); DEPARTMENT OF ETHOLOGY, EÖTVÖS LORÁND UNIVERSITY (dog in fMRI scanner)

## Like humans, dogs tend to express emotions through vocalization, and they seem to react to the emotional nuances of human speech and cries.

just with each other, then with a toy offered by the owner. Next a friendly stranger entered. The owner left, and the dog spent some time either alone or in the company of the stranger. Somewhat to the surprise of the researchers, most of the dogs behaved like human infants. When the owners were present, the dogs stayed near them and did not attempt to leave the room. Most of the dogs also played readily with their owner. They played less with the stranger, and most stopped playing with the stranger when their owner left. The researchers interpreted this preference as an indication that the dog regarded the owner as a safe refuge in case of potential danger, as attachment theory would predict.

Topál's team then set out to test whether this behavior represents an attachment relationship with a comparative study of juvenile dogs and wolves. In this experiment, 13 wolves and 11 dogs were separated from their mothers within four to six days of birth and raised by humans until they were four months old. The researchers then conducted the experiment of the stranger and the toy. Despite having the same social experience as the dogs, the wolves did not differentiate between their owner and the stranger, and only dogs used their owner as a secure base. In a parallel study in 2001 animal behaviorist Márta Gácsi of Eötvös Loránd discovered that even adult dogs could develop an attachment relationship with humans, as when an older dog is rescued from a shelter. (As head of the group, I was also on the team for this study and all of the others conducted at Eötvös Loránd.) Thus, the ability to form an attachment relationship with humans is lifelong.

### For Better or for Worse

The propensity that dogs show for attachment leaves their relationships with us open to some familiar, humanlike dysfunctions, especially for pets of city-dwelling people. Dogs that a century ago

would have had the freedom to wander off and encounter people and other dogs are now often confined to apartments, lonely and with few opportunities to enjoy their time. Most people do well at socializing their dogs, perhaps even without knowing it. But when the owners are neglectful, their dogs, just like infants, are prone to develop separation anxiety. When left alone, these dogs bark excessively, try to escape by destroying walls and doors, and defecate and urinate on the floor.

A 2011 study of this phenomenon conducted by ethologist Veronika Konok and her colleagues at Eötvös Loránd found that when separated from their owner, most dogs stay close to the chair where the owner usually sits. In contrast, dogs displaying signs of separation anxiety do not show a preference for objects touched or left behind by their owner. The researchers concluded that these dogs might have problems associating their owner with his or her home or possessions, so the dogs do not feel safe when their owner is absent.

And just as with distressed infants, anxiety in canines is often an outcome of their caregiver's personality. In a study published in the journal *PLOS ONE* in 2015, Konok and her colleagues reported that owners who show greater degrees of avoidance in their human attachment relationships (say, by not accepting help from others) tend to have dogs with higher levels of separation anxiety. This correlation suggests that behavioral problems in dogs could arise when owners interact with their dogs in an inappropriate way. The owners might not be



**Dogs that disobey rules—by stealing food, say—may appear guilty to their owners but are more likely fearful of punishment.**

## Dogs can learn by watching us, which helps them master the rules to fit in with human groups and our idiosyncratic habits.

providing social support when the dog needs it, or they might be absent or negligent when an inexperienced dog is exposed to a social threat. In contrast, a stable and balanced attachment relationship makes dogs feel safe, and it creates a strong emotional bond between dogs and their owners.

### Emotional Ties

Not least because of this bond, dogs are often admired for their emotional sensitivity, and people living with dogs have always attributed emotions to their animal companions, assuming that dogs are happy, sad, angry and jealous just as humans

differ in emotions of greater complexity, such as guilt. In humans, guilt arises when people violate a social rule, such as stealing someone's food.

Two independent studies, one led by cognitive scientist Alexandra Horowitz of Barnard College in 2009 and the other by canine behavioral researcher Julie Hecht, then at Eötvös Loránd, in 2012, examined dogs' behavior after they were told not to break just such a rule. In Horowitz's experiment, 14 dogs were told by their owners not to eat food on a table in the living room. The owners then left the room, presumably to give the dogs a chance to obey or disobey. But an experimenter then surreptitiously either offered the treat to the dogs (guaranteeing disobedience) or took it away (guaranteeing obedience).

Next the experimenter reported the dogs' behavior to the owners, sometimes truthfully, sometimes not, and directed the owners of "obedient" dogs to greet their pets in a friendly manner and to scold dogs they were told had disobeyed. All the dogs that were scolded, whether or not they actually ate the food, displayed in equal measure the behaviors that owners identified as signs of guilt, suggesting that dogs were reacting to the behavior of their owners—that is, scolding and a dissatisfied expression—rather than awareness of their own transgression. Hecht also noted that the dogs' demeanor was a survival mechanism of sorts, reporting that when asked about their habits at home,



are. Yet for years academic researchers refused to attribute emotions to animals. That attitude is changing slowly, and nowadays talking about emotions in dogs or other nonhuman species is no longer considered sacrilege.

Still an open question, though, is whether a dog's emotions signify what we think they do. Although some researchers accept that dog happiness and fear are akin to the human experience, experimental work has shown that dogs and humans

owners who observed guilty behavior said they were less likely to scold their dogs after discovering a misdeed.

No definitive research exists on dogs and sorrow, whether they feel their own or react to ours, but psychologists Deborah Custance and Jennifer Mayer, both then at Goldsmiths, University of London, were able to provide scientific evidence for the long-held belief that human crying evokes affiliated behavior in dogs. In a 2012 study, the experimenters observed the reaction of 18 dogs in a home setting as their owners and strangers hummed, talked or pretended to cry. Almost all the dogs approached the crying person, looked at her and touched her. These behaviors were much less frequent when the humans were talking or humming. Although owners may anthropomorphize the dogs' behavior and believe it to be a sign

**Helping tend the flock has long been a canine practical specialty; a modern equivalent is assisting people with physical disabilities.**

### THE AUTHOR

**ÁDÁM MIKLÓSI** is a biologist and head of the department of ethology at Eötvös Loránd University in Budapest. He is a leading scientist in the study of human-dog interactions, with special interest in cognitive abilities of dogs.

GETTY IMAGES (herding dog and assistance dog); RICHARD LEVINE-Alamy (guide dog)



# Decoding the Cat

**Felines may be hard to study, but we have learned a few things about them**

By Julia Calderone

Cats have a curious allure. Even the most pampered house cats seem to flaunt their independence, as if to say that they do not really need us to get by. Despite this hauteur—or perhaps because of it—many of us cannot resist bringing these regal creatures into our homes, litter boxes and all. In fact, cats outnumber canines as human companions, although we know surprisingly little about their cognition.

Our partnership with cats is long-standing. Feline DNA suggests that the domestic cat may have split from its wild counterpart in the Middle East nearly 10,000 years ago. In 2014 a study by Michael J. Montague of Washington University in St. Louis and his colleagues identified a set of genes that may have been crucial in the transformation of the prehistoric cat into the cuddly pets we know today. These genes have been linked to key behavioral traits, such as the ability to learn and reduced fearfulness, which would have helped cats adapt to life in human company.

Yet many mysteries remain in deciphering feline behavior and intelligence, particularly in contrast to our growing knowledge of dogs. This gap arose in part because of the more urgent need to study dogs. Negative interactions between humans and hostile or misbehaving dogs are common societal problems.

A bigger reason for our poor grasp of the feline mind stems from the challenges of cat behavior. Whereas the ancestors of dogs roamed in packs and learned sophisticated strategies for interacting socially with other animals, the wildcat progenitors of today's house cats were more solitary animals. The patterns that govern their exchanges with one another and humans are therefore harder to parse. Ádám Miklósi and his colleagues have found that like dogs, cats are able to follow a pointed finger to food, but if the setup is rigged (say, if the bowl is just out of reach), the cat will give up; a dog will creatively strategize or look to humans for help. "If there's a problem," says anthrozoologist John Bradshaw of the University of Bristol in England, a specialist in human-animal interaction, "cats try to solve it on their own. And if they fail, they just walk away."

Cats are also tough to manage in the laboratory. "The second you take a cat out of its own home, it becomes nervous," says Marieke Gartner, a psychologist at the University of Edinburgh. If the cat is in its own territory, Gartner continues, it will react more naturally. As a result, most studies of cats are based on observations in the home rather than controlled experiments in the lab.

Given these challenges, we still have much to learn about cats. We can easily decipher a score of signals from dogs, but, Bradshaw says, "with cats, it's more like five or six." Some of the signs we know are listed to the right.

*Julia Calderone is a freelance science writer based in New York City.*



**PURR** The purr seems to serve multiple purposes: to share emotional states such as happiness or distress; to express urgency, typically when a cat wants to be fed; or to signal stress or injury.

**MEOW** Cats generally do not meow at one another, but they learn a repertoire of meows to communicate with humans. Typical meow meanings are specific to a given relationship: an owner knows what his or her cat's meow means but cannot necessarily understand that of another feline.

**EARS** Ears back signals aggression. Ears forward signals interest.



**TAIL** Tail straight up shows that the cat is fond of you but also acknowledges that you are slightly superior to it.

Tail straight up and puffed out means the cat is angry.

Tail tucked between legs means the cat is insecure, trying to get away or withdrawing from the world.

**RUBBING ITS HEAD AND FACE ON THINGS** A cat has glands on the corners of its lips, between its eye and ear, and under its chin; this behavior marks territory, and some scientists believe it could signal affection.

**LYING ON ITS BACK, BELLY EXPOSED** The cat is relaxed and trusts you.



**KNEADING** Kittens make this motion to stimulate their mother's milk. In adulthood, researchers suspect the behavior is affectionate and signals that the kneaded individual is in a superior, mothering role.

**LICKING** Cats of the same size and status groom one another frequently, which is thought to improve bonds and eliminate aggression within the colony. "It's a genuine demonstration of affection," Bradshaw says, "which in cat societies is very important."



of empathetic skills, the authors of the study concluded that there is a simpler explanation. They argued that the human cry was similar to distress vocalizations of mammals, including dogs, so the cries evoked distress as opposed to empathy, which would have required the dog to recognize the humans' inner state.

Supporting this conclusion, a 2014 study led by psychologists Ted Ruffman and Min Hooi Yong of the University of Otago in New Zealand showed that listening to a human baby cry evokes stress in dogs, as revealed by an increase in the levels of cortisol in their blood. Needless to say, when your dog nuzzles you, his behavior is comforting whatever the impetus, but keep in mind that if you are tempted to elicit some affection by showing your sadness, your dog may not be feeling bad for you; he may just be feeling bad because he is stressed out.

## Do as I Do!

Much of human culture is based on social learning. Language, the rules of society and the use of objects are all transmitted from the old to the young and from peer to peer. Dogs are very keen to learn by observation, too. The ability to learn socially is widespread among animals, but learning from representatives of a different species is much rarer. Because dogs regard humans as their social companions, their eagerness to learn by observing our activities should not be surprising; shepherds have long known as much. Yet science began probing the depth of this facility only a few years ago.

One of the most common tests of observational abilities involves a simple detour task, in which a dog must go around a fence of about three meters in length to reach a visible target (such as some food or a toy). In a 2001 study, animal behaviorist Péter Pongrácz and his team at Eötvös Loránd showed that family dogs need six or seven attempts to master this task through trial and error—but they can learn to make the detour after watching an expert dog complete the task only once. And the dogs learned equally well by watching a human expert.

The age-old imitation game that parents like to play with their babies is also helping researchers understand how dogs learn by observing. Mothers and fathers often dem-

ISTOCKPHOTO (cat)

onstrate a specific action (such as touching the tip of the nose with their index finger) and then encourage their infant to do the same. In 2006 Topál, then at the Hungarian Academy of Sciences, and his team were the first to show that people could play a similar game with dogs. A human first trains the dogs to perform three or four tasks (such as turning around, jumping on a table or going around a cone) by demonstrating each of the actions and telling the dog, “Do it!” The dog receives a reward when it completes the task. Most dogs can learn these rules quickly. Then the human demonstrates new tasks (such as touching the cone with a hand). After regular practice, the dogs will naturally imitate novel actions performed by their human companions.

The do-as-I-do game awakens the natural inclination of dogs to copy our behavior. Yet we do not always wish them to do so. Who wants a puppy to eat from the table, dig in the garden or “read” the newspaper? So humans often discourage dogs from imitating them, and the dogs quickly learn not to copy most activities performed by their human companions. Even so, the number of things dogs learn by watching us might surprise even people who have had dogs for years. Some dogs may learn to open doors by watching their owners turn the handle, or they may jump on a sled just because they see people having fun as they slide down a hillside. Indeed, the ability to learn from observation helps dogs master the rules necessary to fit in with human groups and their owners’ idiosyncratic habits.

