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**MIND**

BEHAVIOR • BRAIN SCIENCE • INSIGHTS

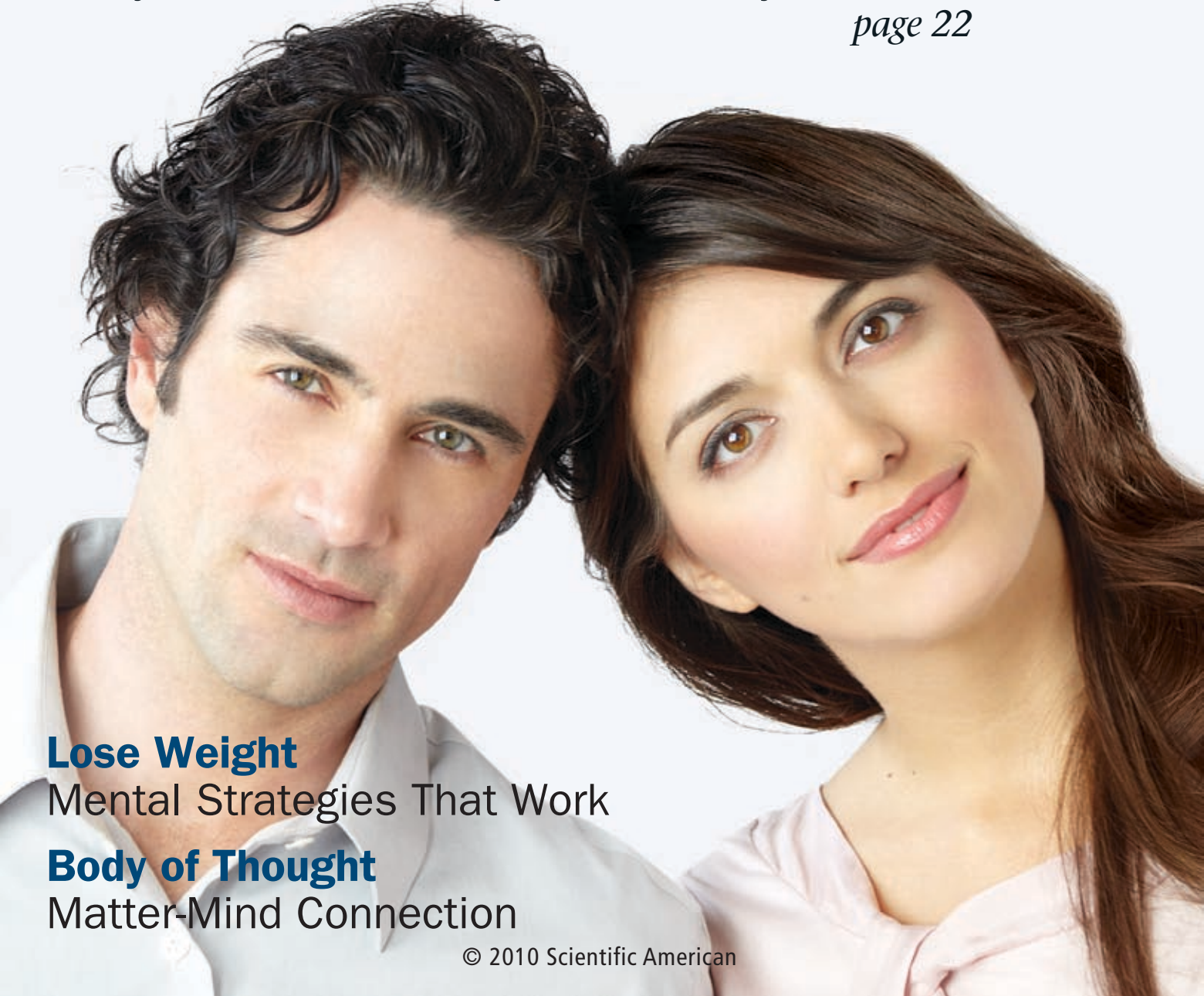
January/February 2011

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# Get Attached!

Find your attachment style and make your match  
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# SCIENTIFIC AMERICAN MIND

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## Together and Apart

In the six years since *Scientific American Mind* began, I've learned a lot about how the mind and brain work. No surprise there. What is startling is how some articles can still make me completely rethink things that I thought I knew.

One such piece is this issue's cover story, "Get Attached," by psychiatrist and neuroscientist Amir Levine and psychologist Rachel S. F. Heller, starting on page 22. The importance of attachment—a sound emotional relationship—between a child and a parent has long been well understood. Essentially, the more secure the emotional bond, the more able the child is to develop independence and head into the world successfully. Different types of attachment styles also predict behavior.

I had no idea, however, that attachment goes beyond the links between parents and children. Adults who set out to find romantic relationships, too, display different types of attachment styles—and those styles predict behavior with unnerving accuracy. An understanding of our own attachment style and that of our partner can also predict our eventual happiness in a given relationship. The important take-home message is that you don't have to leave your love life to chance: psychological science can help. When you are done reading the article, you can visit [www.ScientificAmerican.com/mind/jan2011/quiz](http://www.ScientificAmerican.com/mind/jan2011/quiz) to find a survey that identifies attachment styles.

Connections loom large for people, because humans are such social creatures. Getting along with others helps us succeed as individuals. What about the opposite—when a person is ostracized, or shunned, by a group? The sad result is pain that can be physical as well as mental, as psychologist Kipling D. Williams explains in "The Pain of Exclusion," beginning on page 30. The sting (which, in experiments, actually was lessened with pain reliever) is an evolutionarily helpful reminder to try to get along with others to enhance the odds of survival. As Ben Franklin, commenting about the likelihood of the Revolutionary patriots avoiding the noose for treason, wryly put it: "If we do not hang together, we will most assuredly hang separately."

Mariette DiChristina  
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COVER IMAGE BY AARON GOODMAN



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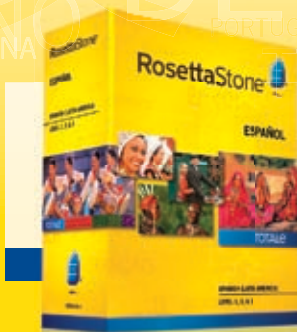
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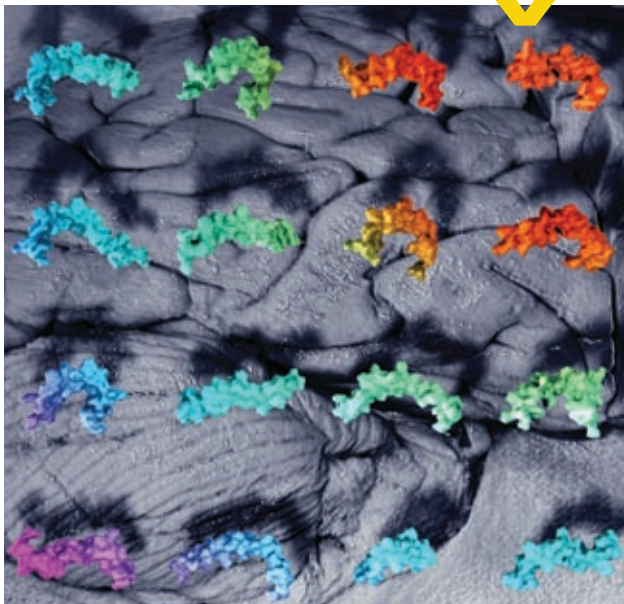
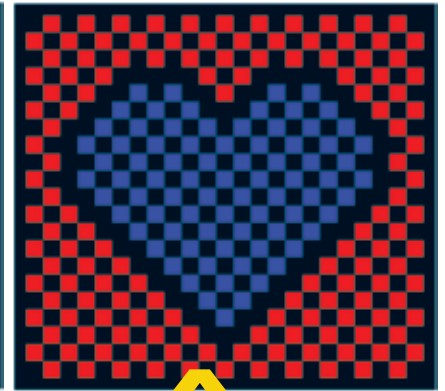
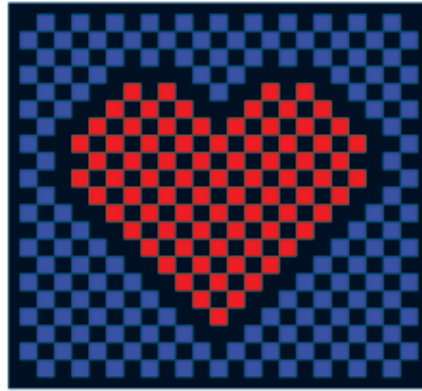
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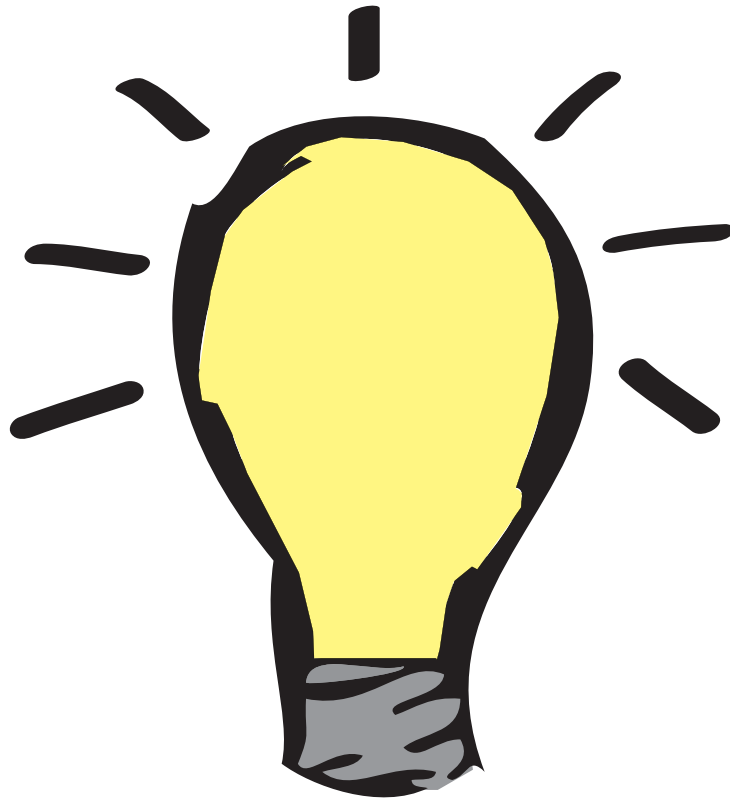
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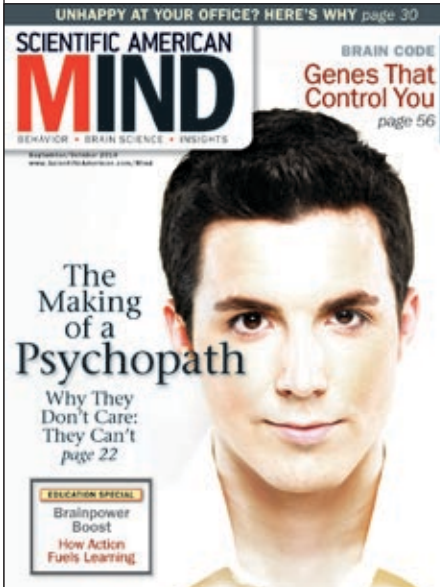
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### AN EMOTIONLESS MIND

**Thank you** for the balanced article on psychopaths ["Inside the Mind of a Psychopath," by Kent A. Kiehl and Joshua W. Buckholtz]. All too often I hear people with this condition referred to as monsters or with the Dark Ages moniker of being "evil." I have a good friend who has this problem, and it is heartbreaking to see such an intelligent young man have brushes with the law because he does not seem to have the ability to understand common social codes of ethics.

Let's hope that in the near future sensationalism will give way to understanding and research and that it will be possible to treat and prevent this condition.

**Alice**  
via e-mail

**Twenty-five years ago** I was working as a psychologist at a Texas state hospital and interviewed a 12-year-old boy. He was nine years old when he shot his best friend to death. He expressed no remorse.

By state law, he would be released on his 19th birthday with his criminal record sealed. With this loophole in mind, I would encourage mental health workers in state hospitals to advocate thorough screening procedures (including the Hare Psychopathy Checklist, Revised) to diagnose psychopaths early on

and provide them therapy and medication that will benefit them and protect the public later.

**Joe Roberts**  
Jackson, Miss.

### TOO TOUCHY-FEELY

**As a high school student**, I completely disagree with what was said in the article entitled "The World at Our Fingertips," by Derek Cabrera and Laura Colosi. When I was in elementary school, I absolutely hated any time that we used physical objects to learn a lesson. In geometry, for example, we would always have to use differently shaped blocks to learn about polygons, and I never had any clue what was going on until the textbooks got cracked open and I could read about it for myself. My worst subjects in school were the ones that teachers tried to make the most engaging through the use of "manipulatives."

I would have found the article more enjoyable if it had incorporated a few paragraphs about students who don't see any gains in learning when they use physical objects. As it was, I felt that the article was one-sided and shallow.

**Clare**  
via e-mail

### MATH PROBLEM

**How could a** scientific lay magazine like yours show a set of equations (in "Smart Jocks," by Steve Ayan, on page 42) that are nonsense? Don't your editors know that your readers are educated? Using that stock photo seems like really sloppy work that reeks of marketing, not substance.

**Tom Malzbender**  
via e-mail

### PHILOSOPHY COUNTS

**At one point in** "Reading between the Lines" [Illusions], Vilayanur S. Ramachandran and Diane Rogers-Ramachandran state that "the question of whether you actually 'see' the train's movement comes perilously close to being a philosophical one." I do not know whether they mean to imply that such philosophical questions are bad (at least





**Clinical psychologists spend hours working to understand their patients' problems. Can Dr. Laura perform a similar service in only a few minutes?**

in this context), but the comment does highlight one thing that is missing from your magazine: the perspective of philosophers working in cognitive science. I am a great fan of the magazine and enjoy all the fascinating articles and blurbs. But cognitive science is an interdisciplinary field, and I think that there are many philosophical questions that ought to be part of your coverage—not avoided as perilous.

**Benjamin J. Stenberg**  
Department of Philosophy  
Western Oregon University

**DEFENDING DR. LAURA**

**Are Hal Arkowitz** and Scott O. Lilienfeld serious when they infer that Dr. Laura's and Dr. Phil's callers and guests have "psychological problems?" Of course, such problems cannot be "changed by simple directives." But to conclude their column [Facts and Fictions in Mental Health] with that blanket statement is to infer that the two are practicing psychology without a license, as opposed to helping housewives and students (like myself) by utilizing their life experiences and opinions.

I find many faults with this article. One is the criticism leveled at Dr. Laura for not spending enough time with her callers. Obviously she finds it impractical to host only three guests during her three hour show, so she instead chooses to interact with several callers during her allotted broadcast time. In doing so, her millions of listeners are given the chance to hear her personal advice on several real-world situations.

Her trademark "lack of empathy," though perhaps not as helpful to the individual caller as the authors would like, illustrates problems and advice to listeners who are helped by the back and forth. In my opinion, Dr. Laura's directness with her callers is probably more helpful to those listeners than if she were indirect and more reassuring.

Dr. Laura also knows her limits and routinely advises callers on air that she cannot help them when they present her with a problem beyond her training and knowledge.

**Chris McDaniel**  
Riverside, Calif.

**THE AUTHORS REPLY:** *McDaniel's comment implies that people who call in to Dr. Laura's show do not suffer from psychological problems; however, the main reason for their calls is to seek help for marital and relationship difficulties, child abuse, domestic violence, eating disorders, and the like.*

*The reader argues that it would be "impractical" for Dr. Laura to spend more time with each caller given that she wants her listeners to hear her advice concerning many different problems. But Dr. Laura has chosen to spend little time with callers and, by doing so, offers strongly worded advice based on minimal information about callers and their problems. As a result, callers and listeners may come away from the show with the false impression that there are simple and easy solutions to*

*their complex life difficulties and may end up feeling guilty or hopeless, or both, if these "solutions" fail.*

*McDaniel falls victim to the very trap we cautioned readers against, namely, assuming that advice can only be helpful. As we noted, research suggests that advice given in a very directive way that is low in empathy is unlikely to be helpful and may even be harmful. Without systematic follow-ups of callers, there is no way to know whether Dr. Laura has helped or harmed her listeners.*

**SETTING THE RECORD STRAIGHT**

**What a kick** to have my book *The Twenty-four Hour Mind* reviewed in the September/October issue, especially alongside the excellent Charlie Rose brain series. I was not happy, however, to see some errors and misunderstandings in my review.

In the very first sentence, a strong finding that short sleep in humans leads to increased appetite, weight gain and higher rates of obesity is linked to results of an acute study of total sleep deprivation in rats. In that study three weeks of loss of total sleep was followed by rapid, untimely death. Luckily, humans are not rats, and readers will note the statement in the review that "less than six hours of sleep can lead to obesity and even death" mixes species.

Furthermore, the reviewer misunderstands the weight of evidence now supporting two psychological functions of sleep: the consolidation of new learning in long-term memory and mood regulation in dreams. These are no longer "hypotheses" about which sleep researchers disagree. They are both based on many well-designed studies by many different investigators.

I hope readers of this book will not mistake the facts (the results of the studies) with their implications (the discussion of their meaning). This is an important distinction to maintain not only in publications but also in their reviews.

**Rosalind Cartwright**  
Chicago

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>> MIND-BODY CONNECTION

## Toxic Together

Depression and heart disease are most lethal when combined

Clinicians have long suspected that depression worsens cardiac symptoms, but recent research suggests this combination is even more dangerous than previously believed. A study published in the journal *Heart* found that on any given day participants with both depression and heart disease were nearly five times more likely to die than their healthy peers. Depression alone doubled mortality risk, and heart disease increased risk by only two thirds.

The study authors evaluated about 6,000 subjects, employing statistical models to see if other factors, such as age and medication use, affected the results. Surprisingly, heart disease

became a relatively insignificant mortality risk once these other factors were accounted for, but the combination of depression and heart disease remained lethal. "It shows the pervasiveness of depression," says Martica Hall, a psychologist at the University of Pittsburgh and a study co-author. Indeed, studies indicate at least 20 percent of the 17 million Americans with heart disease also suffer from depression. The mechanism behind depression's lethality is unclear, but researchers surmise that inflammatory factors associated with the brain's stress response play a role.

—Erica Westly

JO TYLER

>> BELIEFS

## Why Smear Campaigns Work

People are more likely to believe misinformation about someone they see as different from themselves



We are often surrounded by bogus claims about other people—especially in the context of political elections. But why do we sometimes believe blatant misinformation? A new study from the University of Arizona suggests that our

gullibility can be triggered by subtle reminders of how we are different from the person in question.

During the months before and after the 2008 presidential election, psychologist Spee Kosloff and his colleagues asked predominantly white, non-Muslim students to evaluate smears about both candidates. They found that cues about social differences, such as age or race, were enough to get many participants to buy into false allegations against a candidate. Students who were undecided about which candidate to support, for example, when asked to report their own race on a questionnaire, increased their belief that Barack Obama was Muslim from 38 to 58 percent. Similarly, reminding students about their own age helped to make them believe that John McCain was senile. Overall, thinking about differences in social categories increased students' acceptance of smear-campaign misinformation by 24 percent, Kosloff says.

Scientists have long known that we tend to have a preference for people of our own social category, “an us-versus-them sort of mentality,” Kosloff says. But he adds that he was surprised by the magnitude of this effect in his experiments. He plans to use upcoming elections to look at ways to counter the effect, for example, by reminding people of similarities they have with a candidate. To wit, “I am an American; he is an American. Would that reminder attenuate people's willingness to believe that [Obama] is Muslim?” Kosloff asks.

—Nicole Branan

>> SOCIAL DEVELOPMENT



## Immune to the Contagious Yawn

Seeing someone else's sleepy facial contortions does not affect young children or kids with autism

There's nothing worse,

when you're trying to stay awake at work during the postlunch lull, than looking over and seeing a colleague yawn. To most of us, yawning seems all too contagious, but a new study in the journal *Child Development* suggests that the ability to “catch” a yawn actually requires some sophisticated social skills.

Psychologists at the University of Connecticut studied more than 120 children, who ranged in age from one to six. While reading each child a story, a researcher would stop several times to yawn conspicuously. Fewer than 10 percent of the children younger than four yawned in response. Among the older kids, that percentage jumped significantly, with 35 to 40 percent of kids displaying contagious yawning.

“We know that the social brain develops over the first few years of life,” says Molly Helt, the study's lead author and a doctoral student in psychology. Although youngsters are certainly sensitive to others' expressions, she says, their brains may not yet be capable of unconsciously mirroring those emotions. “At some point we sort of start to take on the emotions of other people without even thinking about it,” Helt says.