### Cooperation: Getting Practical

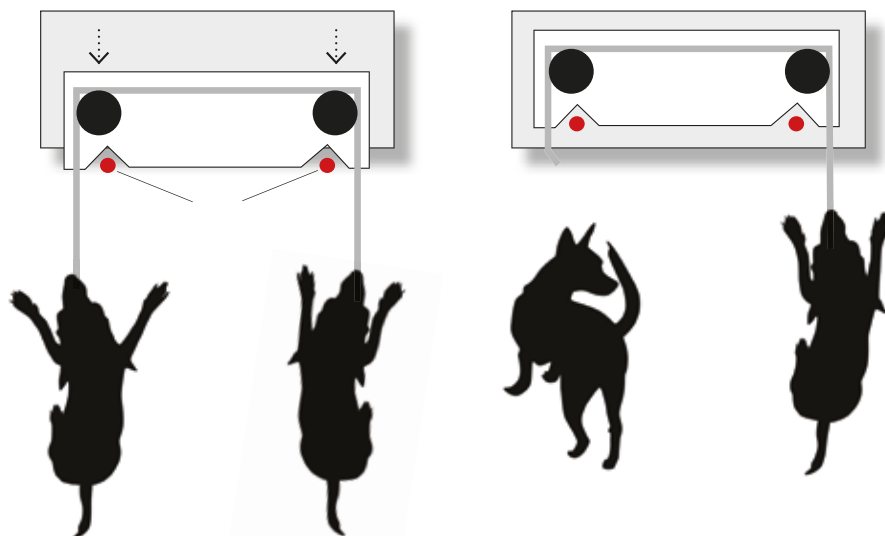
In modern Western society, dogs are often loved just because they are dogs. But dogs would probably not be around today if they had not proved themselves so useful to societies in the past—serving as household alarm systems, protecting the herd from wolves, pulling sledges. And that usefulness continues today as dogs assist the police (with drug detection, say) and help people living with disabilities. Guide dogs for the blind and dogs for people in wheelchairs or living with hear-

## Guide dogs show impressive cooperative skills: self-control, awareness of another’s goals and the ability to take turns.

ing impairment not only provide round-the-clock practical help but also fill important social roles, of which friendship is one of the most important.

Indeed, a vital element of dogs’ social competence involves their impressive cooperative skills. In a useful partnership, each individual must display self-control, take notice of the other’s goals and actions, and learn to take turns, so that at different times one or the other is in the lead. Studies have shown that guide dogs possess all these skills. In 2001 a detailed behavioral analysis of blind people and their guide dogs, conducted by animal behaviorist Szima Naderi, then at Eötvös Loránd, and her team revealed the fine-grained nature of the interaction as the two walk together, with each partner acknowledging the objectives of the other and switching leadership very rapidly. For example, the blind person initiates a turn to the left or right (because she knows where she wants to go) while the dog takes the lead in evading an obstacle in the street (because the canine can see it).

Dogs can also collaborate on tasks in which they seem to understand the consequences of coordinated action. In a study published in 2014, psychologists Ljerka Ostojic and Nicola Clayton, both at the University of Cambridge, reported on dogs’ ability to solve the so-called loose-string task, considered a benchmark test for joint problem solving. In the usual setup, the partners are giv-



In the loose-string task, two dogs learn that if they pull together, they can move a treat (red) within reach. But if one pulls and the other does not, the string slips out and the prize is lost.



**Search-and-rescue dogs are learning to form cooperative relationships not only with people but with machines; one day airborne robots might direct the dogs to the vicinity of a missing person.**

en a box from which two strings emerge. In fact, they are seeing two ends of a single string. If both partners take an end and pull simultaneously, they will move the target object (placed at the back of the box) to within their reach. If only one tugs at the string, however, it will slip out of the apparatus without moving the prize. During the

experiment, dogs learned to get the prize by coordinating their behavior with either a human or a dog partner. Thus, dogs were able to recognize that the specific actions of the other were necessary for their own success. And this rapid development of cooperative behavior between the dogs and their partners explains why dogs are so good at helping humans in tasks that are narrowly defined, such as leading a sightless person through busy city streets.

### Dogs in the High-Tech Future

The invasion of modern technology into everyday life may have dog owners wondering how their relationship with their companions will fare in the digital age. Yet dogs have already begun to interact with today's technology and even to form ad hoc partnerships with devices. In a recent experiment published in

*PLOS ONE*, animal behaviorist Anna Gergely, then at Eötvös Loránd, and her team delivered some food to family dogs via a remote-controlled car. After a few such interactions, the dogs began to look at, touch or push the car when it was not moving, as if their goal was to get the car to do its "job." On the surface, the dogs' actions resembled those they displayed toward their owners in similar circumstances. In principle, if the abilities of devices grow more complex, so should the relationship between dogs and machines.

Such dog-machine interactions can also have practical benefits. In a recent project headed by computer engineering professor Bernhard Plattner of the Swiss Federal Institute of Technology in Zurich and supported by the Swiss National Science Foundation, researchers tested the idea that searches for people lost in the woods or mountains would be more effective if the human rescuers were complemented by a team of dogs and airborne robots armed with cameras. Animal behaviorist Linda Gerencsér of Eötvös Loránd worked with dog trainer Barbara Kerekes to teach four dogs to follow a flying robot over a distance of 100 to 150 meters. They also trained the dogs to stop following the robot and start searching for the missing person by smell if they saw the robot hovering above a specific location. Dogs would then alert the human rescuers by barking if they found the missing person. Researchers believe that as the technology develops, such machine-aided groups will outperform

traditional rescue teams, especially if dogs acknowledge the flying robot as a social partner—one to which they might respond with the eagerness they would show to a human companion.

Human life is growing ever more distant from the natural world, and dogs will never be able to understand the breadth of these changes. But their social competence will help them successfully negotiate an evolving society, just as they have since beginning their long journey alongside the human family. **M**

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# Can Infection Give You the Blues?

An overactive immune response can seed psychological illnesses

By Erich Kasten

ILLUSTRATIONS BY MANDY ROOT-THOMPSON

**B**y the time she visited her doctor, Anne, a 28-year-old graduate student, had felt listless for months. Plagued by headaches, dizziness, anxiety and visual disturbances, she was struggling in her seminars and failed two exams. She also quit hobbies she enjoyed and stopped socializing. Her doctor diagnosed burnout, a depressive reaction to ongoing stress. He prescribed antidepressants and referred her to me for psychotherapy. Neither helped. A year later I suggested she

go for a routine checkup to rule out any underlying physical illness. Her doctor discovered that she suffered from chronic sinusitis. After two weeks on antibiotics, Anne's infection cleared. What is

more, her depression began to lift as well.

Anne's case is one of a growing number in my own practice and others to suggest that depression can be a symptom of something as simple as infection. Clinicians have long viewed depression as a complex disorder. Stress, neurochemical imbalances, physical pain and ill health can all precipitate an emotional collapse. Yet a flurry of research during the past 25 years has linked many of depression's contributing factors to a single root cause: inflammation.

In the short term, inflammation is an important part of our immune system's built-in ability to thwart disease and injury. But when prolonged, it can prompt fatigue and melancholy. In addition, investigations hint that an upset immune

system might underlie a host of other psychiatric illnesses, including obsessive-compulsive disorder, panic disorder and post-traumatic stress syndrome.

With these growing insights, scientists are testing new treatments to heal the psyche by tempering chronic inflammation. Even if the approach may help only some people with depression, the benefit could be enormous. About one in 10 individuals in the U.S. suffers from a serious spell of despondency at least once during their lives, and depression is the most prevalent mental illness among women.

## Self-Defense in Overdrive

Our immune system deploys an arsenal of diverse cells to keep us healthy, choreographing their actions by way of messenger molecules called cytokines. Cells attacked by harmful bacteria, viruses, parasites or cancer secrete interferons, a class of cytokines that warn neighboring tissues to bolster their defenses and rally killer cells to engage. Cytokines called interleukins help to coordinate fever (which limits the spread of an infection) and inflammation (which rushes specialized immune cells to the scene). Tumor necrosis factors, yet another large family of cytokines, destroy abnormal cells and activate other cytokines. They also promote swelling, reddening and pain, which have both positive and negative effects.

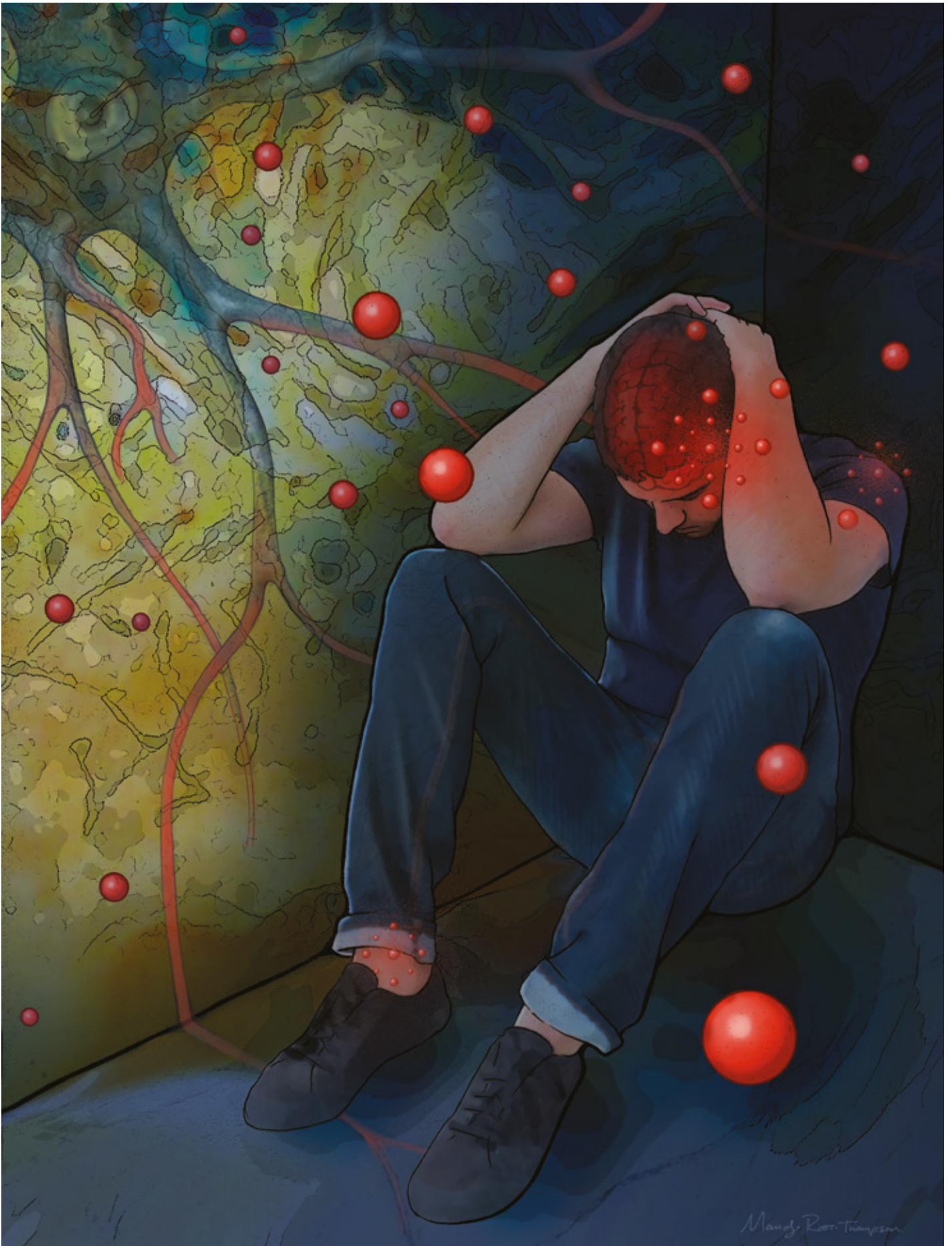
Working together, these various proteins modulate the type, intensity and duration of an immune response. Across the blood-brain barrier, they also hold considerable sway over our emotional state. When we are unwell, interferons and interleukins announcing the start of an attack flood the brain. Numerous studies have revealed that these proinflammatory cytokines can disrupt the normal functioning of multiple neurotransmitters and dampen the production of serotonin, often called a happiness hormone for its ability to boost mood. As a result, even people with minor colds often lose their appetite, feel tired, seek warmth,

### FAST FACTS

#### IMMUNITY GONE AWRY

- 1 Cytokines—the messenger molecules of our immune system—not only coordinate the body's defenses but also make us feel tired and listless when we are sick.
- 2 Stress may shift our immune system to a perpetual state of alert, causing higher levels of inflammation and increasing the risk of depression and other disorders.
- 3 Both medicines and dietary interventions that reduce inflammation appear to help some patients suffering from depression and anxiety disorders.





avoid others and struggle to concentrate.

Biologically, this sickness behavior, as it is called, makes sense. Our immune system works more efficiently and we can recuperate faster if we stay in bed. We are also less likely to infect our co-workers and friends. Once an illness has cleared, anti-inflammatory cytokines see to it that our bodies and our brain chemistry reset. But what if an illness drags on and the immune system continues to pump out proinflammatory signals? In that case, sickness behavior begins to look a lot like depression. Tooth decay, urinary tract infections and sinusitis are all examples of infections that do not always produce obvious symptoms or pain but might perpetuate sickness behavior for a long period.

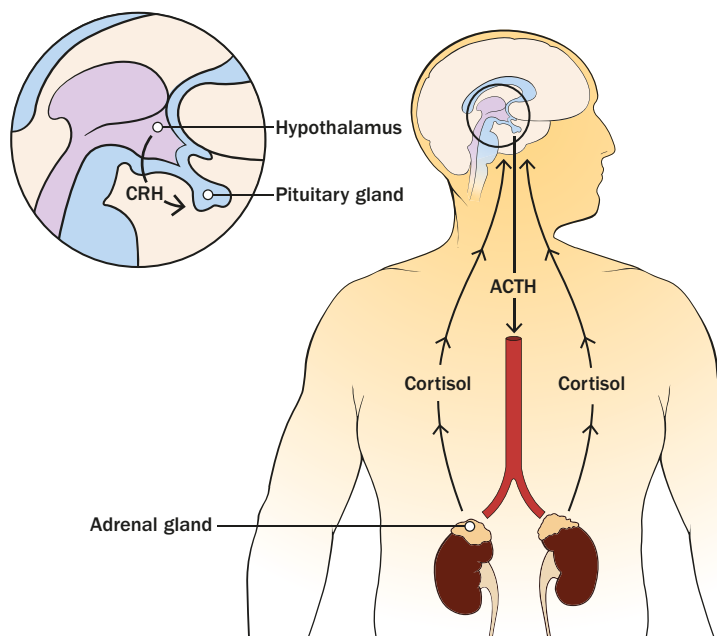
To test the idea that depression can sometimes be a kind of extended sickness behavior, psychology researcher Yekta Dowlati of the University of Toronto and her colleagues evaluated 24 studies in a paper published in 2010, looking at measurements of proinflammatory cytokines in about 400 depressed individuals. Overall, these subjects showed significantly heightened blood levels of tumor necrosis factor alpha (TNF-alpha) and interleukin-6, hallmarks of an ongoing immune reaction. Two years later researcher Simon Gray and psychiatrist Michael Bloch of Yale University conducted another meta-analysis of 12 studies of obsessive-compulsive disorder, often diagnosed alongside depression. They, too, reported elevated blood levels of TNF-alpha in individuals suffering from both depression and obsessive-compulsive disorder.

An overcooked immune response may also trigger anxiety disorders. In 2009 psychiatrist Elizabeth Hoge of Harvard Medical School and her co-workers compared the immunological status of 48 patients suffering from panic disorder or post-traumatic stress disorder with that

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## STRESS RESPONSE SYSTEM



When we are threatened, the hypothalamus releases corticotropin-releasing hormone (CRH), causing the pituitary gland to secrete adrenocorticotropic hormone (ACTH), which reaches the adrenal gland via blood circulation. The adrenal cortex produces cortisol, which suppresses the immune system so we focus all our energies on any immediate dangers. Long-term stress can permanently damage this feedback and kick the immune system dangerously into overdrive.

of 48 age- and gender-matched healthy control subjects. The team tested blood serum levels of 20 different inflammation markers and found 18 of them to be higher in the psychiatric patients. To look for a generalized inflammatory state—indicative of an underlying injury or infection—they measured how many participants had detectable levels of at least six out of nine common proinflammatory cytokines. Some 87 percent of the anxiety sufferers met the criterion, compared with only 25 percent of the controls.

### The Role of Stress

There seems to be little doubt that protracted low-grade inflammation can engender depression and other emotional disorders in some people. Whether or not a person succumbs may depend in part on how aggressive their immune system is to begin with. In 2013 psychiatrists Charles L. Raison of the University of Arizona and Andrew H. Miller of Emory University conducted a meta-analysis examining data on genes that predispose

humans to depression. They noted that many of these genes are present in individuals with an especially vigorous immune response—which might explain why the genes have persisted in the human population even though they can have a detrimental effect.

Until the advent of good hygiene and antibiotics, infection was arguably the greatest threat to staying alive, so having an overactive immune system conferred a real advantage. Raison and Miller speculate that today, when most of us are not routinely exposed to hazardous microbes, some people's immune systems habitually overreact to harmless stimuli, leading to a persistent increase in proinflammatory cytokines. This may account for an increased prevalence of not only depression and other emotional disorders but also allergies, autoimmune diseases, cardiovascular disease, stroke, cancer, diabetes and dementia.

Stress probably plays a crucial role in this nexus of cause and effect. In the short term, the mere anticipation of injury can

amplify inflammation. Several experiments have confirmed that animals experiencing moments of acute stress crank out higher levels of proinflammatory cytokines, and prolonged stress can eventually elicit depressionlike behavior in these same creatures. In 2009 psychiatrist Lisa Christian and her co-workers at Ohio State University demonstrated a similar phenomenon in humans. They studied 60 women during pregnancy and found an association between depression and blood levels of TNF-alpha and interleukin-6. Proinflammatory cytokines rise during any pregnancy, but the researchers found elevated levels of both cytokines and de-

prone to overreact and add stress. The chance of physical illness skyrockets, proinflammatory cytokines surge and sickness behavior becomes the new normal. Further investigations reveal that trauma in any form primes this pathway. In 2007 psychiatrist Andrea Danese of King's College London and his colleagues conducted a longitudinal study of people who were rejected or mistreated by their parents during childhood. They found that even 20 years after the abuse, many study participants had greatly elevated blood levels of inflammation biomarkers.

Several other studies suggest that disturbing childhood experiences may per-

ture to more inflammation and depression.

Indeed, so complex is the interplay of contributing factors that it may be impossible to determine the degree to which immune reactivity, personality, general physical health and life experiences contribute to depression in any one person. Chronic inflammation in and of itself almost certainly accounts for only a subset of patients with emotional disorders. Yet several trials have shown that patients who do not respond to traditional antidepressants frequently begin to improve when they take anti-inflammatory medications, from everyday ibuprofen to cytokine inhibitors, on top of their other prescriptions. Interestingly, the reverse is also true. Patients suffering from skin cancer or hepatitis C frequently take the cytokine drug interferon-alpha, which causes inflammation, and many develop symptoms of depression as a side effect.

Practitioners are thus pursuing a variety of approaches—from medications to dietary interventions—to tackle unwanted inflammation in psychiatric patients. For instance, in 2011 psychiatrist Janice Kiecolt-Glaser and her colleagues at Ohio State reported that omega-3 fatty acids, which curb inflammation, alleviated anxiety in medical students before an exam. Scientists are hopeful that drugs aimed at blocking cytokine receptors in the brain might also help quell emotional disorders. Several initiatives are under way to develop effective cytokine antagonists. Meanwhile more studies on the role of stress and trauma may reveal better ways to keep inflammation in check, lessening the risk that a chance infection will lead to an intractable disease. **M**

## Prolonged low-grade infection can engender depression and other emotional disorders in some people.

pression in women under stress and the highest levels of depression in women under presumably the greatest stress—those with unwelcome pregnancies and those who received the least support.

Chronic stress is even more deleterious. Faced with some threat, the body prepares for fight or flight. A hormonal cascade along the so-called stress axis—from the hypothalamus to the pituitary gland to the adrenal gland—jump-starts the production of cortisol. Among other functions, this hormone temporarily suppresses the immune system to guarantee that we focus all of our energy on external dangers. If the stress endures, though, cortisol keeps the immune system offline, and we are more susceptible to illness. Over the course of several years, stress can permanently damage signaling along the axis, and we begin to release too little cortisol—in which case, the immune system reawakens and kicks into overdrive, with proinflammatory cytokines flowing freely.

### Stacking the Deck

The sum of this research is a rough mechanism by which inflammation can seed depression: take an immune system

manently unbalance the stress axis and alter the sensitivity of cortisol receptors in the brain. Miller and his colleagues have discovered that compared with emotionally healthy control subjects, depressed men who were distressed as children mount much stronger immune responses when they take a test designed to cause psychosocial stress. Physical pain can also overload the immune system. Scientists have documented especially high levels of TNF-alpha in depressed women who also exhibit an increased sensitivity to pain—itsself a symptom of sickness behavior. Constant pain is a stress factor, creating a vicious circle: pain begets inflammation and stress, leading

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That boy who never speaks in class? Chances are he has an anxiety disorder called selective mutism that demands the one thing he dreads the most: **attention**

**By Claudia Wallis**

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**It** is 11:30 on an August morning in New York City's Central Park Zoo—breakfast time for the sea lions. A joyful crowd oohs and aahs as trainers put the animals through their paces: catching tossed fish in midair, high-fiving with their flippers, squirting water and torpedoing around the pool. Amid the raucous throng, nine small children watch in wide-eyed silence. When a sea lion zips past at stunning speed, they do not add their voices to the squeals of delight. Some of these children are talking quietly to a camp counselor. Others sit with worried expressions that seem sadly at odds with the scene.

The nine children, ages three to six, are subdued by an anxiety disorder called selective mutism, a condition that often looks and feels like very painful shyness but with a twist. These kids will generally speak—and some will blithely chatter away—when out of the public eye and in the comforting cocoon of their own homes. But in certain settings and most typically in school, they shut down and go silent.

The zoo outing is part of a four-day program called Camp Courage, offered by the Child Study Center at New York University. It is the model for half a dozen summer camp programs for kids with selective mutism. Once thought to be extremely rare, the disorder is now believed to affect between 0.5 and 0.8 percent of youngsters—meaning there is at least one such child in most elementary schools.

#### FAST FACTS

##### STRUCK SPEECHLESS

- 1 Selective mutism, a disorder that leaves individuals too anxious to speak in certain contexts (usually school), is now believed to affect between 0.5 and 0.8 percent of young children.
- 2 Evidence suggests that genetics plays a significant role in the disorder. Issues with auditory processing may also contribute.
- 3 Therapies focus on gradually increasing a child's exposure to speaking in distressing situations and providing rewards for braving his or her fears.



Some children with selective mutism are outgoing, but most are not. Somewhere between half and 90 percent also suffer from social anxiety, which can cause them to pull back in settings such as a crowded playground full of unfamiliar children.

These are the kids who never speak in class or whisper to only one or two confidants on the playground. They are the kindergartners who wet their pants, or worse, because they are too mortified to ask permission to use the bathroom. One child at Camp Courage accidentally hammered his thumb during a school craft project and said nothing; a teacher finally came to his aid after noticing the trail of blood.

Pediatricians often dismiss the disorder, which typically emerges when a child begins preschool or kindergarten, as a passing phase that will resolve itself. In the meantime, parents get in the habit of speaking for their child, asking others to accept shrugs and gestures as communication and explaining their youngster's "shyness" to baffled teachers and neighbors. But selective mutism does not always fade away. Survey findings and clinical experience suggest that many affected children continue to struggle for more than five years, according to child psychologist Richard Gallagher, who heads N.Y.U.'s selective mutism program. A small percentage of children remain mute into high school.

Psychologists and educators familiar

with selective mutism now believe intervening to break the mute behavior pattern is important so that it does not compromise a child's academic, social and psychological development. That belief is in keeping with a broader trend toward early intervention in other childhood conditions that affect learning and socialization, such as attention-deficit/hyperactivity disorder, communication disorders and autism. Selective mutism is less well recognized, however, and many kids who would benefit from therapy either receive the wrong kind or none at all. Only in the past few years has rigorous research validated a therapeutic approach to selective mutism. At the same time, scientists are beginning to explore the mysterious—and in some cases, surprising—roots of this once obscure disorder.

### Naming the Silence

Spend a few days around children who have selective mutism, and you begin to wonder if they have a hidden on/off switch. In the large, airy classroom where Camp Courage convened, I saw a child stop a conversation in its tracks the minute an unfamiliar therapist tried to join in. Conversely, a boy who had been

largely silent all day got into an elevator with his mom at pickup time and began a perfectly ordinary chat about where she had parked the car.

Because these kids are capable of speaking normally, their mute behavior can look willful. In 1877, when German physician Adolph Kussmaul penned what may be the earliest description of selective mutism, he named it *aphasia voluntaria* (Latin for a “voluntary lack of speech”). In keeping with the idea that the child has chosen silence, psychiatrists called the disorder elective mutism when it first appeared in the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* in 1980. The name changed in the 1994 edition after research and clinical experience made it clearer that selective mutism was driven more by anxiety than defiance. The current edition (*DSM-5*), published in 2013, classifies selective mutism as a unique childhood anxiety disorder marked by a failure to speak in certain settings that cannot be explained by communication or language difficulties [see box above].



Kids with the disorder tend to be self-conscious and fretful about making mistakes. “They react to speaking as if it were a performance,” says psychologist R. Lindsey Bergman of U.C.L.A.

## Selective Mutism in the *DSM-5*

Five diagnostic criteria distinguish the disorder:

- The child consistently fails to speak in certain settings.
- The problem has lasted at least a month (not including the first month of school).
- The issue cannot be fully explained by a communication disorder.
- The condition interferes with the child’s education or social communication.
- The child’s silence cannot be attributed to an unfamiliarity with spoken language.

Most children who are treated for selective mutism are also diagnosed with an additional anxiety disorder. Usually this is social anxiety disorder, which involves grave distress in social settings and often a paralyzing fear of making a social mistake. Although most socially anxious kids are withdrawn but not mute, more than half and perhaps as many as nine out of 10 selectively mute children also suffer from social anxiety. A number of clinicians regard selective mutism as a subtype of this disorder.

Despite its sometimes dramatic symptoms, selective mutism is often overlooked. In 2002 R. Lindsey Bergman, a child psychologist at the University of California, Los Angeles, studied the prevalence of this disorder among 2,256 kindergartners and first and second graders in a large California school district. She noted that most of the children who matched *DSM* criteria for the disorder (based on detailed input from their teachers) had not been previously identified. “Teachers just think the kids are super, super shy,” Bergman says. “And at this age, the teacher is more worried about the child who is acting out and not staying in his seat.”

Another common issue is mislabeling. In her clinical practice, Bergman has seen youngsters with selective mutism who have been incorrectly diagnosed with a speech and language problem or

an autism spectrum disorder. Sue Newman, co-director of the Selective Mutism Foundation, says that she frequently hears about misdiagnosed children who have been placed in educational settings designed for kids with autism or speech disorders that not only fail to address their mutism but may make them feel more self-conscious and anxious.