In the second part of the study the researchers put kids with autism through the same scenario. They discovered that children with disorders on the autism spectrum were significantly less likely to catch yawns—among five- to 12-year-olds, 11 percent yawned, compared with 43 percent of typically developing children.

Although kids with autism may have no problem identifying that someone else is yawning, Helt says, their brains seem less likely to respond by unconsciously mimicking the expression back. “They're not developing that automatic emotional linkage with those around them,” Helt says. “If we learn more about how the social brain wires up in the early years, maybe we can take that and apply it to kids with autism as an early intervention.”

—Emily Anthes

ERIC GAY AP Photo (top left); NORBERT SCHAEFER Corbis (top right); GETTY IMAGES (bottom)

>> BEHAVIOR

## How to Form a Habit

Established habits demand little conscious effort, but creating a new habit is hard work. Psychologist Phillippa Lally of University College London asked 96 undergraduates to form a habit in 12 weeks by repeating daily a healthy behavior, such as drinking a bottle of water with lunch. Published in the October *European Journal of Social Psychology*, her results suggest that habits take much longer to form than researchers previously thought (an average of nine and a half weeks and potentially as long as several months), but missing one or two days of repetition will not impede the process.

—Ferris Jabr



## >> PAIN

### A Soothing Touch

Why the instinct to clutch a wounded part of the body helps to relieve discomfort

If you've ever accidentally brushed your hand against a hot stove, you'll probably remember immediately clutching the burn with your other hand—an instinct that seems to help relieve the pain. In contrast, we often pull back in fear if someone else tries to touch a wound. Although psychologists have long recognized this distinction, no one properly understood the cognitive mechanisms that allow reflexive self-touch—rather than a stranger's touch—to soothe the pain. A new study published online September in *Current Biology* suggests that touching an injured area on one's own body reduces pain by enhancing the brain's map of the body in a way that touch from another cannot mimic.

In the study cognitive neuroscientist Marjolein Kammers of University College London and her colleagues asked blindfolded par-



ticipants to place their index and ring fingers in tubs of warm water while their middle fingers rested in cool water, a common experimental trick that creates the illusion that the middle fingers are burning hot. When the participants withdrew from the water and touched only their middle

fingers of both hands together or joined only their outer fingers, they found little relief. Touching all three fingers to an experimenter's hand also failed to reduce pain. Only when the participants entwined their three affected fingers on both hands did they soothe themselves, diminishing perceived pain by 64 percent.

Uniting two parts of the same body, Kammers explains, sends diverse signals to the brain about temperature, spatial position and identity that can come only from self-contact. In this case, bringing all three fingers together probably provided the brain with enough comparative information to readjust its interpretation of skin temperature on each finger. "When you get input from many different signals, the brain increases the coherence of its body map, which reduces acute pain," Kammers says. The new findings parallel previous work demonstrating that adding more sensory input can relieve chronic phantom limb pain experienced by some amputees: when a mirror tricks the brain into thinking the body is whole again, the pain subsides.

—Ferris Jabr

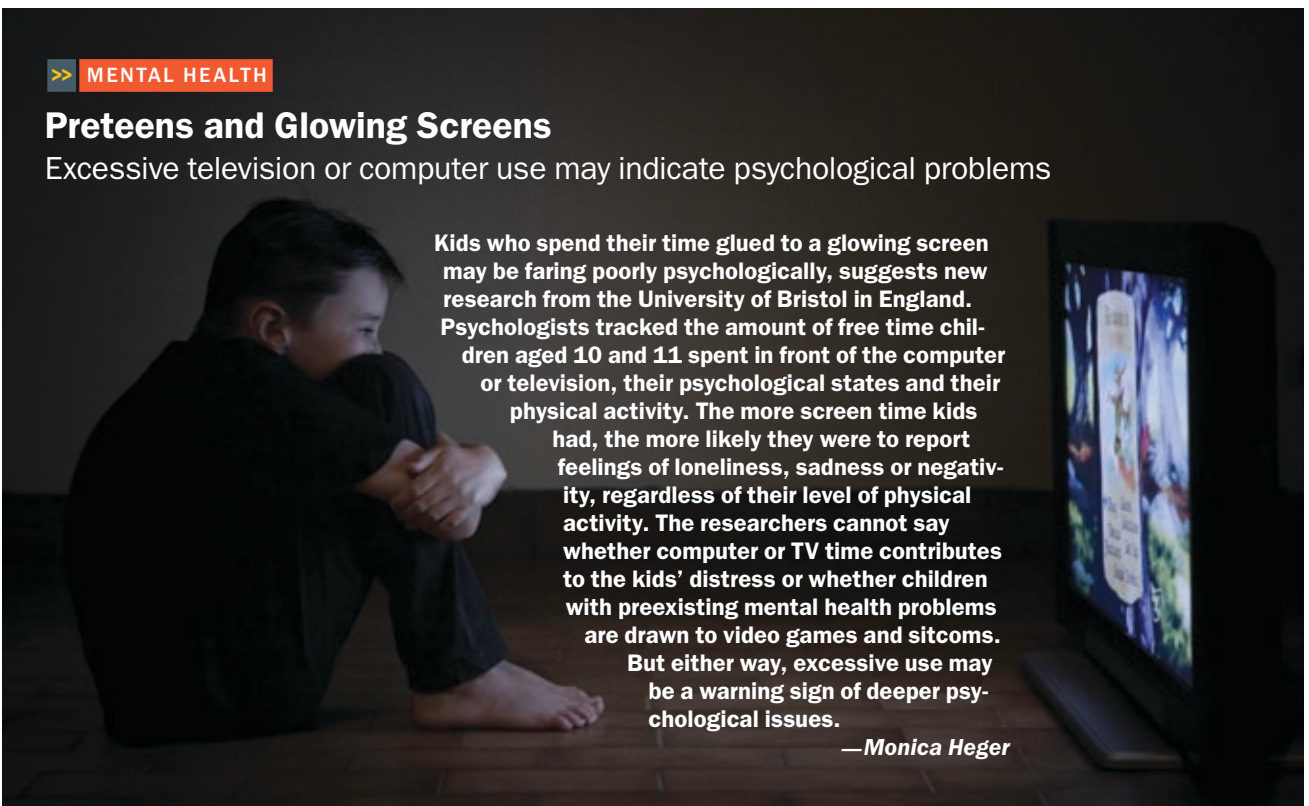
## >> MENTAL HEALTH

### Preteens and Glowing Screens

Excessive television or computer use may indicate psychological problems

**Kids who spend their time glued to a glowing screen may be faring poorly psychologically, suggests new research from the University of Bristol in England. Psychologists tracked the amount of free time children aged 10 and 11 spent in front of the computer or television, their psychological states and their physical activity. The more screen time kids had, the more likely they were to report feelings of loneliness, sadness or negativity, regardless of their level of physical activity. The researchers cannot say whether computer or TV time contributes to the kids' distress or whether children with preexisting mental health problems are drawn to video games and sitcoms. But either way, excessive use may be a warning sign of deeper psychological issues.**

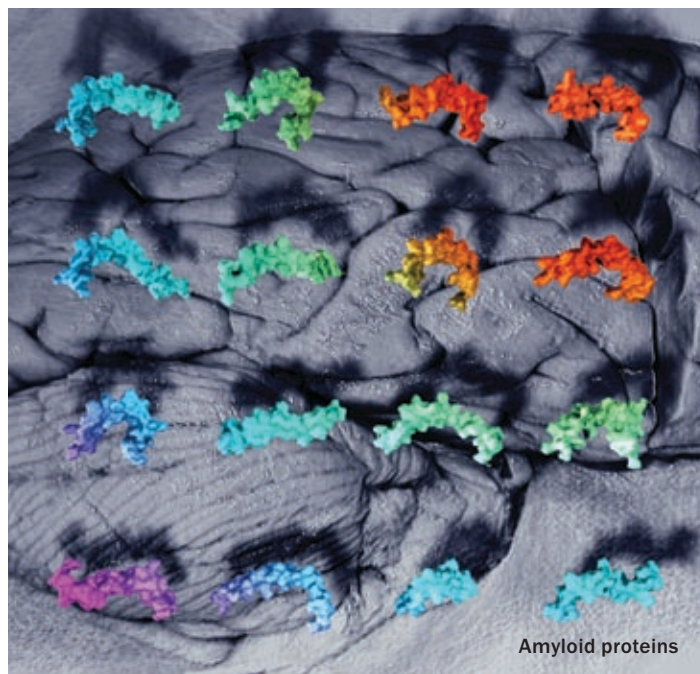
—Monica Heger



CORBIS (top); CW HANLEY Getty Images (bottom)

## A Case of Low Energy

Alzheimer's symptoms may arise from damaged "power plants" in brain cells



Amyloid proteins

Five million Americans suffer from Alzheimer's disease, but scientists still have more questions about it than answers. Arguments abound over whether the hallmark protein clusters that accumulate in the brain are a cause or an effect of the illness, and current treatments do not address the main problem that causes impaired thinking: broken synapses, the junctions that allow neurons to communicate with one another. Researchers are now zeroing in on a promising missing link: mitochondria, the cell components responsible for energy regulation. In October researchers at Columbia University reported that young mice predisposed to acquiring Alzheimer's accumulate protein clusters

in synaptic mitochondria and that these clusters directly impair synapse function.

The link between mitochondria and Alzheimer's is not exactly new. In the 1990s studies suggested that in the diseased brains of people and mice, mitochondria do not produce and distribute energy normally. And as early as 1994 researchers at the University of Kentucky showed that amyloid-beta protein fragments, the type found in Alzheimer's, interfere with mitochondrial function. But no one knew how, exactly, mitochondria were linked to synaptic problems, if at all.

To find out, Shirley ShiDu Yan and her colleagues at the Columbia University Medical Center genetically engineered mice to overproduce a compound that leads to the formation of amyloid-beta clusters. When the mice were at various ages, the researchers isolated mitochondria from their synapses and from other brain regions. When the mice were just four months old—well before they showed symptoms of the disease—their synaptic mitochondria had accumulated approximately five times more amyloid protein than nonsynaptic mitochondria had. The affected mitochondria could no longer provide the synapses with enough energy, which ultimately prevented the synapses from functioning—providing the first direct link between

cellular injury caused by amyloid protein and the characteristic breakdown of neuronal communication that occurs in Alzheimer's patients.