Even when the problem is correctly diagnosed, finding help (and a qualified therapist who accepts health insurance) is a challenge. According to Brittany Roslin, who is one of three N.Y.U. child psychologists at

Camp Courage, “a lot of clinicians don’t want to work with these kids, because they don’t know what to do. You can be sitting across from a kid for years without speaking.”

### Why They Go Quiet

A child’s mute behavior can come as a shock. Susan\* still gets emotional recalling events on her son’s third day of kindergarten when a teacher came up to her spouse at pickup time and cheerily asked, “So, is he ever going to start talking?” Evan\* was exuberant and verbal at home and had been vocal during three years of preschool. “We were totally flabbergasted,” she remembers. “We were both up all night.” Only in hindsight did they see the warning signs: Evan’s refusal to say hello to waiters, store clerks and adult neighbors. The couple, who live in New York City, recognized their son’s symptoms from online descriptions of selective mutism and quickly made contact with N.Y.U.’s program.

Clinicians who work with kids with

*\*Not their real names.*

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Teachers usually play an important role in helping a child conquer selective mutism. A therapist may coach them to gently nudge a student from nonverbal participation in class to brief, whispered answers to full engagement—with rewards for progress.

the disorder say that parents often describe them as having been cautious and socially reticent since infancy. These characteristics—what psychologists call a behaviorally inhibited temperament—are typical of 15 to 20 percent of babies and toddlers. “They are hesitant to interact with peers—they withdraw from social situations and are highly vigilant,” says developmental psychologist Nathan Fox of the University of Maryland. Although most go on to be perfectly fine, behaviorally inhibited children have a 30 percent increased risk of developing an anxiety disorder, especially social anxiety.

As with most psychiatric disorders, the causes of selective mutism are not well understood, but a genetic component seems likely. Studies have found that anxiety disorders of various types tend to run in the families of affected kids. Bergman says, “When I see parents of kids with selective mutism, about 75 percent of the

time I can say, ‘Which one of you was like this as a kid?’ and one will say they either did not speak in class or sat there in fear that they would be called on.”

A 2011 study involving 106 children with the disorder offers a hint as to its genetic origins. University of California, San Diego, psychiatrist Murray Stein and his colleagues found preliminary evidence that a variation in a gene called *CNTNAP2* raises the risk of the disorder. The study also discovered that the same gene variation was associated with symptoms of social anxiety in a group of 1,028 young adults. The *CNTNAP2* gene codes for a protein that is expressed in the developing cortex of the brain and plays a role in brain cell connectivity. Intriguingly, variants of the gene have been implicated in autism and certain language impairments—findings that suggest the gene might have a part in a variety of social and communication disorders.

One research group in Israel has

found evidence that many children with selective mutism have a hearing abnormality that affects the way they perceive their own voice. In a series of small studies published between 2004 and 2013 involving a total of 75 subjects with selective mutism, psychologist Yair Bar-Haim of Tel Aviv University and his collaborators found that roughly 50 percent of affected children have some kind of problem with their “efferent” auditory system. This system—which involves the middle ear, brain stem and cerebral cortex—normally attenuates the sound of one’s own voice, which, as Bar-Haim says, is otherwise loudly “bone-conducted directly into our own brain.” Quieting down our voice helps us tune into our environment while speaking. Bar-Haim’s findings could help explain why some children with this disorder complain that their voice sounds funny or loud to them. If he is correct, then treating anxiety alone will be insufficient for many cases of selective mutism.

Indeed, numerous factors can contribute to anxiety about speaking. According to osteopathic physician Elisa Shipon-Blum, director of the Selective Mutism Anxiety Research and Treatment Center in Jenkintown, Pa., developmental delays, learning disabilities, speech and language issues, and sensory processing challenges can cause a child to shut down in a noisy, overstimulating classroom. “We may see a deficit in their narrative skills—their ability to tell a story, to tell you what they read in a book or what a movie is about,” Shipon-Blum says.

For the most part, children who have selective mutism are too young to offer their own explanations for their behavior, but a preoccupation with making verbal or social mistakes seems to be central for many. Danica Cotov, a recent college graduate from New Jersey who struggled with mutism for 16 years, gives this account: “I lived in constant fear of being judged by my peers, who I was certain would think negatively of me. I had a constant stream of thoughts and worries running through my head.” After years of silence, she dreaded the fuss that would be made if she ever did speak up.



## Finding Help

At Camp Courage, each of the nine children was working toward a specific goal. For Cindy,\* an elfin girl with big, brown eyes and a honey-colored braid, it was to use her “full voice” instead of a whisper. Evan was working on allowing anyone besides Gallagher, with whom he chatted easily, to hear his voice. Campers earned points by participating in group games such as Go Fish that required simple, predictable utterances (“Do you have any zebras?”). At the end

week waiting list. The other group received 24 weeks of an intervention that included 20 hour-long private sessions with a therapist and assignments designed to gradually increase the child’s exposure to speaking in feared settings—mainly school. Therapists worked closely with teachers and parents, who were taught how to continue to help the child once the experiment was over. Independent evaluators, who did not know which kids had the intervention, rated their progress.

After 12 weeks, a quarter of the chil-

elements of cognitive-behavior therapy can help older kids learn to use reason to make their fears seem more manageable.

When school got under way this fall, Cindy’s parents were pleased with her progress. “She’s initiating conversation with her teacher,” her mother says. “That didn’t happen last year.” For Evan, progress is slower. “When we walk into school, he’s saying, ‘Hey, everybody,’ to the kids and has his rambunctious, easygoing personality,” Susan reports. “Then when we say, ‘Gotta go, have a great day, love you,’ that’s when he stops talking. He’s missing out on so much of school, and [his teachers] are missing out on so much of him.”

Few studies have followed children with selective mutism throughout childhood and adolescence, so no one can say, with authority, how long the disorder typically lasts, what

percentage will remain socially anxious or what traits predict a good outcome. One point does seem clear: training teachers, special education personnel and speech and language specialists to better recognize selective mutism and to intervene more effectively could help many children. Once they have begun to speak, most remain timid, but for others, Bergman says, “it’s almost like they’ve had the flu. They go on to be the most gregarious people, and you can imagine that years later their families will say, ‘Oh, my gosh, remember when Mary didn’t talk?’” **M**

Some kids go on to become quite gregarious, Bergman says. She can imagine their families saying years later,

“Oh, my gosh, remember when Mary didn’t talk?”

of each day, they could pick a big or small prize depending on how many points they had racked up.

Psychologists at N.Y.U. and elsewhere typically treat selective mutism with a modified version of therapies shown to be effective for other anxiety disorders and phobias. First they encourage kids to speak with parents in a clinical setting and eventually to speak with the therapist. In close collaboration with teachers, they gradually move the child through a hierarchy of behaviors—from nonverbal exchanges to mouthing words to whispering and then using a full voice—in circumstances where he or she would ordinarily be mute. They also work on widening the circle of people to whom the child will speak. At school, for example, teachers may be coached to permit silent nods, then one-word answers prompted by simple, limited-choice questions (such as “Is the answer 5 or 7?”). Along the way, kids earn rewards for speaking up. The idea is that gradual exposure to speaking will defang their fears.

In 2013 Bergman and her colleagues published a study on this type of treatment. She divided 21 children with selective mutism, ages four to eight, into two groups. One group was placed on a 12-

week waiting list. The other group received 24 weeks of an intervention that included 20 hour-long private sessions with a therapist and assignments designed to gradually increase the child’s exposure to speaking in feared settings—mainly school. Therapists worked closely with teachers and parents, who were taught how to continue to help the child once the experiment was over. Independent evaluators, who did not know which kids had the intervention, rated their progress.

## Getting Results

In Gallagher’s experience, the children who respond fastest to therapy are those who are social, despite the disorder. “They look like they want to be involved with other kids,” he says. “They play, they use a lot of gestures, they have friends.” More challenging are those who have some features of autism and lack motivation to engage with others and youngsters with symptoms of a broader social anxiety who appear distressed or uncomfortable even when playing. Several studies have shown that some children improve when given a selective serotonin reuptake inhibitor such as Prozac, which reduces anxiety. Adding

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# WOMEN ON THE

# EDGE

What's the best way to address gender disparities in science and technology?  
Focus on the positive

**By Laura Di Bella and  
Richard J. Crisp**

*Illustration by* **RAUL ARIAS**



## Much recent debate has focused on the fact that scientific and technical careers are still dominated by men.

Although many women begin their studies in these fields, their numbers drop at every stage of educational and professional advancement. At the undergraduate level in the U.S., about half of all students are women. Yet in the fields of science, technology, engineering and math—STEM for short—women account for only 39 percent of bachelor's degrees and 35 percent of Ph.D.s. At the end of this leaky educational pipeline, only 27 percent of the people working in STEM-related occupations are women.

Educators and policy makers have deployed various strategies to encourage women to stay in STEM careers, but the effectiveness of these campaigns could be improved. Measures to increase the number of women in these careers typically center on the barriers, biases and stereotypes that discourage them—a so-called prevention focus. The obstacles can be formidable, but emphasizing only the negatives can be demoralizing. Psychology studies find that when students feel that life events are out of their control, their performance suffers. Similarly, teaching women about the cognitive burden of stereotypes without giving them tools to overcome these challenges can be counterproductive, harming their performance.

In contrast, our research in behavioral science suggests that acknowledging burdens and barriers while emphasizing the potential benefits of pursuing a scientific career—a promotion focus—can help women develop effective cognitive strategies to cope with the challenges they face in STEM fields. A promotion focus encourages a new type of flexible thinking that can change the way women perceive their own careers. This thought process also stimulates creativity, which ultimately will help them flourish in scientific and technical careers. What is more, the evidence from our studies and those of other inves-

tigators shows that a diverse workforce will foster innovative ideas from men and women alike.

### Learning from Behavioral Science

Research in social cognition reveals that focusing on the benefits of a career can counteract a well-known effect of bias: the psychological phenomenon of stereotype threat. Even brief reminders of a commonly held stereotype—in this case, the idea that women are inherently less talented in math and science—can actually degrade performance.

In a 2012 study at Leiden University in the Netherlands, psychologists Tomas Ståhl, Colette Van Laar and Naomi Ellemers told female students they would be doing a task that tested gender differences in math skills, an instruction designed to elicit stereotype threat. Before turning to the task, the students were asked to solve a pencil-and-paper maze on behalf of a cartoon mouse. If the participants were told the mouse was at risk of being captured by an owl—that is, encouraged to enter into a prevention-focused mind-set—their math performance suffered. On the other hand, if they were encouraged to help the mouse reach a piece of cheese—a promotion focus—the stereotype threat had no impact.

Recent findings can help foster this beneficial mind-set. A new psychological exercise in thinking about professional gender roles indicates that if women persevere in careers in science, engineering and math despite the obstacles, they may ultimately improve their cognitive performance and develop more flexible thinking. In fact, the very same challenges that women face when confronting stereotypes may in the long run encourage creativity and cognitive resilience.

To better understand how this capacity develops, try this exercise: Imagine a female nurse. What words would you use to describe her? You might think of adjectives such as caring, empathetic and nurturing. Now picture a female engineer and the words you would use to describe her. That exercise would probably require more mental effort.

Over time this cognitive exertion may change the way you think. In a 2011 article in *Psychological Bulletin*, one of us (Crisp, along with co-author Rhiannon N. Turner) proposed that the mental effort of imagining someone behaving in non-stereotypical ways can actually make the mind stronger and more resilient. Just as the body eventually adapts to increased physical demands so that muscles become more powerful, the mind adjusts to the burden of deflecting stereotypes and becomes more efficient, improving cognitive performance.

A growing body of research supports this idea. Interventions that encourage people to challenge stereotypes also foster lateral thinking—the use of indirect and novel approaches to solving problems—along with general creativity and mental flexibility. In a 2013 study conducted by Crisp and psychologist Milica Vasiljevic, now at the University of Cambridge, participants wrote down five pairings of gender and occupation that either

#### FAST FACTS

##### THE BENEFITS OF STAYING WITH STEM

- 1 For women, science and engineering are leaky pipelines: although many start out studying these subjects, they tend to leave these careers because of bias and isolation.
- 2 Despite the obstacles, pursuit of careers in STEM fields may provide women with unique cognitive benefits, such as increased creativity and flexible thinking.
- 3 A promotion-focused mind-set emphasizing these advantages can help women overcome frustrations and stay in STEM careers—to the benefit of all.

#### THE AUTHORS

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# 3 BIG THREATS

Social science has identified three factors that contribute to an inhospitable environment for women in STEM fields:

## 1. The Math Myth

One popular explanation for the lack of women in STEM fields blames supposedly inherent gender differences in math and science proficiency. This observation is not very well supported by data. Instead gender differences in math performance are closely correlated with overall social markers of gender equality. For example, nations with a larger proportion of female parliament members also have a smaller gender gap in math performance.

## 2. Stereotype Threat

In this well-documented phenomenon, the widespread belief that women are inherently inferior to men in science and math can itself handicap women's performance. Research finds that women know that they are not expected to perform as well as men and that other people may evaluate their performance according to this stereotype. This knowledge burdens women with additional cognitive demands, increasing the stress of test taking and hampering performance.