The findings could provide new treatment possibilities. In earlier research Yan reported that cyclosporin D, a drug used to treat patients with organ transplants and autoimmune diseases, prevents amyloid-beta proteins from injuring mitochondria. Although the drug has serious side effects, Yan hopes that she can develop a similar but safer compound that prevents synaptic problems early on. Scientists need to "stop the disease early, before neurons have already died," she says.

—Melinda Wenner Moyer

## What's That Robot Looking At?

Babies will follow the gaze of social robots just as they do with people

Starting at 12 months old, infants follow the gaze of others—an instinctive behavior that allows them to learn from observation. But will they track just anyone's eyes? In a recent study published in *Neural Networks*, University of Washington psychologist Andrew Meltzoff tested whether infants would follow the gaze of a humanoid robot. One group of 18-month-olds observed an experimenter play a mimicry game with a mobile robot, whereas another group of babies got to know the same robot as it remained completely stationary. Thirteen of the 16 babies who observed human-robot interaction later followed the robot's gaze as it turned toward a toy, compared with only three of the 16 babies who observed no robot playtime. Infants, it seems, are highly attuned to social information, which they use to constantly update their perception of others—even to change a hunk of metal into a thinking being.

—Ferris Jabr



## >> GENETICS

### Handicapped by Our Genes?

Knocking out a “dumb” gene boosts memory in mice

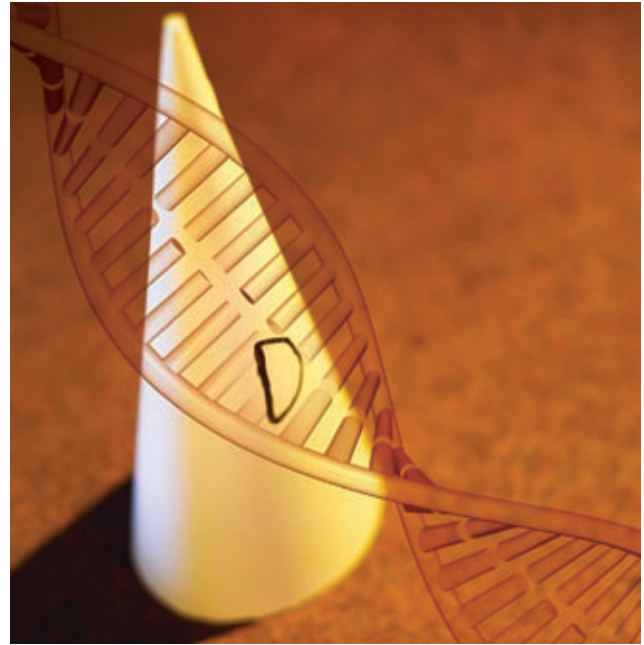
We like to think of our brain as an incredibly sophisticated thinking machine that has been fine-tuned by evolution. But recently researchers working with mice found that a tiny genetic manipulation significantly boosted brainpower with seemingly no negative consequences. People have this gene, too, and it is active in the same brain area. In other words, we may have a gene in our heads that is actively making us dumber.

Emory University pharmacologist John Hepler and his team studied a section of the hippocampus called CA2, found in both mice and humans. Although the hippocampus is crucial for memory, the neurons in CA2, oddly, fail to participate in the cellular process on which learning and memory depend: long-term potentiation, which strengthens communication between neurons that fire together.

The researchers noticed that the neurons in CA2 were saturated with RGS14, a signaling protein that mysteriously inhibits long-term potentiation. When the investigators bred mice lacking the gene that codes for RGS14, they found that the neurons in CA2 suddenly demonstrated long-term potentiation.

The genetic tweak affected more than physiology—it changed how the mice performed on memory tests, too. The experimenters presented two identical objects to knockout mice, which lacked the RGS14 gene, and to normal mice. Four hours and again 24 hours later, the researchers switched one of the objects with a new object. The knockout mice spent far more time exploring the new object than the normal mice did, indicating that the altered rodents had a better memory for distinguishing familiar and strange objects. Knockout mice also learned to navigate a water maze and locate a submerged platform faster than normal mice did. The scientists observed no detriments from removing the RGS14 gene.

“Why would we have a gene that makes us dumber?” asks Serena Dudek, a neuroscientist at the National Institute of Environmental Health Sciences and a co-author of the study, which was published in the September issue of the *Proceedings of the National Academy of Sciences USA*.



“We don’t know. But if the gene is conserved by natural selection, there must be some reason. Intuitively, it seems there should be a downside to having this gene knocked out, but we haven’t found it so far. It may be that these mice are hallucinating, and you just can’t tell.”

Alcino Silva, a neurobiologist at the University of California, Los Angeles, and an expert on the biology of memory enhancement who was not involved in the new study, agrees. “My suspicion is when you enhance one thing, you cause deficits in others,” Silva says.

Despite their suspicions that the consequences of disabling this gene will materialize eventually, both Silva and Dudek see therapeutic potential: the RGS14 gene and protein are now promising future targets of treatments for learning and memory disabilities.

—Ferris Jabr

## >> MENTAL ILLNESS

### Occupational Hazard

Social anxiety is more likely than depression to keep people unemployed

Job interviews are stressful for most, but the process can be unbearable for people with social anxiety. As a result, social anxiety sufferers often wind up unemployed or in jobs below their training level. Ethan Moitra, a clinical psychologist at Brown University, decided to quantify this problem by comparing unemployment rates across similar disorders. His results were surprising: individuals with social anxiety were more than twice as likely to be unemployed as those with depression and generalized anxiety, which had minimal effects on employment. Psychotherapy can help reduce social anxiety, Moitra says, but early detection is key.

—Erica Westly



CORBIS AND GETTY IMAGES (photo/illustration at top); CORBIS (bottom)

>> PERSONALITY

## If You Don't Have Anything Nice to Say ...

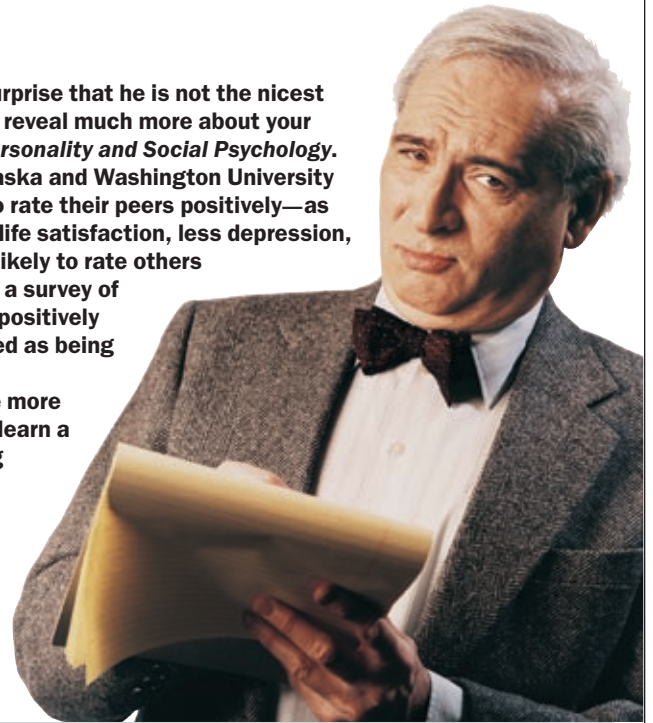
What you say about others reveals a lot about you

Got a friend who thinks most people are jerks? It is probably no surprise that he is not the nicest person in other contexts, either. But the way you view others may reveal much more about your character than you think, according to a study in the *Journal of Personality and Social Psychology*.

Researchers at Wake Forest University, the University of Nebraska and Washington University in St. Louis found that college students who were more inclined to rate their peers positively—as being trustworthy, nice and emotionally stable—reported greater life satisfaction, less depression, and better grades and test scores. In general, women were more likely to rate others positively than men, although the study did not examine why. And a survey of the volunteers' classmates showed that people who rated others positively were more likely to be well regarded by their peers and to be judged as being agreeable, conscientious and emotionally stable.

On the other hand, those with negative opinions of others were more apt to be disagreeable, antisocial and narcissistic. “You stand to learn a number of very different things about a person from just observing whether the person describes others positively or not,” says lead author Dustin Wood, an assistant psychology professor. Most surprising, Wood says, was how little those perceptions changed a year later. “The stability of these tendencies means that they may consistently act as a lens that darkens your experience of other people or brightens it,” he says. And therefore, Wood says, your perception of others “may be hard to change.”

—Winnie Yu



>> IMITATION

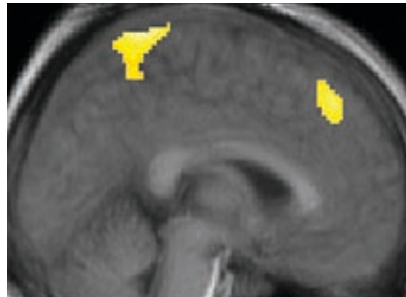
## Monkey See, Monkey Don't

We learn from our competitors' failures by not repeating them

When we perform an action and get an unexpected reward, we learn to repeat that action. And in the presence of others competing for resources—food, money, and so on—our competitors' actions offer opportunities to guide our behavior. According to new work from researchers at the University of Bristol in England, it is not our peers' successes that stick with us, but their failures.

Volunteers played a simple game, modeled after foraging in the wild, against a computer-controlled competitor. Players chose one of four boxes, which paid out varying sums of money. To maximize winnings, a player had to occasionally sample each of the boxes. When players saw their competitors get an unexpectedly high sum, functional MRI scans showed no measurable brain activity in reaction. When the drones got an unexpectedly low payout, however, parts of a player's brain associated with inhibition went bonkers.

Learning from competition, then, “is not learning to act like your competitor,



When a competitor makes a mistake, our brain halts the process of mentally mirroring his or her actions. Inhibition regions, including the posterior medial frontal cortex (yellow, above right), kick into gear.

it is learning not to act like your competitor when they fail,” explains Paul Howard-Jones, who co-led the study with Rafal Bogacz.

Howard-Jones notes that while the computer was making its move, which simply consisted of one box changing color, the player's mirror neuron system—which is known to respond to the actions of others—was active, as if the

player was making the same choice. When that action led to failure, the inhibitory areas put an immediate stop to the mental simulation. Howard-Jones says this is the first time that researchers have seen people show a mirror neuron response to an action performed by a computer (the players were aware that their opponent was simply software).

Marco Iacoboni, a mirror neuron expert at the University of California, Los Angeles, who was not involved with the study, cautions that fMRI's resolution is not fine enough to distinguish whether the neurons firing are mirror neurons or just motor cortex neurons, which fire both when we think about an action and when we actually perform an action. Even if the computer is simply recruiting a player's motor neurons, however, that is still a compelling finding. “It's really a mechanism for why we anthropomorphize pretty much everything,” Iacoboni says. “We tend to mentalize even things that we know have no mind.”

—Nikhil Swaminathan

## >> EMOTIONS

### Revulsion Arising

Our innards differentiate between types of disgust



Where do our emotions come from? Scientists addressing this long-standing philosophical question recently got some answers by using—bear with us—videos of people licking vomit off their fingers and other revolting scenarios.

Human emotions are associated with measurable changes in heart rate, gut motility and sweat gland secretions, but some experts have argued that these bodily

responses are simply a general stress reaction and therefore cannot account for different types of emotions. A *Journal of Neuroscience* study from September 22 suggests otherwise, presenting evidence of distinct physiological signatures of two forms of disgust.

Neuroscientist Neil Harrison and his colleagues at the University of Sussex in England monitored heart rate, stomach contractions and brain activity as study participants viewed videos designed to elicit two kinds of disgust. The vomit video and other gross-out films elicited what is known as core disgust; videos of surgical operations—such as an above-knee amputation—induced body-boundary violation (BBV) disgust. Although both types of videos were judged as equally revolting, core disgust evoked strong increases in stomach contraction, whereas BBV elicited increases in heart rate. If these bodily changes form the basis of our emotional experiences, the researchers predicted that disgust-specific brain activity should reflect similar patterns. They found this very type of activity in the insula, an area deep in the brain where information about the body intersects with that about emotions.

The findings support the idea that these bodily responses are more than generalized arousal: they can form the outlines of specific emotions. Our own cognitive interpretations of the scene may then add to these physical responses to create a full-fledged emotion. “These bodily responses are not going to be the whole story of where our emotions come from, but they provide a kind of skeleton,” Harrison says. [For more on embodied cognition, see “Body of Thought,” by Siri Carpenter, on page 38.] —Michele Solis

## >> SCHADENFREUDE

### Kids These Days

Delinquent youths boost older people’s self-esteem

The image of a retiree complaining about the local kids is so ubiquitous it has become a cliché—everyone knows that each generation loves to be appalled by the behavior of those born later. Now research confirms this observation and suggests that by thinking about youngsters getting in trouble, older people are actively boosting their self-esteem.

Silvia Knobloch-Westerwick of Ohio State University and her colleague Matthias Hastall of Zeppelin University



in Germany asked people between the ages of 50 and 65 to read articles in a magazine under the guise of becoming familiar with the publication. In a subsequent survey, the participants who read experimenter-created articles about the trouble young people got themselves into reported higher levels of self-

esteem. The more the older subjects looked at the articles about the bad behavior and ill fortune of younger people, the more their self-esteem rose. Knobloch-Westerwick explains this as a classic case of schadenfreude—people feel good about the misfortunes of a group to which they do not belong.

For 18- to 30-year-old volunteers, however, the reverse was not true. Knobloch-Westerwick suggests that in our youth-idealizing culture, older people are simply marginal in the eyes of the young. [For more on the psychology of schadenfreude, see “Their Pain, Our Gain,” by Emily Anthes; *SCIENTIFIC AMERICAN MIND*, November/December 2010.] —Harvey Black



>> MEMORY

## Why Testing Boosts Learning

Getting quizzed strengthens memory-jogging keyword clues

For more than a century scientists have known that individuals who are tested on material are more likely to remember it than those who simply study. But questions remain about why that is the case. Kent State University psychology researcher Katherine Rawson argues that part of the explanation is that testing gets people to come up with better keyword clues, which bridge the gap between familiar and new information—and it strengthens ties between these keywords and the newly learned information.

Rawson and former graduate student Mary Pyc asked 118 college students to learn four dozen Swahili words by matching them with their English counterparts, such as *wingu*, which means “cloud.” After an initial study period, half were given practice tests before studying the words a second time, and half restudied the words without taking a practice test.

As expected, students in the practice test group were better at remembering the word pairs during a final exam a week later. But Rawson and Pyc also asked students to tell them their keywords—for instance, “bird” might serve as a bridge between *wingu* and cloud—and they revealed that the people in the practice test group not only remembered more of their keywords, but they were more likely to have changed their keyword before restudying the word pairs than those who had not been tested. As the researchers reported in *Science* last October, these results suggest that testing improves memory by strengthening keyword associations and weeding out clues that do not work.

—Andrea Anderson



>> DEVELOPMENT

## Social before Birth

Twins interact purposefully in the womb

Every mother knows that newborns are social creatures just hours after birth. They prefer to look at faces over objects, and they even imitate facial expressions. Now a study suggests that the propensity for social interactions exists in the womb. Twins begin interacting as early as the 14th week of gestation.

Researchers at the University of Turin and the University of Parma in Italy used ultrasonography, a technique for imaging internal body structures, to track the motion of five pairs of twin fetuses in daily 20-minute sessions. As published in the October *PLoS ONE*, the scientists found that fetuses begin reaching toward their neighbors by the 14th week of gestation. Over the following weeks they reduced the number of movements toward themselves and instead reached more frequently toward their counterparts. By the 18th week they spent more time contacting their partners than themselves or the walls of the uterus. Almost 30 percent of their movements were directed toward their prenatal companions.



These movements, such as stroking the head or back, lasted longer and were more accurate than self-directed actions, such as touching their own eyes or mouth.

The results suggest that twin fetuses are aware of their counterparts in the womb, that they prefer to interact with them, and that they respond to them in special ways. Contact between them appeared to be planned—not an accidental outcome of spatial proximity, says study co-author Cristina Becchio of Turin. “These findings force us to predate the emergence of social behavior,” she says.

The fact that fetuses can control their actions in the womb is not a surprise. Co-author Vittorio Gallese, a neuroscientist at Parma, and his collaborators previously showed that fetuses display skilled movements by the fifth month of gestation. Becchio speculates that the presence of a twin may accelerate motor development.

In the future the team plans to develop diagnostic tests by systematically tracking the motion of a large number of fetuses. Patterns of activity in the womb may predict later motor development or impairments in social cognition, such as autism, Gallese says. “The womb is probably a crucial starting point to develop a sense of self and a sense of others.”

—Janelle Weaver

# What, Me Care?

A recent study finds a decline in empathy among young people in the U.S.

BY JAMIL ZAKI



Nearly 75 percent of college students today rate themselves as less empathic than the average college student did 30 years ago. Social forces may be altering the natural human tendency to feel for others.

**HUMANS ARE UNLIKELY** to win the animal kingdom's prize for fastest, strongest or largest, but we are world champions at understanding one another. This interpersonal prowess is fueled, at least in part, by empathy: our tendency to care about and share other people's emotional experiences. Empathy is a cornerstone of human behavior and has long been considered innate. A forthcoming study, however, challenges this assumption by demonstrating that empathy levels have been declining over the past 30 years.

The research, led by Sara H. Konrath of the University of Michigan at Ann Arbor and published online in August in *Personality and Social Psychology Review*, found that college students' self-reported empathy has declined since

1980, with an especially steep drop in the past 10 years. To make matters worse, during this same period students' self-reported narcissism has reached new heights, according to research by Jean M. Twenge, a psychologist at San Diego State University.

An individual's empathy can be assessed in many ways, but one of the most popular is simply asking people what they think of themselves. The Interpersonal Reactivity Index, a well-known questionnaire, taps empathy by asking whether responders agree to statements such as "I often have tender, concerned feelings for people less fortunate than me" and "I try to look at everybody's side of a disagreement before I make a decision." People vary a great deal in how empathic

they consider themselves. Moreover, research confirms that the people who say they are empathic actually demonstrate empathy in discernible ways, ranging from mimicking others' postures to helping people in need (for example, offering to take notes for a sick fellow student).

Since the creation of the Interpersonal Reactivity Index in 1979, tens of thousands of students have filled out this questionnaire while participating in studies examining everything from neural responses to others' pain to levels of social conservatism. Konrath and her colleagues took advantage of this wealth of data by collating self-reported empathy scores of nearly 14,000 students. She then used a technique known as cross-temporal meta-analysis to measure whether scores have

JUPITERIMAGES

Americans have abandoned reading in droves, and people who read less fiction report themselves to be **less empathic.**

changed over the years. The results were startling: almost 75 percent of students today rate themselves as less empathic than the average student 30 years ago.

### What's to Blame?

This information seems to conflict with studies suggesting that empathy is a trait people are born with. For example, in a 2007 study Yale University developmental psychologists found that six-month-old infants demonstrate an affinity for empathic behavior, preferring simple dolls they have seen helping others over visually similar bullies. And investigators at the Max Planck Institute for Evolutionary Anthropology in Leipzig have shown that even when given no incentive, toddlers help experimenters and share rewards with others. Empathic behavior is not confined to humans or even to primates. In a recent study mice reacted more strongly to painful stimuli when they saw another mouse suffering, suggesting that they “share” the pain of their cage mates.

But the new finding that empathy is on the decline indicates that even when a trait is hardwired, social context can exert a profound effect, changing even our most basic emotional responses. Precisely what is sapping young people of their natural impulse to feel for others remains mysterious, however, because scientists cannot design a study to evaluate changes that occurred in the past. As Twenge puts it, “you can’t randomly assign people to a generation.”

There are theories, however. Konrath cites the increase in social isolation, which has coincided with the drop in empathy. In the past 30 years Americans have become more likely to live alone and less likely to join groups—ranging from PTAs to political parties to casual sports teams. Several studies hint that this type of isolation can take a toll on people’s attitudes toward others. Steve Duck of the University of Iowa has found



Before they have been taught social graces, toddlers instinctively offer to help others.

that socially isolated, as compared with integrated, individuals evaluate others less generously after interacting with them, and Kenneth J. Rotenberg of Keele University in England has shown that lonely people are more likely to take advantage of others’ trust to cheat them in laboratory games.