## 3. Implicit Bias

The unconscious, automatic devaluation of women's abilities and contributions is pervasive at every step in the career path. For example, one recent study demonstrated that STEM faculty members judged job application materials from a potential female applicant more critically than when they were given identical materials and told the applicant was male. The male candidate was perceived as more competent and more employable. Research finds that academic scientists may see female doctoral students as less committed to academic careers than their male counterparts, and both experimental studies and citation surveys indicate that researchers consider established female scientists to be less appealing collaborators and perceive publications by them to be less worthy of citation.

conformed to stereotypes (for example, female nurse) or did not (female mechanic). Those who had to stretch their minds to come up with less predictable combinations, such as female firefighter or male midwife, subsequently stigmatized others to a lesser extent, as measured by their choices on a questionnaire. They also showed superior lateral thinking. For instance, they were more likely to correctly answer the question "If a plane crashes on the Italian-Swiss border, where do you bury the survivors?" (Solution: you don't, because the survivors all survived.)

If merely thinking against stereotypes can stimulate creativity and mental flexibility, what about actually living a life that defies

gender conventions? In a 2008 study Chi-Ying Cheng of Singapore Management University and Jeffrey Sanchez-Burks and Fiona Lee, both at the University of Michigan, found that female engineering students who were comfortable with their dual identities performed better on a creativity task (designing a mobile communications device targeted at women) than those who struggled to integrate these two roles. The finding suggests that women who challenge stereotypes in their educational and career choices might develop precisely the cognitive skills that are highly valued in STEM fields, such as innovative and flexible thinking. Indeed, a 2011 analysis by Catalyst, a research and advisory organization focusing on women's issues in the workplace, found that companies with a higher percentage of women on their boards have better financial performance and improved cost efficiency.

## A New Way to Encourage Women

These insights from behavioral science could inspire a wave of promotion-focused campaigns to improve the retention of women in STEM fields. Policy makers, the media, universities and recruitment teams could send a positive message to young women considering a career in science by highlighting the rewards to be reaped, such as high incomes and a relatively small gender-based pay gap. Educators could also emphasize the potential cognitive advantages associated with choosing counter-stereotypical career paths.

Focusing on positive outcomes can nurture the confidence and inner drive to excel that are so clearly major components of success. Publicizing research on the benefits of a promotion-focused approach could motivate women to choose career paths precisely because they defy stereotypes. As this research reveals, women will not be the only ones to benefit: accepting women in roles traditionally assigned to men can encourage everyone to think against stereotypes, improving creativity, originality and mental flexibility for all. **M**

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# PATIENTS HELPING PATIENTS

People who have suffered from mental illness are increasingly recognized as a resource in caring for others **By Karen Weintraub**



**On a February day 15 years ago** Paul Bradford took himself to a local emergency room. Bradford felt agitated and confused; he and his wife thought he needed professional help. To his surprise, two large men came into the waiting room, grabbed him by the arms and hustled him into a treatment room. Petrified, Bradford asked his wife to stay with him, but he says the security guards forced her out, tied him to a gurney and gave him a sedative that knocked him out for 18 hours. He awoke in a locked ward, where he was kept for more than two weeks.

Bradford's doctor diagnosed him with manic depression. Although he has not had an episode since this incident, the care he received as a psychiatric patient left permanent scars. "The experience of mistreatment," he says, "was far more of a trauma to me than the mental illness." Instead of forcible psychiatric treatment, Bradford believes what he really needed was someone to comfort him through the terrors of his psychosis and help him get some restful sleep.

His experience made him so angry that he abandoned a career as a computer programmer with a \$75,000-a-year salary for an entry-level position as a mental health peer counselor, where at first he made less than \$12,000 for part-time work. Still, delivering the kind of care he wishes he had received has been therapeutic. "It was the smartest move I ever made," says Bradford, now a full-time peer specialist at a psychiatric firm.

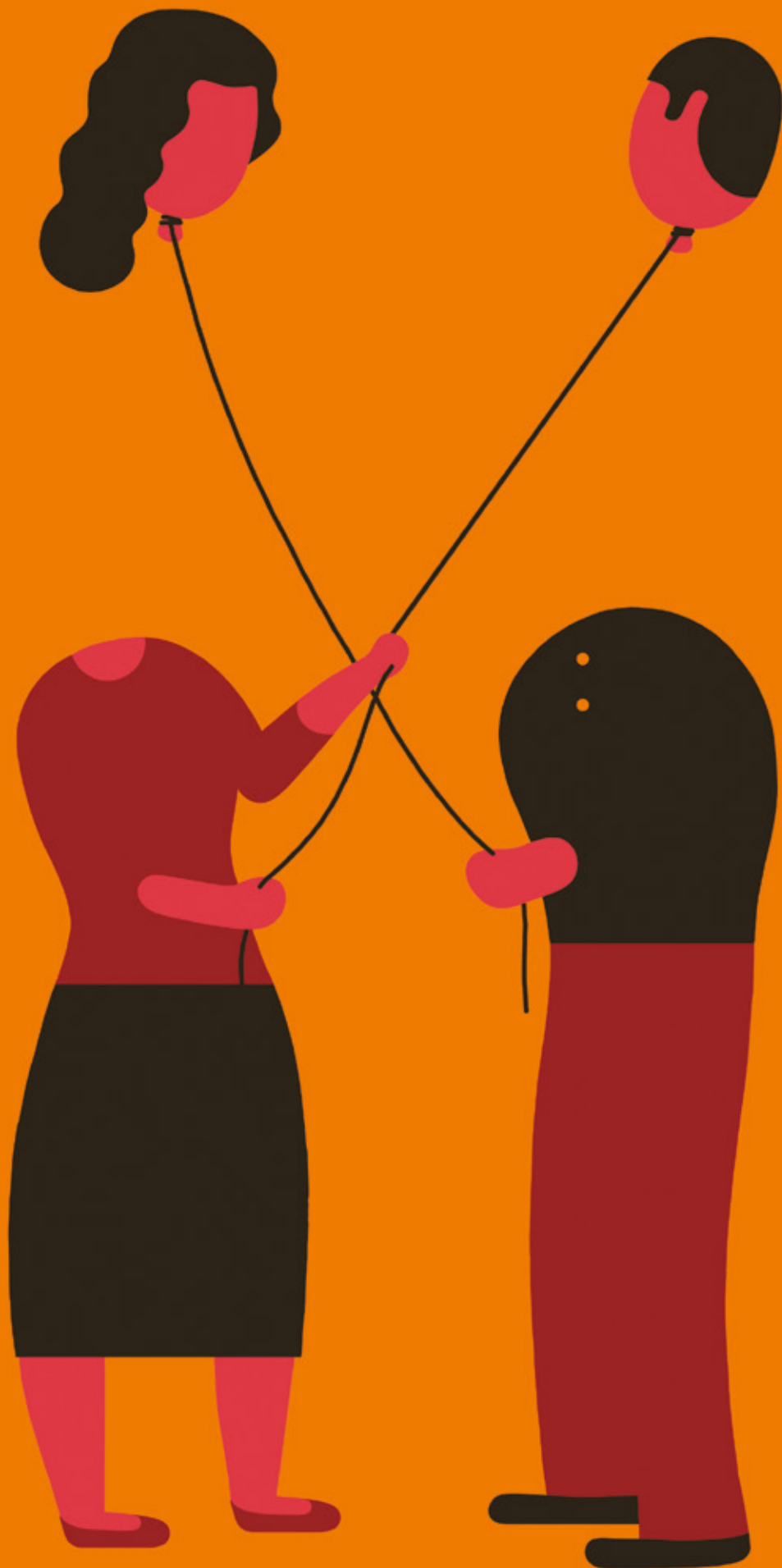
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## FAST FACTS

### PATIENT, HEAL THYSELF

- 1 Individuals previously diagnosed with mental illness who assist other patients postrecovery are increasingly common participants in treatment.
- 2 Inconsistent standards and ill-defined roles, however, have posed difficulties in evaluating the impact of peer specialists.
- 3 Nevertheless, peer care is encouraging mental health professionals to rethink treatment in a more inclusive way, inviting patients into the process.

Illustrations by **MÁGOZ**



Peer specialists such as Bradford have been providing mental health care since the early 1990s, when a few community health centers started hiring former patients who had spontaneously been counseling their peers. These former patients (who also go by “peer counselors” or “peer supporters”) act as coaches, advisers and mentors to people who are struggling or facing hospitalization.

Although peer specialists encountered a lot of hostility in the early days and their acceptance is still mixed, they are now a routine part of mental health care. In several states, Medicaid reimburses for their services, and most major mental health providers have at least one peer specialist on staff. Yale University psychologist Larry Davidson, who has studied this practice, says that peer specialists seem “to provide a pathway for people who would otherwise not have engaged in care and who would otherwise not have benefited from the treatment.” And in the process, the presence of peer specialists challenges the traditional model of mental health treatment.

### First, Do No Harm

When peer specialists first began to participate in care, many clinicians doubted their benefits. Therapists worried that allowing people with mental health diagnoses to coach others was unsafe. Health care workers feared that peer specialists lacked sufficient training and might even be a bad influence on those in treatment, teaching people how to evade the system.

Early investigation allayed some of these fears, finding no significant downside to peer specialists. Gradually some researchers even found benefits—for both patients and peers. In a 1998 six-month pilot study in Pennsylvania, 10 severely mentally ill people who had peer counseling in addition to intensive case management experienced fewer crises and were significantly less likely to be hospitalized than 51 other individuals who received only intensive care. People with peer counselors also reported better quality of life and improvements in their physical and emotional well-being.

In addition, counseling seemed to help the peers themselves. This is perhaps not surprising, given the fact that helping a fellow sufferer is a long-established principle of many recovery approaches focused on addiction, such as Alcoholics Anonymous. In a 1991 study 15 people who served as peer specialists for two years spent only two days during that time period as hospitalized patients—a rate far lower than most people that are diagnosed with serious mental illness. Indeed, the satisfaction that individuals in recovery can obtain from helping others informally often prompts them to pursue part- or full-time positions as peer specialists.

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#### THE AUTHOR

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Bolstered by these early findings, the movement quickly took off. Experts at the International Association of Peer Supporters estimate that there may now be some 12,000 peer specialists in the country.

### Unanswered Questions

Today peer specialists coach people receiving treatment in three basic ways: as an addition to existing services, as substitutes for clinical staff and instructors, and as teachers. In different settings the nature of their involvement varies. Typically a case manager will assign peer support to individuals who they believe could benefit from someone’s guidance. Yet much about their role remains undefined.

A qualitative investigation from 2014 by researchers at the Center for Health Policy and Research at the University of Massachusetts Medical School suggested that this ambiguity could be problematic. The team interviewed 44 peer specialists, 14 of their supervisors and 10 people diagnosed with mental illness whom a peer specialist was counseling. The specialists described themselves as being in a position to bond with a client and aid in recovery by sharing common experiences.

The researchers also found, however, that peers were unsure of their place in the system—and supervisors did not know how to guide the peer specialists in their charge. Although many states have certification requirements, no national standards exist for training or evaluating peer counselors. Such ambiguity heightens the tension between people who have long been a part of treatment and these relative newcomers.

The nebulous nature of the peer specialist’s role has led some advocates to question whether mental health agencies



might abuse this system. Activist and filmmaker Sera Davidow, director of the peer-run Western Massachusetts Recovery Learning Community, suspects that peer specialists are increasingly hired to be coercive voices in the treatment process. She believes that conventional treatment providers rely on peer supporters to earn the trust of and draw information from reluctant clients.

Another unresolved question involves cost. Peer specialists could either add to the expense of mental health care by teaching people how to use more services or save money by prevent-

## **Adding a peer specialist to the therapy team may reduce hospitalizations, improve the patient's social functioning and elevate overall quality of life.**

ing hospitalizations. Most peer supporters are part-time staff employed by a health care provider, and they may earn anything from zero to \$70,000 a year. And in certain cases, peer support is being used to provide cheaper care than offered via a traditional specialist.

As a result, evaluating the overall efficacy of peer care is difficult. A 2013 review from the Cochrane collaboration, a nongovernmental organization that evaluates medical research, explored the use of peers working in professional roles or whose services were added to traditional treatments. Across 11 experiments, they found no significant differences in most measures of success between people who had worked with peer specialists and study participants who did not have peer support. Yet these findings may reflect the fact that the methodology of the studies, according to the reviewers, was of “moderate to low” quality, with many studies failing to control for the possibility of bias in the subjects’ reporting.

In 2014 a group of researchers led by Matthew Chinman of the U.S. Department of Veterans Affairs came to a more positive conclusion. Although their review of 20 studies also uncovered research weaknesses, Chinman and his colleagues found that in most cases, adding peers to traditional services delivered more benefits than traditional services alone. The advantages included reduced hospitalization, better social functioning and improved quality of life. Peers who led six- or eight-session classes generally helped their participants with recovery, job readiness, communication and assertiveness, according to four studies considered in the review.

The contradiction between these reviews underscores the pressing need for more rigorous research and perhaps clearer guidelines for the practice of peer specialists. In the interim, it seems clear that peer specialists are not dangerous to the patients whom they serve—although they may pose a challenge to the status quo of mental health treatment.

## **Treatment Revolution**

Sitting in the meeting room of an old Masonic Lodge, Bradford leans forward and asks his client: “What was the most important information that you needed to know?” He is interviewing a woman recovering from profound depression. The two are surrounded by some 20 people who make up her care team, assessing how they had done now that her treatment was nearing its end. Bradford sticks out compared with most of the doctors and specialists. He is physically bigger than the others, and in contrast to the measured, quiet manner of most of the “professionals” in the room, he speaks loudly and with great urgency and passion.