The types of information we consume have also shifted in recent decades; specifically, Americans have abandoned reading in droves. The number of adults who read literature for pleasure sank below 50 percent for the first time ever in the past 10 years, with the decrease occurring most sharply among college-age adults. And reading may be linked to empathy. In a study published earlier this year psychologist Raymond A. Mar of York University in Toronto and others demonstrated that the number of stories preschoolers read predicts their abil-

ity to understand the emotions of others. Mar has also shown that adults who read less fiction report themselves to be less empathic.

Whereas the sources of empathic decline are impossible to pinpoint, the work of Konrath and Twenge demonstrates that the American personality is shifting in an ominous direction. Still, we are not doomed to become a society of self-obsessed loners. Konrath points out that if life choices can drive empathy down, then making different choices could nurture it. “The fact that empathy is declining means that there’s more fluidity to it than previously thought,” she says. “It means that empathy can change. It can go up.” **M**

JAMIL ZAKI, a postdoctoral fellow at Harvard University, studies the psychology and neuroscience of social behavior.

### (Further Reading)

- ◆ **Social Evaluation by Preverbal Infants.** J. K. Hamlin, K. Wynn and P. Bloom in *Nature*, Vol. 450, pages 557–559; 2007.
- ◆ **The Narcissism Epidemic: Living in the Age of Entitlement.** J. M. Twenge and W. K. Campbell. Free Press, 2009.
- ◆ **Changes in Dispositional Empathy in American College Students over Time: A Meta-Analysis.** S. Konrath, E. O’Brien and C. Hsing in *Personality and Social Psychology Review*. Published online August 5, 2010.
- ◆ **Exposure to Media and Theory-of-Mind Development in Preschoolers.** R. Mar, J. Tackett and C. Moore in *Cognitive Development*, Vol. 25, pages 69–78; 2010.

# Think Different

The ways in which brains differ from one another show up in the ways their owners perceive the world

BY CHRISTOF KOCH



**PERCEPTUAL PSYCHOLOGY** and the brain sciences emphasize the communal-ity in the way that people experience reality. Leaving aside cases of brain damage or mental disease, we all see the sun rise in the east, enjoy the scent of a rose and experience a jolt of fear when we are woken up in the middle of the night by the sound of breaking glass. This is a reflection of the great similarities of our brains compared with the brains of our close cousins on the evolutionary tree, the great apes. Laboratory science reinforces this bias by lumping together the performance of its subjects on any one experiment and reporting only the average and the variation around this mean. This conflation is also true for the telltale hot spots that show up in functional magnetic resonance brain images that we are used to seeing in newspapers, in magazines such as this one, on television and in the movies.

Yet as we know from our own life, each one of us has his or her own preferences, likes and dislikes. Some people are acutely sensitive to flashing lights, some have perfect pitch, some cannot see in depth, some can introspect and analyze their own failures and triumphs, whereas others—remarkably frequently, public figures such as politicians—lack this knack. Take me. I am hopelessly attracted to brilliant colors. As a magpie is drawn to anything glittering, I am drawn to school-bus yellow, tangerine orange, burgundy red, rich magenta, electric violet, imperial purple and navy blue. My love of the garish is reflected in my flowery shirts and pants and, I'm sure, in an enhanced cortical representation of these hues.

It is obvious that if the apparatus that senses the world differs between two individuals, then the conscious experience of the brains wired to these sensors cannot be the same either. In a previous



Consciousness Redux column, I discussed color blindness—the fact that about 7 percent of men lack one of the genes for the retinal photopigments needed to see hue. But what about differences in the brain proper? Do they influence consciousness in measurable ways? To answer this question, scientists must plumb the minds of many individuals and relate them to measures of their brains. The widespread availability of fMRI scanners makes such a project feasible today.

Cognitive neuroscientist Geraint Rees, a professor at the Wellcome Trust Center for Neuroimaging at University College London—undoubtedly the world's leading fMRI center—published a trio of studies that relates differences in the way people experience things with differences in gross aspects of their cerebral neocortex, the highly convoluted part of the forebrain that crowns the brains of all mammals.

In one study 30 subjects looked at the Ponzo [see illustration on opposite page] illusion while their brains were scanned. Whereas everybody who looks at the

Ponzo perceives the upper bar as larger than the lower one, the magnitude of this effect differs substantially across individuals. (The size of the illusion is established by asking how much larger the lower bar has to be to make it look the same size as the upper one.) Surprisingly, these differences are reflected in the surface area of the primary visual cortex (V1) at the back of the head. For unknown reasons, the area of V1 can differ by a factor of three among people (unfolded, the size and width of a typical V1 compares with that of a credit card). Rees and his collaborators discovered that the smaller a person's V1, the more powerfully he or she experiences the illusion. Those individuals with a large V1 judged the size of the bars to be more similar than those with a smaller V1. Curiously, the size of the two immediately adjacent visual areas did not influence the amplitude of the illusion.

### Clues from Illusions

Bistable illusions are those delightful images that can be seen in one of two ways. Probably the best known is the

CHRISTOF KOCH (Koch); CORBIS (rose)

Can differences in this higher-order **aspect of consciousness** be tied to differences in brain structures? Yes.

Necker cube, or the “old woman, young girl illusion.” These two interpretations flip back and forth. The time it takes for the percept to flip differs consistently across individuals. One person might see the figure alternate every five seconds; another sees it flip every 10.

Rees and his group used a dynamic version of such bistable illusions: a cloud of moving dots perceived as a cylinder rotating either to the left or to the right. Here the scientists correlated the width of the cortical sheet—the thickness of its gray matter—with how long each stable percept lasts before it switches. Scanning the brains of 52 subjects—in a field dominated by studies that come to grand conclusions by querying a handful of brains—they found only a single region, the left and right superior parietal lobe (SPL), in which the thickness of the gray matter (and its density) significantly and consistently correlated negatively with the perceptual duration. In other words, the thicker the SPL cortex, the faster two interpretations switch back and forth. It is known from other imaging and clinical studies that the SPL in the back of the brain controls selective visual attention, but how the thickness and density of SPL gray matter should be important is anybody’s guess.

Ask people what they believe to be the defining feature of consciousness, and most will point to self-awareness. To be capable of being aware of your hopes, to worry about your spouse’s illness, to wonder why you feel despondent or why he provoked you is taken to be the pinnacle of sentience. Self-awareness is, by and large, absent in nonprimates. Although my dog—as with many and, perhaps, all animals—experiences the sights, sounds and, in particular, the smells of life, she doesn’t worry why her tail isn’t wagging as it used to or whether tomorrow’s food will appear.

So can differences in this elusive higher-order aspect of consciousness be

tied to differences in brain structures? Yes, as a just published third study by Rees and his colleagues concludes.

Thirty-two healthy volunteers carried out a difficult visual task in the scanner. They had to judge which one of a number of faint patches was a tad more salient than the other ones; this judgment was purposefully made demanding. Following each trial, subjects had to choose a number between one and six, indicating the confidence they had in their own judgment. A six indicated that they were very confident of their judgment, whereas a one implied a guess. That is, they were asked to introspect: Are you sure you just saw the bright patch here? Psychologists know this as meta-cognition: thinking about thinking.

Not surprisingly, subjects differed greatly in the accuracy of their judgments (independent of the level of their performance). Think of the game show *Who Wants to Be a Millionaire*, where contestants have to judge whether they want to use a lifeline before they know the answer, depending on their confidence. Some people are astute, using the lifelines wisely; other people fritter them away. The cognitive scientists extracted a measure of variability of introspection and discovered that this measure correlated with variability in gray matter volume in the right anterior prefrontal cortex. The more neurons you have in this region in the front of the brain, the better your introspection. Not that your performance goes up, but the insight you have into your performance—whether you thought you did well or not—in-



The Ponzo illusion provides a visual cue of converging railroad ties, so the upper blue bar is perceived to be farther away—and thus much larger—than the lower blue bar. Yet they are exactly the same dimensions. The smaller the size of your primary visual cortex, the more dramatic the illusion.

creased. Patients with lesions in these regions typically lose the ability to introspect. And this part of the neocortex has expanded more than any other region in primates. Again, the neuronal mechanisms underlying this correlation remain unknown for now.

Rees’s studies establish that differences in the morphology, or shape, of our brains are mirrored in differences in the way we consciously experience and apprehend the world, including our own brains and bodies. In this way, neuroscience maps the physical structure of the material brain onto the inner geometry of phenomenal and ineffable experience. **M**

CHRISTOF KOCH is Lois and Victor Troendle Professor of Cognitive and Behavioral Biology at the California Institute of Technology. He serves on *Scientific American Mind*’s board of advisers.

(Further Reading)

- ◆ **Human Parietal Cortex Structure Predicts Individual Differences in Perceptual Rivalry.** Ryota Kanai, Bahador Bahrami and Geraint Rees in *Current Biology*, Vol. 20, No. 18, pages 1626–1630; August 19, 2010.
- ◆ **Relating Introspective Accuracy to Individual Differences in Brain Structure.** Stephen Fleming, Rimona Weil, Zoltan Nagy, Raymond Dolan and Geraint Rees in *Science*, Vol. 329, pages 1541–1543; September 17, 2010.
- ◆ **The Surface Area of Human V1 Predicts the Subjective Experience of Object Size.** Samuel Schwarzkopf, Chen Song and Geraint Rees in *Nature Neuroscience* (in press).

SCIENTIFIC AMERICAN MIND

# Bright Horizons™ 10

Rome to Athens, October 1–13, 2011



[www.InSightCruises.com/SciAm-10](http://www.InSightCruises.com/SciAm-10)

Set a course for intellectual adventure on the Black Sea with your curiosity as a guide and Scientific American to take care of the details. Join Scientific American on the Bright Horizons cruise conference on Holland America Line's ms Rotterdam, sailing Rome to Athens October 1–13, 2011.

As you ply the wine-dark seas, join Dr. John Steele in tracing the astronomical legacies of the Babylonians and Greeks. Dr. Michael Wysession conveys the impact of volcanoes and tsunamis in the flow of civilization. Sit with Dr. Michael Benton as he brings dinosaurs to life. Tune in to Dr. Mohammed Noor, as he details the nature of species. Get the latest concepts on comets with Dr. Mark Bailey. Illuminate dark matter with Dr. Lawrence Krauss.

The Draconid meteor shower will punctuate your Black Sea sojourn. Typically a minor celestial event, the 2011 shower is forecast to be a humdinger.

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Cruise prices vary from \$1,799 for an Interior Stateroom to \$5,299 for a Deluxe Suite, per person. For those attending our program, there is a \$1,475 fee. Government taxes, port fees, and InSight Cruises' service charge are \$208.91 per person. For more info please call 650-787-5665 or email us at [Concierge@InSightCruises.com](mailto:Concierge@InSightCruises.com)



## COSMOLOGY

Speaker: Lawrence Krauss, Ph.D.

**Quantum Man: Richard Feynman's Life in Science** — It took a man who was willing to break all the rules to tame a theory that breaks all the rules. Learn about the scientific legacy of one of the greatest and most colorful scientists of the 20th century, and in turn get insights into the questions driving the science of the 21st century.

**An Atom from Greece** — Every atom in your body was once inside a star that exploded. Lawrence Krauss will present the life history of an atom in a glass of wine you will have with dinner, from the beginning of the universe to the end. The story is rich in drama and surprises, and will leave you thinking differently about your place in the cosmos.

**The Dark Side of the Universe: From Black Holes, to Dark Matter, and Dark Energy** — The most interesting things in the universe apparently cannot be seen. Learn why scientists are fascinated by them, and why they hold the key to understanding our origins, and our future.

**Hiding in the Mirror: Extra Dimensions, CERN, and the Universe** — The largest machine humans have ever built has turned on in Geneva, and happily has not created a black hole that destroyed the world. But what might be discovered there, and will it tell us that there is, literally, infinitely more to the universe than meets the eye?

CSF# 2065380-40



## PALEONTOLOGY

Speaker: Michael J. Benton, Ph.D.

**The Life and Times of the Dinosaurs** — Many people think images of dinosaurs in museums and films are largely imaginary. Find out how paleobiologists reconstruct the life of the past using a combination of three modern scientific methods. Dr. Benton will share the standard tools, unexpected finds, and new engineering approach to understanding how these ancient giants looked, moved, and fed, putting dinosaur discoveries and imagery in a new light.

**Origins and Extinctions** — Life has existed on Earth for four billion years, punctuated by origins and extinctions. From the origin of life to the origin of humans we'll look at one of the grandest questions in science: where did we come from . . . and can we be sure? Dr. Benton then explores international research from North America, Russia, China, and Europe on the causes and consequences of extinctions.

**Origins of Modern Biodiversity** — Life today is hugely diverse. Darwin wondered at this richness, and argued that life was more diverse than it had to be! Research efforts now concentrate on reconstructing the evolutionary 'tree of life' using genomes and fossils, bound by massive computing power. Get the scoop on biodiversity and the latest on biogeographic investigations, fossil data, and number crunching of the new genomic sequences.

**The Dinosaurs of Eastern Europe and the Mediterranean** — In the days of the dinosaurs, continental drift and sea level change led to ever-changing geography. See how geologists create paleogeographic maps to locate the dinosaur fauna of what is now Eastern Europe. Meet colorful characters from early days of paleontology. Learn how regional research changed during the Iron Curtain days and how current researchers are bringing Europe's unique dinosaurs back to life.

## SCIENTIFIC AMERICAN TRAVEL BRIGHT HORIZONS



## VATICAN OBSERVATORY

When in Rome, do as the Romans who are astronomy buffs wish they could do—visit to the new digs of the Vatican Observatory and get a privileged look at its world-class meteorite collection.

Join Bright Horizons on an optional pre-cruise trip to Castel Gandolfo, Italy on a private insider's tour

of the Observatory's laboratory, home to a 135 kg collection of 1081 samples, from 469 meteor falls. See a bit of Mars on your Mediterranean trip! Perhaps almost more intriguing is the Observatory's library. We'll browse over the shoulders of giants, seeing historic and antique astronomy books including early editions of Newton, Copernicus, Galileo, Kepler, Brahe, Clavius, and Secchi. VO astronomers will brief us on the Vatican's interest in astronomy and the latest on VO research at Steward Observatory, Mount Graham, Arizona.

We'll lunch on the shores of Lake Albano, an extinct volcano, and linger to enjoy the scenic and historic nature of the Castel Gandolfo area before returning to the bustle of Rome.

## ISTANBUL TOUR

It's impossible to describe, and has mesmerized travelers for millennia. Layered, amalgamated, flowing. Ancient and modern, secular and sacred. Plunge into Istanbul's cultural whirlwind with Bright Horizons staff, who have been there, done that.

On your itinerary: Hagia Sophia. It was the largest cathedral in the world for a thousand years, then a mosque, now a secular museum (so Istanbul). The Blue Mosque is defined by its 20,000 Iznik tiles. We'll peruse the sweets, spices, and nuts at the Spice Bazaar (A little hazelnut-pomegranate nougat, perhaps?).

Onward to our learning lab in Turkish hospitality, doing lunch at Topkapi Palace's former guard house. Then we'll immerse ourselves in the context and treasures of Topkapi, including the Treasury, Harem, and Holy Relics sections. Risking total sensory overload, we'll conclude our day at the Istanbul Archaeology Museum.





## COMETS

Speaker: Mark Bailey, Ph.D.

### Meteors, Meteor Showers, and the Draconids

— Meteors or shooting stars are fragments of dust from comets, burning up in the Earth's atmosphere. The time of this lecture coincides with a predicted outburst of the annual Draconid meteor shower. It is expected that activity will increase to a peak over a 2- to 3-hour period beginning around 8pm, with up to several hundred meteors per hour possibly being seen, depending on local weather conditions. After a brief introduction to meteors and meteor storms, we go up on deck to observe the "dragon's" fiery flame.

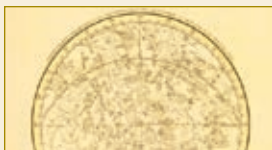
**Comets and Concepts in History** — Humans have a love-hate relationship with comets. We'll look at the oldest theories of the nature of comets and the role they played in astronomy's development. Blaze a trail with Dr. Bailey through the historic observations, arguments, and theories leading to the realization that comets are largely Oort cloud products, formed with the Sun and planets 4.5 billion years ago.

### The Life, Times, and Persistent Puzzles of Comets

— Broaden your horizons delving into 20 years' worth of discoveries on comets and their origins — whether in the Edgeworth-Kuiper belt just beyond Neptune, the trans-Neptunian disc, or the Oort cloud. Survey the natural history of comets in the inner solar system, and discover the persistent puzzles and uncertainties in this vibrant, active field of solar-system research.

### Risks Posed by Comets and Asteroids

— Comets occasionally descend on the Earth with catastrophic effect. At one extreme, such impacts can change the course of evolution disrupting the normal "Darwinian" process. At another extreme, relatively small impacts may have important implications for the development of civilization. Find out how the risk of rare, high-consequence events is assessed.



## ANCIENT ASTRONOMY

Speaker: John Steele, Ph.D.

**Astronomy in Ancient Babylon** — Cuneiform writing on thousands of clay tablets documents the astronomical activity of the ancient Babylonians. These texts circa the first millennium BC, include lists of astrological omens, astronomical observations, and calculations of the positions and phenomena of the moon and the planets. Join Dr. Steele to investigate the astronomical traditions of the ancient Babylonians and their invention of scientific astronomy.

**Ancient Greek Astronomy** — How could Ptolemy insist that the earth was the center of the Universe? The ancient Greeks didn't invent astronomy, but they were the first to combine philosophy with mathematics to model the motion of the heavens using geometry. Along the way they figured out the size of the Earth, the distance of the moon from the Earth, and developed geometrical methods for modeling planetary motion. Delve into the legacy of Greek astronomy, and trace its impact in the medieval Islamic world and Renaissance Europe.



## EVOLUTION

Speaker: Mohamed Noor, Ph.D.

### What is "Evolution" Anyway and Why Should I Care?

— The mere word "evolution" conjures images in the public ranging from movie dinosaurs to something vaguely half-human-half-gorilla. What does the word evolution actually mean in the biological sciences, what is the evidence that it is true, and why should the general public know and care? In fact, evolution affects your everyday life, from your health to your livelihood — come learn why!

**On the Origin of Species, Really** — Although Darwin's book title suggested that he defined the origin of species, in fact, he only focused on the process of divergence within species and assumed the same processes "eventually" led to something that could be called a new species. Dr. Noor will talk about how species are identified (in practice and in principle), how to modern evolutionary biologists use this type of information to get a handle on how species are formed, and what questions remain.

### Genetics, Genomics, and You: Don't Fear Your Genotype!

— The missing element to Darwin's theory was how it worked in terms of inheritance. Genetics answered that. Today "personal genomics" issues span medical, legal, ethical, and other areas and pose big question. Get ready for discussion and a lab exercise to help understand the lingo, opportunities, and issues associated with living in the genomics era.

**Life in the US Academic Sciences** — What happens behind closed doors in the "Ivory Tower" of an academic scientist? Scientists at universities juggle multiple roles. What do these people actually do all day? What are these scientists trained well to do and what are areas where they really are not trained well? What is a typical career trajectory in the sciences, and how are scientists evaluated? Get an inside look from a noted academic.

### The Antikythera Mechanism: An Ancient Mechanical Universe

— In 1900 sponge divers off the tiny island of Antikythera discovered an ancient Roman shipwreck laden with works of art. Almost unnoticed were the poorly preserved remains of a small mechanical device — the Antikythera Mechanism. Through painstaking reconstruction and analysis over the past century, we now know the device was a mechanical astronomical computer of great ingenuity. Learn the story of research on the mechanism — and what it has revealed about ancient Greek science and technology.

**Eclipses in History** — Eclipses are one of the most awe-inspiring astronomical events. Throughout history eclipses were viewed with fear, excitement, astonishment, and scientific curiosity. Take a look at how eclipses have been observed, interpreted, and commemorated in different cultures around the world and discover how scientists today benefit from ancient eclipse records.

### DRACONID METEOR SHOWER

"Every year around Oct. 8th, Earth passes through a minefield of dusty debris from Comet Giacobini-Zinner, source of the annual Draconid meteor shower. On Oct. 8, 2011, Earth will have a near head-on collision with a tendril of dust, setting off a strong outburst of as many as 750 meteors per hour. People in Europe, Africa and the Middle East will have a front-row seat for what could be the strongest shower since the Leonid storms a decade ago." From SpaceWeather.com.

© Wally Pacholka / AstroPics.com



## ATHENS' BEST

Visit the new Acropolis Museum and the National Archaeological Museum with our skilled guide who will add immeasurably to your experience. See the Parthenon frieze, exquisite sanctuary relics, and Archaic sculpture at the Acropolis Museum. Lunch, of course, is tucked away at a taverna favored by Athenian families. For dessert, we'll visit the richest array of Greek antiquities anywhere at the National Archaeological Museum.