His presence in the circle—and the patient’s—illustrates a paradigm shift in treatment. Until a few years ago, Prakash Ellenhorn, the psychiatric firm where Bradford works, had not thought to include patients in such meetings about their care. But once a peer specialist became part of the team, including the client seemed logical, according to the firm’s co-founder, psychotherapist Ross Ellenhorn. Peer specialists such as Bradford forced the rest of the staff to confront a tendency toward us-versus-them thinking about clients, Ellenhorn says.

Even if much about peer specialists still needs to be standardized, the movement could nonetheless encourage a wholesale rethinking of the way mental health care is delivered and even how people think about mental health. People who are diagnosed with mental illness often get the message that they are permanently damaged and, in some sense, beyond recovery. Peer specialists by definition contradict that hopelessness and the stigma it entails. They have bounced back enough to be able to help others.

Even at an enlightened place such as Prakash Ellenhorn, Bradford must still occasionally remind his professional colleagues that their clients experience the mental health system differently than they do. Although doctors and health workers are often ready to declare victory when they have been able to alleviate a client’s unusual behavior, Bradford knows from experience that their job is unlikely to be over. “You can’t just say, ‘You’ve stopped howling at the moon, so I’m satisfied,’” he declares. “They have to have a life worth living.” **M**

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# CONSCIOUSNESS AS ART

Our subjective experience of the world may be like  
a visit to a gallery where the artist is our brain

**By Nicholas Humphrey**

ILLUSTRATIONS BY JON HAN



Consciousness matters to us. Many would say it matters more than anything. We relish the beauty of a winter sunset, the memory-fueled comforts of a homecoming, the inviting caress of a lover's hand. Conscious sensations lie at the core of our being. Without access to this marvel, we'd be poorer creatures living in a duller world.

Yet the fundamental nature of consciousness remains a scientific mystery. The problem is not that we do not understand consciousness at all: some aspects of it are relatively easy to explain. The problem is that one aspect of it continues to baffle everyone, and that's the "feel" or "phenomenal character" of consciousness—or, as philosopher Thomas Nagel has put it, simply "what it is like." Biologist H. Allen Orr probably speaks for most scientists when, in a recent review of Nagel's book *Mind and Cosmos*, he writes: "I... share Nagel's sense of mystery here. Brains and neurons obviously have everything to do with consciousness, but how such mere objects can give rise to the eerily different phenomenon of subjective experience seems utterly incomprehensible."

Theorists tend to fall into one of two camps. Some assert that the manifestly eerie and ineffable qualities of subjective experience can only mean that these nonphysical qualities are inherent in the fabric of the universe. Others, including me, are more suspicious. They argue that consciousness may be more like a conjuring show, whereby the physical brain is tricking

#### FAST FACTS

##### THE GRAND ILLUSION

- 1 Debate rages as to whether the qualities of conscious experience can be explained simply as the workings of the physical brain or whether there must be an additional ingredient of a nonphysical kind.
- 2 Considering consciousness to be an illusion—a mere trick of the physical brain—offends people, so perhaps we should think of consciousness as art instead. Whereas people resent being duped by illusions, they are proud to be art lovers.
- 3 If our brains have evolved to create masterpieces of consciousness for our private enjoyment, scientists will want to know what the evolutionary payoff is. Perhaps the purpose of this brain art is to make people fall in love with themselves—and other people, too.

people into believing in qualities that don't really exist.

But no one wants to be told the latter story! So I am going to try telling the story in a different way. While I believe consciousness may indeed be a stage trick by the brain, I want to suggest that it is also a stroke of artistic genius. Consciousness as art is surely a more palatable notion than consciousness as illusion. I am not just looking to make friends for a theory that may be hard to swallow; I also want to influence the further questions scientists ask.

### The Experience of Pain

Suppose you prick your thumb. Your brain responds to signals from the thumb with an internalized hurt response, the neural correlate of pain. From an objective point of view, this response is nothing more than the activity of nerve cells. From your subjective point of view, however, this experience seems to be nothing less than—well—conscious pain.

Yet how can this transformation possibly occur? How can there be physical matter on one side of the equation and non-physical consciousness on the other? Philosophers talk about the existence of an "explanatory gap" here. As Colin McGinn has put it, "You might as well assert that numbers emerge from biscuits or ethics from rhubarb."

I am a scientist. But when the philosophical skeptics put it like that, I agree they may be right. You really can't get numbers from biscuits, and you really can't get pain from nerve cells, at any rate not if the pain is conceived of as some kind of alchemical substance exuded by the brain.

But what if this is simply the wrong way to conceive of pain? What if pain is nothing other than your "inner picture" of the neural activity? And what if this picture is actually pure make-believe—part of your brain's internal conjuring show?

These are some big what-ifs, and we should tread carefully. I may be convinced that some such explanation must be true, but other theorists treat the idea with incredulity and even scorn. British philosopher Mary Midgley has entitled her latest book *Are You an Illusion?* Her answer is to pinch herself, feel the reality of the sensation and say, in effect, "Don't be daft."

Midgley balks at the suggestion she is an illusion because she takes it to imply she is some kind of mistake. But let's try telling the story in another way. How about suggesting that when you see red or taste a lemon, your brain is creating something like a cubist painting—not necessarily a misrepresentation but an artistic *re*-presentation of the facts? Would Midgley feel better if she could be persuaded that she is actually a remarkable work of art?

### Consciousness, Defined

Let's step back so we can place this new idea in the context of consciousness in general. The "eerily different phenomenon" to which Orr drew attention may still prove to be the sticking point. But we should not assume at the start that everything about consciousness is impossibly difficult. Indeed, the first steps toward a scientific understanding are straightforward and have already been taken.

## The subjective quality of consciousness seems to defy explanation. Why does the sound of a trumpet or the pain of a bee sting feel to you the way it does?



We should begin with a definition. Although opinions differ, I think it is helpful to start by describing consciousness simply as introspective access to mental states. That is to say, you, the subject of consciousness, are conscious of mental states—perceptions, memories, wishes, and so on—just in so far as you know about them by looking in on your own mind.

Note that we encounter only one you here. When you feel pain, or you want breakfast, or you remember your mother's face, it's the same you in each case. This unity is not a logical necessity. It is theoretically possible your brain could have housed several independent versions of you, each representing a different module of the mind. Indeed, you may actually have started out this way at birth. As your life got going and your body began interacting with the world, however, the separate subjects soon became orchestrated as one. Your perceiving self, your remembering self, your acting self became merged into the one big you.

The unity of the self underlies the most obvious function of consciousness: namely to provide a mind-wide forum for planning and decision making. Your brain has brought information from different modules to the same table, as it were, to allow fertile cross talk. This integration opens the way for a central processing unit to recognize patterns, marry past and future, assign priorities, and so on. Computer programmers might call this central processor an “expert system,” rather like an intelligent autopilot. You call the onboard pilot “I.”

With all this activity happening on a single stage, consciousness has become something like a theater, where the engine of the mind is on show. You find you can reflect on what's going on. And this capacity for self-reflection supports a second important function of consciousness: to allow you to appreciate how your mind works. Observing, for example, how beliefs and desires generate wishes that lead to actions, you find your mind revealed as having a clear psychological structure. You

begin to gain insight into why you think and act the way you do: you can explain yourself to yourself and explain yourself to other people, too. What's more, you have a model for explaining other people to yourself. Consciousness has laid the ground for what psychologists call “theory of mind.”

So far so good. We have a definition, two important functions for consciousness and a suggestive metaphor, the theater of consciousness. We have not yet had to raise the question of illusion, and—for that reason perhaps—nothing about this account of consciousness seems completely incomprehensible. In fact, as readers of *Scientific American Mind* will know, neuroscientists are already making considerable headway in discovering how the brain could realize some of these features. Stanislas Dehaene of the Collège de France in Paris has been mapping what he calls “the global neuronal workspace.” Giulio Tononi of the University of Wisconsin–Madison has proposed a statistical model of “integrated information.” Christof Koch of the Allen Institute for Brain Science in Seattle (who is a *Mind* columnist and serves on the magazine's board of advisers) has identified a brain structure, the claustrum, as a likely candidate for the master of ceremonies.

### The Eerie Quality

Hold on, however. The picture that is emerging may not be incomprehensible but neither is it eerie. Where's the peculiar

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**The eeriness of consciousness changes your sense of who and what you are. It feeds your self-worth, your joy in life, your fear of death. Perhaps the evolutionary function of “consciousness as art” is to make you fall in love with the artist—yourself.**

is bizarre that brain matter should exude these phenomenal feelings. Consciousness is so vivid, and its properties appear so otherworldly, that it seems to call for God.” He may have been half-joking. But who’s laughing? Short of invoking some supernatural agency, where are we to go?

Most theorists now accept that only two options can be taken seriously, along the dividing line I sketched earlier. We can be realists about qualia, or else we have to be illusionists. Unfortunately, both options come at a considerable price.

Realists take qualia at face value. In their view, if your sensations appear to

what-it-is-like-ness that Nagel pointed to? Where’s the phenomenal quality philosophers beef about?

We should note that the quality in question does not pervade every aspect of consciousness. In fact (although not everyone agrees), I’d say this quality is not a feature of higher levels of cognition. There is no “what it is like” for you to have the thought that two plus two is four. Rather this quality seems to kick in only at a more animal level, in the way you represent what’s happening at your bodily sense organs. Of the variety of mental states of which you’re conscious, it is your sensations—and only your sensations—that have this peculiar dimension to them.

The special qualities of sensations are what philosophers call “qualia.” Although scientists don’t often use that term, there’s no denying that qualia present natural science with a spectacular challenge. Koch wrote to me not long ago that “it

have qualities that lie beyond the scope of physics, then they really do have such qualities. And these realists explain their reasoning by suggesting that the brain activity underlying sensations already has consciousness latent in it as an additional property of matter—a property as yet unrecognized by physics but one that you, the conscious subject, are somehow able to tap into. The price for this explanation is that it implies that the standard physical description of the world is radically incomplete.

Illusionists take the contrary line. If your sensations appear to have these qualities, then your physical brain is playing tricks on you. Your brain can pull off such magical effects because it houses a computational engine that deals in symbols, and physically based symbols can perfectly well represent states of affairs that do not and could not exist. The price for

this explanation is that it devalues not only the mystery but the majesty of the core experience.

## Art Rather Than Illusion

I belong, as I said, to the illusionist camp, and I've provided extensive psychological and evolutionary arguments for my position over the years. But even if illusionism is scientifically correct, I well understand why it is not the story many people want to hear. So now let me try sweetening the pill. Why might it be more persuasive if we were to talk about qualia as art rather than illusion? I am not proposing an alternative theory to illusionism, but my hope is that shifting the emphasis in a positive direction may in fact make the illusionist theory more scientifically acute and at the same time more humanly agreeable.

First, we generally consider illusions to be sources of error, but we think of works of art as sources of enlightenment. In Pablo Picasso's words, "Art is a lie that makes us realize truth." Or in Paul Klee's, "Art does not reproduce the visible; rather it makes visible." Or in Friedrich Nietzsche's, "Art is not merely imitation of the reality of nature but rather a metaphysical supplement to the reality of nature." Ellen Dissenayake, a writer on art and evolution, has characterized art in general as the activity of "making special." By likening sensations to works of art, therefore, we can emphasize how ordinary information from the sense organs is transformed and embellished on the way to consciousness.

Next, we tend to think of illusions as fortuitous or accidental, but we think of works of art as necessarily involving an artist. So now we can draw attention to the active agency behind conscious sensations. The immediate agent—if not the ultimate designer—is your own brain, when it responds to sensory information by creating the neural correlates of qualia. Neuroscientists do not yet know what these neural correlates amount to (although I have made some detailed suggestions in my book *Soul Dust*). But wouldn't it be revealing if your brain employed some of the same aesthetic principles that artists use?

Furthermore, as Marcel Duchamp said, "The artist performs only one part of the creative process. The onlooker completes it, and it is the onlooker who has the last word." Art necessarily implicates an audience. So now we can also draw attention to your self as the reactive and appreciative observer of the brain art. Moreover, drawing on what we know about art appreciation, we can go on to ask how you evaluate qualia, cognitively and emotionally. Are there individual differences in susceptibility to the illusory message? Do people learn to read qualia, as they learn to appreciate art? What does it take to become a qualia connoisseur?

Last and most important, we seldom regard illusions as having any human value, but we expect works of art to be intellectually and spiritually nourishing, good for our souls. We don't care to be dupes of an illusion, but we are proud to be art lovers. Thus, this way of thinking about sensations allows us to look out for—and celebrate—the psychological growth that human beings derive from participating in the self-made show.

## The Beauty of Consciousness

The chief scientific bonus of conceptualizing consciousness as art may prove to be precisely this: that it raises new questions for an evolutionist about the value and purpose of consciousness. If sensations are art, the artist behind them is actually not the individual brain as such. Rather the artist—the ultimate designer—must be the evolutionary forces of natural selection, which have contrived to put in place the genetic code for building the qualia-generating brain. Yet natural selection promotes only variants that contribute to biological survival. What then can be the biological advantage of a brain that delivers such awe-inspiring but seemingly superfluous flummery?

The analogy with art continues to help. Charles Darwin struggled to explain several of the more exotic features of animal courtship until he hit on the idea that such displays are designed not to serve any obvious utilitarian purpose but rather to show off—and to seduce. The peacock's gaudy tail does not enable him to fly any higher, but it raises his status in the eyes of the peahen. Darwin suggested that one of the chief functions of human art, too, is to induce the onlooker to fall in love with the artist.

Thus, an extraordinary possibility suggests itself: the evolutionary function of brain art is nothing less than to induce you to fall in love with yourself. The qualia of visual sensation, for example, are not necessary to your perception of the outside world, but—along with all your other sensations—they enlarge your sense of who you are. Qualia feed your self-worth, your joy in life, your fear of death. Nor is this idle speculation. In my book *Seeing Red*, I describe a remarkable case of a woman with a form of "blindsight"—vision without conscious qualia—whose sense of self seemed to be so damaged that she became suicidal.

French philosopher René Descartes famously intoned: "I think, therefore I am." But the self that evolves around sensory consciousness is deeper and more generous: I feel, therefore I am. Therefore you feel, and you are, too. Consciousness, by placing you at the center of this brilliant and perplexing work of art, encourages you to think of all humans as equally touched by magic. Thus, you end up, though by a different route, just where Midgley, Nagel and others want you to be: as centers of spiritual excellence, spreading the joy. **M**

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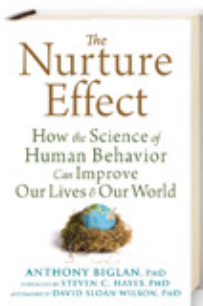
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BEHAVIORISM REDUX

**The Nurture Effect: How the Science of Human Behavior Can Improve Our Lives and Our World**

by Anthony Biglan. New Harbinger, 2015 (\$26.95)



Famed behavioral psychologist B. F. Skinner, my mentor in graduate school, died a happy man. From his hospital bed, he motioned to his daughter to pass him a glass of water, took a sip and said, “Marvelous”—his last word on earth. He had led a long, fulfilling life, and his impact on the behavioral sciences was perhaps unparalleled. There was good reason for his contentment.

Since that day in 1990, however, Skinner’s passionate ideas about the central role that behavioral science could play in improving human life seem to have faded away, overshadowed by advances in the cognitive and brain sciences.

Enter Biglan, a research psychologist at the Oregon Research Institute and one of the country’s leading experts on how to prevent behavioral and psychological problems in children and teens. In his new book, Biglan reviews a wide range of large-scale programs that have put behavioral science to work in tackling just about every problem you can imagine: smoking, delinquency, crime, teen pregnancy, family conflict, drug abuse, poverty—you name it.

While it may be neuroscience that makes the headlines, Biglan shows that behavioral science in its most basic form is the real workhorse in today’s developed world. In the early 1900s, propelled in their thinking by a new philosophy called pragmatism and a fairly new theory called evolution, scientists such as Skinner set about to discover principles of behavior that both revealed the orderliness in behavior and, more important, gave therapists, managers and public policy makers the tools they needed to engineer human behavior in positive ways.

Since then, Biglan says, thousands of behavioral scientists have been working out the details, and many have served as advisers to or directors of some of the most successful behavioral change projects in human history. “In 1965,” he writes, “over 50 percent of men and 34 percent of women smoked. By 2010, only 23.5 percent of men and 17.9 percent of women were smoking.” He documents similar achievements (albeit not always quite as spectacular) in dozens of areas in which behavioral science has been applied, often quietly and behind the scenes.

All in all, Biglan has given us a compelling read about what behavioral science has been doing for us lately and about the potential such science has for helping us solve new problems. Skinner was far from a spiritual man, but if he was wrong about such things and if he is indeed looking down from the heavens today, he has surely taken note of Biglan’s book and said, “Marvelous.” —Robert Epstein

Q&A

**Inside the Mind of the Undead**



The wait has been long, but the discipline of neuroscience has finally delivered a full-length treatment of the zombie phenomenon. In their book, **Do Zombies Dream of Undead Sheep?**, scientists Timothy Verstynen and Bradley Voytek cover just about everything you might want to know about the brains of the undead. It’s all good fun, and if you learn some serious neuroscience along the way, well, that’s fine with them, too. Voytek answered questions from contributing editor Gareth Cook.

**How is it that you and your co-author came to write a book about zombies? Clearly, it is an urgent public health threat, but I would not have expected a book from neuroscientists on the topic.**

Indeed! You think you’re prepared for the zombie apocalypse and then—BAM!—it happens, and only then do you realize how poorly prepared you really were. Truly the global concern of our time.

Anyway, this whole silly thing started when Tim and I would get together to watch zombie movies with our wives and friends. Turns out when you get some neuroscientists together to watch zombie movies, after a few beers they start to diagnose them and mentally dissect their brains. Back in the summer of 2010 zombie enthusiast and author—and head of the Zombie Research Society—Matt Mogk got in touch with me to see if we were interested in doing something at the intersection of zombies and neuroscience.

**What are some of the things you are able to explain with the help of zombies?**

We start with the obvious stuff: Why do zombies move with such a slow, unsteady gait? Why can’t they talk? Do they feel pain? We use those obvious questions as stepping-stones toward what we hope is a much more nuanced view of the modern neuroscientific understanding of how the three or so pounds of brain in your head can give rise to the complexities of the human experience. Each chapter tackles a specific behavioral trait relevant to zombies, including movement, hunger, emotions, speech and cognition. We wrote the book with the intent that it could serve as an introductory neuroscience text.

**Can you tell me what you learned about Haitian zombies?**

I learned that belief can be a very powerful thing. Well, belief combined with powerful neurotoxins and hallucinogens, anyway.

We go into detail in our book about the cultural roots of the Haitian zombie. The word “zombie” comes from an African root word *nzambi*, meaning “spirit of a dead person.” Within vodou, a priest (bokor) can sometimes be asked to take possession of the soul of a particularly troubled or threatening individual. The bokor induces “death” and separates the “little good angel” spirit (*ti bon ange*) from the body. Once “resurrected,” the physical body of the person is then forced to work at the will of the bokor.

An anthropological investigation by ethnobotanist Wade Davis postulated that the process of making a Haitian zombie is neuropharmacological, wherein bokors use a chemical found in many animals (especially puffer fish), called tetrodotoxin (TTX), to paralyze their targets and induce a near deathlike state. A sublethal dose of TTX allows the person to “die” and be “resurrected.” During the recovery, the victim is forced to consume *datura*, a plant that contains chemicals such as scopolamine and hyoscyamine, powerful hallucinogens that leave the individual delirious and compliant. *Datura* alters the victim’s state of mind, making the person easily coercible. The whole idea is fascinating. It sounds so far-fetched and unbelievable, but from a neuroscientific and psychological perspective, it’s not impossible.



## ROUNDUP

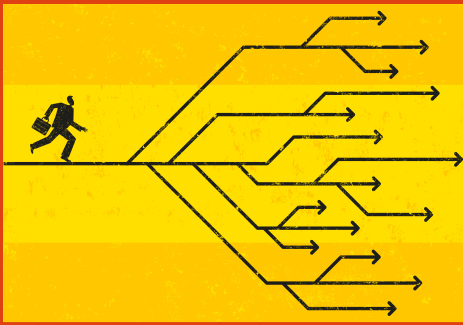
## CHOOSING WISELY

Three books explore how best to make the smartest choices

Choosing between colleges or job offers is challenging: one job may offer more prestige—seemingly the logical choice—but our gut seems to be pulling us in another direction. So which do we trust? In **Feeling Smart: Why Our Emotions Are More Rational Than We Think** (PublicAffairs, 2014), economics

professor Eyal Winter proposes that the best choices often come when we combine logic and emotion. Combining research on decision making, human behavior and evolution, Winter explores how our emotions interact with rational thinking. He finds that we can often trust our gut instincts to lead us to good choices and that our emotional reactions can work in our favor. In one study conducted by Winter, he found that our inclination to become angry actually increases when we can benefit from the emotion. “In other words,” he writes, “there is logic in emotion and often emotion in logic.”

Often, however, we are faced with group, not individual, decisions that involve and affect our loved ones, business and economic ventures, or social activities. In **Wiser: Getting beyond Groupthink to Make Groups Smarter** (Harvard Business Review Press, 2015), Cass Sunstein,



a professor at Harvard Law School, and Reid Hastie, a professor of behavioral science at the University of Chicago Booth School of Business, delve into the psychology of group decision making—why the hive mind can make mistakes and how to avoid those pitfalls. First, Sunstein and Hastie explain that instead of correcting errors in reasoning, the group voice may amplify mistakes or become divided on an issue, leading to

discord. The authors then offer advice to guide the group to better choices, by, for instance, giving quieter members a stronger voice or combining opinions and solutions from different individuals to forge new ideas.

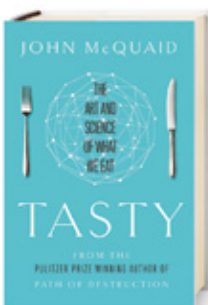
Still, much of our decision-making processes occur outside of our conscious awareness. In **Unthink: And How to Harness the Power of Your Unconscious** (Hodder & Stoughton, 2015), evolutionary biologist Chris Paley explains the interesting, sometimes bizarre, ways in which our unconscious mind influences our choice of friends, how we receive good news or even what foods we buy. Paley also offers advice on how to use this understanding of the unconscious to our advantage. For instance, he explains that you are more likely be asked out on a date if you discreetly mimic your potential mate's body language and speech.

—Victoria Stern

## BON APPÉTIT

## Tasty: The Art and Science of What We Eat

by John McQuaid. Scribner, 2015 (\$26)



In 1942 psychologist Edwin Boring published a 600-page tome on sensory perception that dispensed with the sense of taste in just 25 pages. With in that brief treatment, however, Boring managed to popularize what would become a widely embraced

scientific falsehood—that the tongue has distinct regions of flavor perception, neatly delineated like nations on a map.

Seven decades later we still do not know much about taste, at least compared with the other senses, writes author McQuaid in *Tasty*. The idea of exclusive taste zones was directly challenged in the 1970s, and in the 2000s the “tongue map” was finally debunked when

scientists confirmed that every one of our thousands of taste buds is equipped with molecular receptors for all five tastes—sweet, sour, salty, bitter and umami. McQuaid explores the growing scientific understanding of how the palate works and how it motivates both our ancient survival instincts and modern culinary fancies.

McQuaid makes a case for why taste is special among the senses. It is the most ancient of animal perceptions, most likely evolved from the earliest days of multicellular life. In mammalian fetuses, taste develops before all other senses. But its primitive nature perhaps has long made it less appealing as a subject of scholarly or scientific study. After all, the necessity of eating reminds us of our baser needs and our beastly origins, according to McQuaid. In Plato's *Symposium*, as he recounts, “guests gather for a banquet, but decline food or drink in order to keep their minds clear for the discussion on the nature of love.”

Moreover, unlike sound and light, physical forces that can be quantitatively measured, flavor is complicated by the vicissitudes of biology and chemistry that are still being untangled. Taste

involves much more than the tongue, research shows. Mice genetically engineered to be unable to discern sweetness still strongly prefer sugar water over plain water, hinting at unconscious cravings that bypass our flavor perception.

Our relationship with food is intimate and personal yet also public and cultural. Sensitivity to bitterness, for example, seems to be genetic—a mutation in the *TAS2R16* gene gives some people, known as supertasters, a more vivid experience of the tang, perhaps an evolutionary defense against natural toxins. But bitterness is also prized in cuisines worldwide—coffee, mustard greens, beer—and even supertasters can learn to love it.

An engaging writer, McQuaid takes his subject in unexpectedly wide-ranging directions, from the race to cultivate the hottest chilies to the quest to replicate an ancient Chinese beer. Along the way, you learn that dolphins and whales cannot taste anything but salt, and “chili pepper” is a misnomer coined by Christopher Columbus, after the unrelated black pepper. *Tasty* is packed with such fascinating tidbits—a pleasing sampling menu of a book.

—Nina Bai



## Can visualizing your body doing something, such as moving your arm, help you complete the action? What part of the brain is involved?

—Jim Lohr, Iowa

**Srini Pillay**, an assistant clinical professor of psychiatry at Harvard Medical School and author of *Life Unlocked: 7 Revolutionary Lessons to Overcome Fear*, responds:

Visualization and action are intimately connected, involving the motor cortex. Thinking about our body doing something—raising an arm or walking forward—activates the motor cortex directly.

Imagining allows us to remember and mentally rehearse our intended movements. In fact, visualizing movement changes how our brain networks are organized, creating more connections among different regions. It stimulates brain regions involved in rehearsal of movement, such as the putamen located in the forebrain, priming the brain and body for action so that we move more effectively. Even picturing others in motion warms up the “action brain” and helps us figure out what we want to do and how we can coordinate our actions with those around us. Over time the brain learns our routine movements, allowing these actions to become more automatic and fine-tuned.

Some people ask, “If my

movement brain is activated, why don’t I just move?” You do—but not right away. Initially when you imagine moving, your brain signals the motor cortex below the threshold necessary to prompt physical activity. Several factors affect whether this signaling is great enough to spark action.

Perspective is also important. When we visualize ourselves in the first person, for instance, we see only what is around us. But when we imagine ourselves in the third person, we can envision more specifically what our body is doing in a situation. Some studies show that imagining in the first person may activate muscles more powerfully than when we picture ourselves in the third person. It is also important for the action we imagine to be consistent and believable.

Overall, this ability to trigger the motor cortex by imagining an action offers great promise in therapies for patients recovering from stroke and for athletes or dancers working to develop expertise in their craft. But as we get older, the motor cortex has to work harder to imagine actions, so exercising our vi-

sualization skills remains important throughout our lives. Mirror neurons, located in different regions of the brain but especially the brain’s motor system, may also play a role in generating movement. Studies have shown that the same brain regions become active when a person performs a task and when a person observes someone carrying out a task. But mirror neurons may have an even more complex part than aping others’ movements; these neurons may help explain our capacity for empathy.

## Does introversion exist among nonhuman primates?

—Sue Napier, via e-mail

**Hani Freeman**, a research fellow in animal behavior at Disney’s Animal Kingdom in Florida, answers:

Evidence indicates that some nonhuman primates can be introverts or extraverts. In humans, introverts tend to spend more time alone focusing on their thoughts and less time engaging in group activities, whereas extraverts are often gregarious and enjoy interacting with their peers. Nonhuman primates also exhibit such qualities.

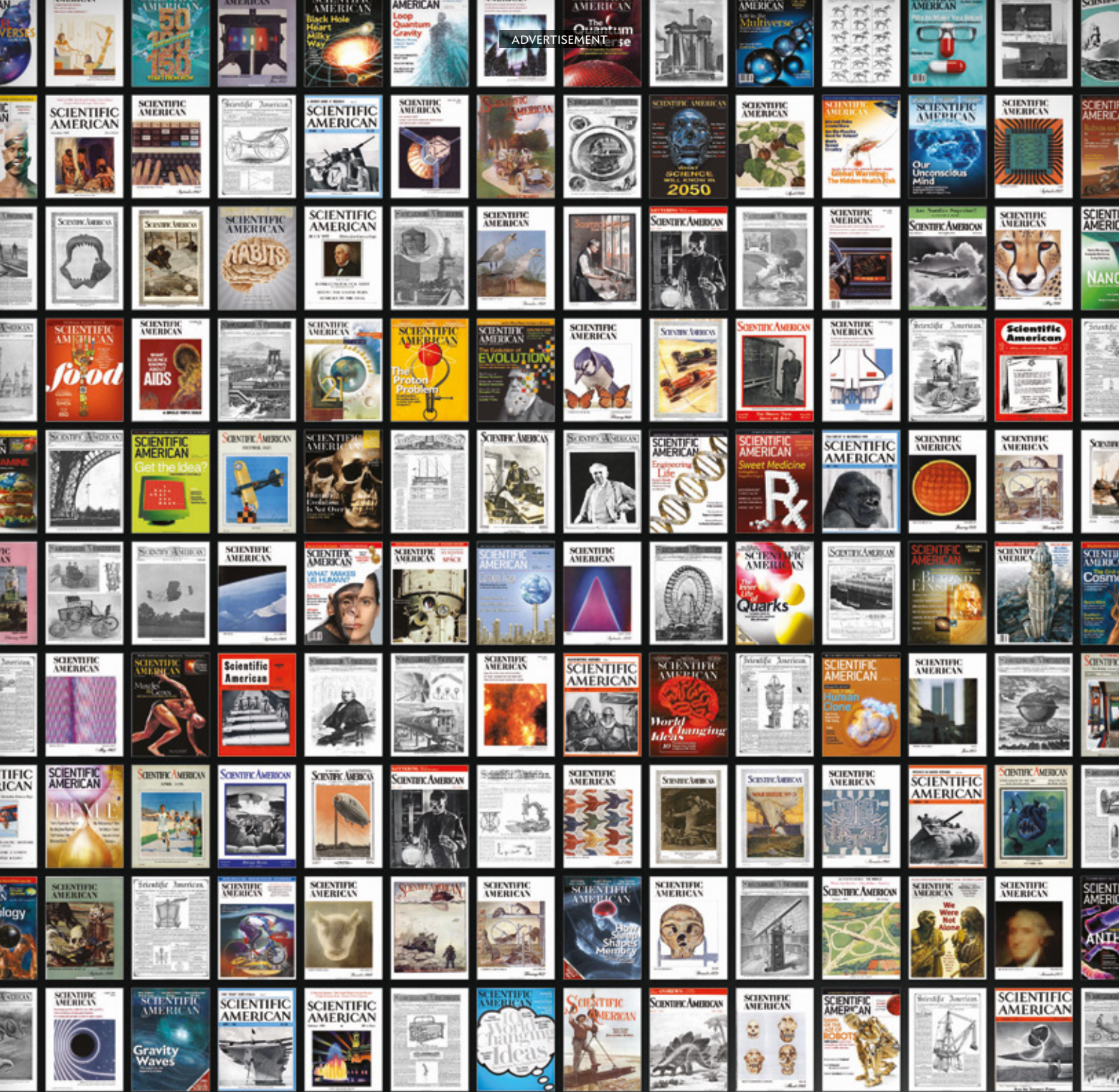
Recent studies have identified extraversion/introversion in great apes, including chimpanzees, gorillas and orangutans. Chimps exhibiting greater solitary and reserved behaviors are considered more introverted, whereas those that are more playful and interactive fall on the extraverted side of the spectrum. Extraversion/introver-

sion behaviors, such as sociability, have also been identified in species of monkeys.

It is important to note that we are limited in our ability to interpret the behavior of nonhuman primates. Apes can learn to communicate with humans to some degree, but overall, they cannot tell us how they feel, at least not to the extent that humans can.

Caregivers who work regularly with apes offer the best impressions of where apes fall on the extraversion/introversion continuum. In one study conducted at zoological parks around the U.S., caregivers rated specific traits, such as friendliness, on a scale from 1 to 5. Gorillas that caregivers classified as introverts also interacted less with their peers than did their more outgoing counterparts. To eliminate the potential for bias, independent behavioral experts have studied these traits in gorillas and have confirmed these findings from caregivers.

Although current research suggests that human and nonhuman primates exhibit many similarities in introversion and extraversion, research on personality in nonhuman primates is still at its early stages. We have only recently started to understand the advantages of being introverted, for instance. In humans, introverts tend to be better observers and listeners compared with extraverts. In nonhuman primates, however, researchers have not yet identified the advantages of introversion. Future work, scientists hope, will delve more deeply into such personality traits in nonhuman primates—how they evolved and why they are important. **M**



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1 FAUX QUOTE

An imaginary quote from Napoleon is coiled in the grid below. To spell it out, start with an "I" and move to an adjacent letter in any direction. Two letters will not be used. All the others will be used exactly once.

(Hint: The enumeration is 1'1, 5, 2, 6, 8, 5.)

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| O | S | R | O | M | I |
| E | H | A | T | G | O |
| S | V | E | L | E | I |
| X | V | E | N | T | N |
| X | N | I | O | T | G |

2 INTERLETTERED

Find the names of three countries intermixed below. The letters are in the correct order.

A L U H R U X N G E M E B  
N O U T R I G N G A R A Y

3 MEET YOUR MATCH

Arrange the nine matchsticks below to make "ten."



4 WORD SQUARE

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

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| A | A | C | O | M | E |
| E |   | O |   |   |   |
| L | L | M |   |   |   |
| S | S | E |   |   |   |
| S | S |   |   |   |   |
| V |   |   |   |   |   |

5 FILL IN THE BLANKS

All the following words contain the letters JUN. Using the definitions, fill in the words.

A lower professorial rank, also an addition to: \_ \_ J U N \_ \_

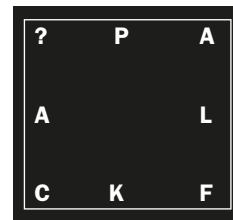
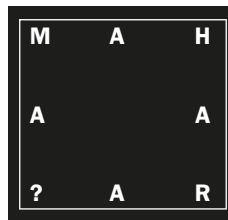
A person not legally an adult: J U \_ \_ N \_ \_ \_

A kind of berry or shrub: J U N \_ \_ \_ \_

A diary, a record of daily events: J \_ U \_ N \_ \_

6 WORD WHEELS

Find the eight-letter word spelled out in each box below by beginning with the correct letter and moving clockwise or counterclockwise around the box, using each letter only once. The question mark represents a letter that you must supply, which is the same for both words.



7 DO YOU KNOW DICE?

There are three dice shown below. One of them is not a genuine die. Which one is it?



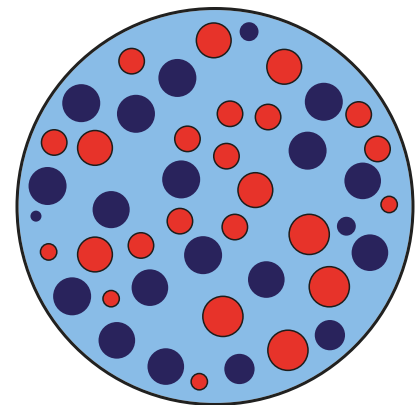
8 PUZZLING PATTERN

The center number in each square is the result of following a mathematical formula involving the numbers on the outside of that square. Figure out the formula to determine the number that should be in the center of the last square.

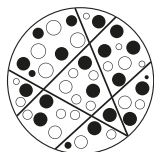
|    |    |    |    |   |   |    |   |
|----|----|----|----|---|---|----|---|
| 6  | 11 | 3  | 21 | 2 | 7 | 2  | 9 |
| 14 | 15 | 12 | ?  | 7 | 4 | 10 | 5 |
| 7  | 4  | 12 | 3  | 4 | 7 | 10 | 5 |

9 DIVIDE AND CONQUER

Use only four straight lines to divide the petri dish below into nine segments such that one area has one microbe in it, another area has two microbes, another has three, and so on, up to nine.



Answers



9.

6. MAHARAJA, FLAPJACK.  
7. Numbers that add to seven are always on opposite sides.  
8. Start on the upper right corner of the square, then add, then subtract and then add clockwise.

4. C O M E  
O V A L  
M A S S  
E L S E  
5. ADJUNCT, JUVENILE, JUNIPER, JOURNAL.

3. TEN  
1. I'm going to invent elevator shoes.  
2. LUXEMBOURG, HUNGARY, ARGENTINA.

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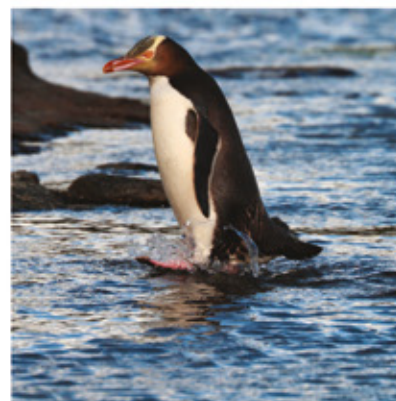


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**Edwin L. Turner, Ph.D.**  
**Jennifer Crocker, Ph.D.**



# FLYING BLIND

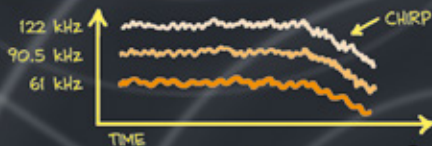
BY DWAYNE GODWIN & JORGE CHAM

BATS NAVIGATE THE NIGHT SKY USING ECHOLOCATION: THEY EMIT SOUND WAVES THAT BOUNCE OFF THEIR SURROUNDINGS AND BACK TO THEIR EARS.



TO SUPPORT THIS REMARKABLE SKILL, THE ANATOMY AND BRAINS OF SOME BATS HAVE EVOLVED SPECIALIZED FEATURES.

THEIR VOCAL CORDS EMIT PRECISE ULTRASONIC PULSES AT A SPECIFIC FREQUENCY AND ITS HARMONICS. EACH PULSE CONSISTS OF A CONSTANT PITCH, FOLLOWED BY A PUNCTUATING CHIRP.



IN THE BRAIN, SPECIAL AREAS IN THE CORTEX HAVE DEVELOPED TO PROCESS THE BIOSONAR:

THE FM-FM AREA USES THE RETURN TIME OF THE ECHO TO CALCULATE HOW FAR A BAT IS FROM THINGS.



OTHER AREAS SPECIALIZE IN DETECTING AND COMPENSATING FOR DOPPLER SHIFTS, OR CHANGES IN THE RETURN PULSE FREQUENCY.

SPECIAL STRUCTURES IN THEIR INNER EAR ARE TUNED TO THE SECOND HARMONIC OF THE EMITTED PULSE, MAKING IT SENSITIVE TO THE ECHO.



THIS AREA IS SO SENSITIVE, A BAT CAN PROCESS ACOUSTIC FEATURES LIKE THE WING BEATS OF INSECTS AND EVEN DETECT TEXTURES.

SOME INSECTS, SUCH AS CERTAIN MOTHS, HAVE EVOLVED A JAMMING RESPONSE TO BAT CHIRPS.



BY RUBBING THEIR GENITALS, THEY EMIT HIGH-FREQUENCY SIGNALS THAT DISRUPT OR CONFUSE THE BAT SONAR.

SOME BLIND HUMANS HAVE LEARNED TO USE THE BATS' VOCAL TRICK.



BY EMITTING SOUNDS AND READING THE SUBTLE ECHO INFORMATION, THEY CAN BETTER NAVIGATE THEIR WORLD.

SO THE NEXT TIME SOMEONE TELLS YOU THEY'RE "AS BLIND AS A BAT" (BATS AREN'T BLIND) ...



I HEARD THAT.

... TELL THEM THEY'RE JUST ECHOING AN OLD MYTH.

● 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](http://www.phdcomics.com).

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