## EPHESUS

Many civilizations left their mark at Ephesus. It's a many layered, many splendored history, often oversimplified. Bright Horizons pulls together three important elements of Ephesus rarely

presented together. Meander the Marble Road, visit the legendary latrines, check out the Library, and visit the centers of the city. A visit to the Terrace Houses enlivens your picture of Roman Ephesus. Lunch on Mediterranean cuisine in the countryside, and then visit the Ephesus Museum where you get a fuller look at local history, from the Lydians to the Byzantines.



### The Eruption of Vesuvius and the Impact of Volcanoes

— The term "Plinian volcanic eruptions" honors Pliny the Elder who chronicled the 79 CE eruption of Vesuvius. These eruptions eject ash high in the atmosphere, having their greatest impact through global climate change. From Peru to Russia, from eruptions 74,000 BCE to the French Revolution, you'll focus on the impact of volcanoes on history. Time well spent with Dr. Wyssession, who keeps his eye on the Yellowstone Caldera!

**Fermi's Paradox and the Likelihood of Finding Another Earth** — During a discussion on the likelihood of intelligent civilizations existing elsewhere, the physicist Enrico Fermi asked "Well, where is everybody?" Geologic research shows that the conditions required for life to exist continuously for nearly four billion years are stringent, and may rarely occur in the galaxy. Learn all of the factors that had to happen just right to produce Earth's spectacular and potentially unique diversity of geologic and biologic environments.



## GEOLOGY

Speaker: Michael Wyssession, Ph.D.

### Changing Climates, the Black Sea Flood, and the Rise of Civilization

— The philosopher Will Durant said, "Civilization exists by geologic consent, subject to change without notice." The history of climate change illustrates this richly. Dr. Wyssession lays out the factors controlling the climate and how climate change has been the driving factor for the course of human history. You'll get a detailed look at the Black Sea Flood of 7500 years ago, and enrich your understanding of the impact of climate change.

### Santorini and the History of Megatsunamis

— 3600 years ago, Thera/Santorini saw one of most powerful volcanic eruptions known, leaving just the island ring we see today, burying the Minoan city of Akrotiri under 60 feet of ash, creating a megatsunami that devastated the entire Mediterranean. The the U.S. Northwest's 1700 M-9 earthquake, Lisbon's 1755 quake, Krakatoa's 1883 eruption, and the devastating Sumatra 2004 quake created similarly catastrophic tsunamis. Survey the terrain of megatsunamis, and learn potential future tsunami triggers.

SCIENTIFIC AMERICAN TRAVEL

BRIGHT HORIZONS



# The Illusions of Love

How do we fool thee? Let us count the ways that illusions play with our hearts and minds

By **Stephen L. Macknik and Susana Martinez-Conde**

**O**n Valentine's Day, everywhere you look there are heart-shaped balloons, pink greeting cards and candy boxes filled with chocolate. But what is true love? Does it exist? Or is it simply a cognitive illusion, a trick of the mind?

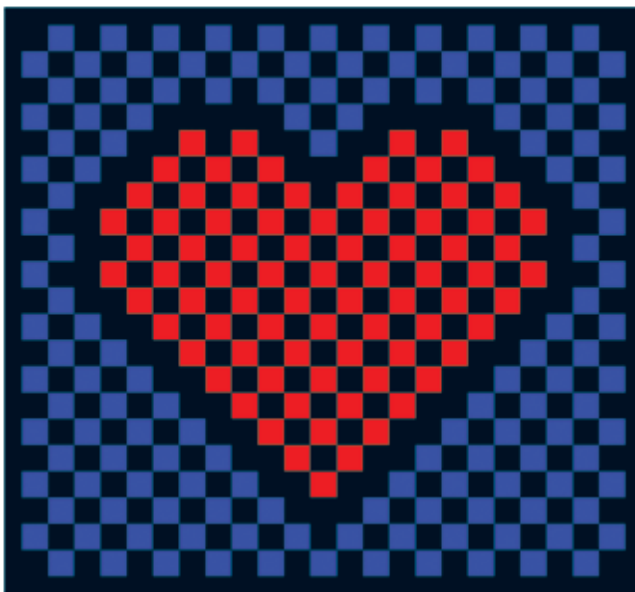
Contrary to the anatomy referenced in all our favorite love songs, love (as with every other emotion we feel) is not rooted in the heart, but in the brain. (Unfortunately, Hallmark has no plans to mass-produce arrow-pierced chocolate brains in the near future.) By better understanding how the brain falls in love, we can learn about why the brain can get so obsessed with this powerful emotion. In fact, some scientists even see love as a kind of addiction. For instance, neuroscientist Thomas Insel and his colleagues at Emory University discovered that monogamous pair bonding has its basis in the same brain reward circuits that are responsible for addiction to drugs such as cocaine

and heroin. Their study was conducted in the prairie vole, a small rodent that mates for life. But the conclusions are probably true for humans, too, which may explain why it is so hard to break up a long-term romantic relationship. Losing someone you love is like going through withdrawal.

In this article, we feature a number of visual illusions with a romantic motif. We hope that you and your special one will enjoy them. And remember, even if love is an illusion, that doesn't mean it's not meaningful and real (to our brains, anyway).

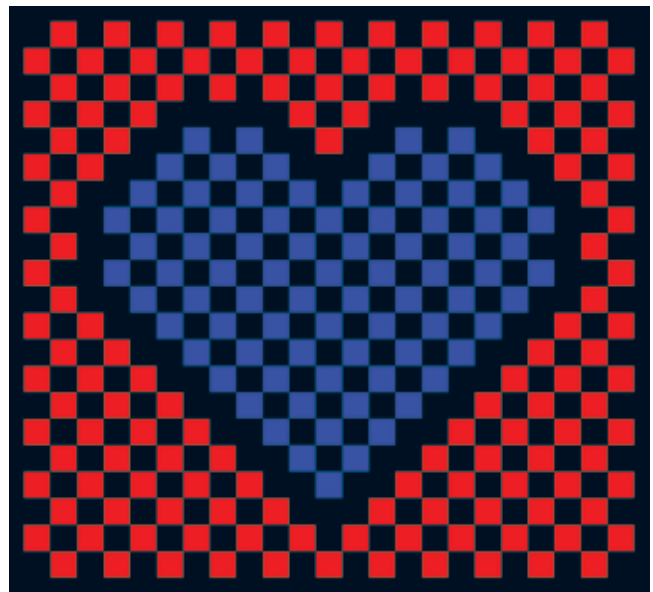
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STEPHEN L. MACKNIK and SUSANA MARTINEZ-CONDE are laboratory directors at the Barrow Neurological Institute in Phoenix. They are authors of the book *Sleights of Mind: What the Neuroscience of Magic Reveals about Our Everyday Deceptions*, with Sandra Blakeslee (<http://sleightsofmind.com>, published by Henry Holt & Co., 2010).



**POPI GOES MY HEART**

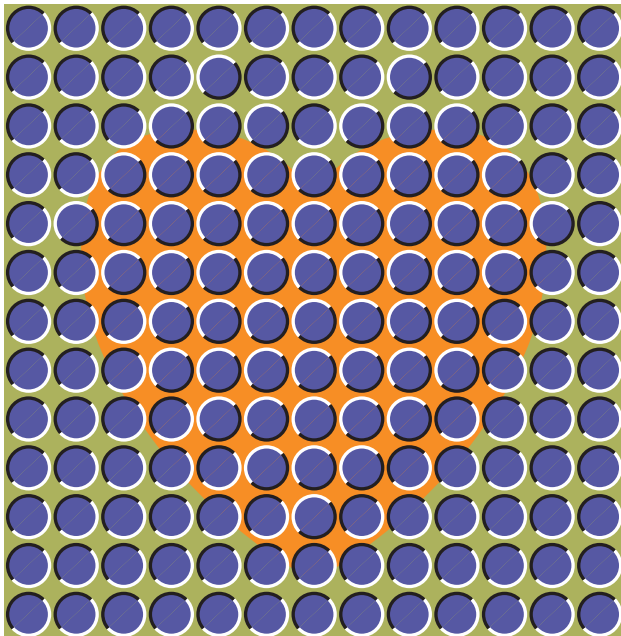
Nothing is more romantic than curling up in front of a fire with your loved one on Valentine's Day as you lovingly whisper "chromostereopsis." Okay, maybe it's not as passionate as a sonnet—unless you are a vision scientist. Look at the red and blue hearts and examine their depth with respect to the background. Most people find that the red heart pops in front of the blue background, whereas the blue heart sinks beneath the red background.



This illusion comes about because the lenses in our eyes refract blue light more than red. This phenomenon is called chromatic aberration; another example of this effect is seeing a rainbow when you shine white light through a prism. When both eyes view the red and blue images simultaneously, the cornea and lens of the eyes refract different amounts of the colors. The brain deals with this sensory aberration by imagining depth—the red heart is in front of the blue background, and vice versa—even though none actually exists.

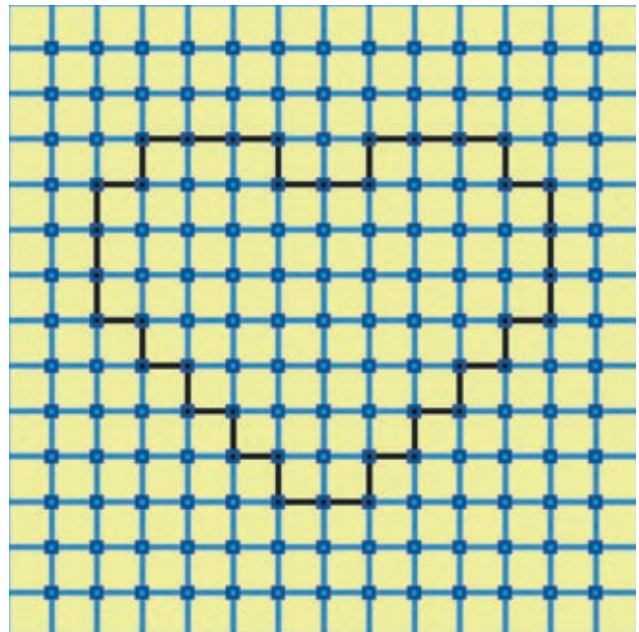
COURTESY OF AKIYOSHI KITAOKA, Ritsumeikan University





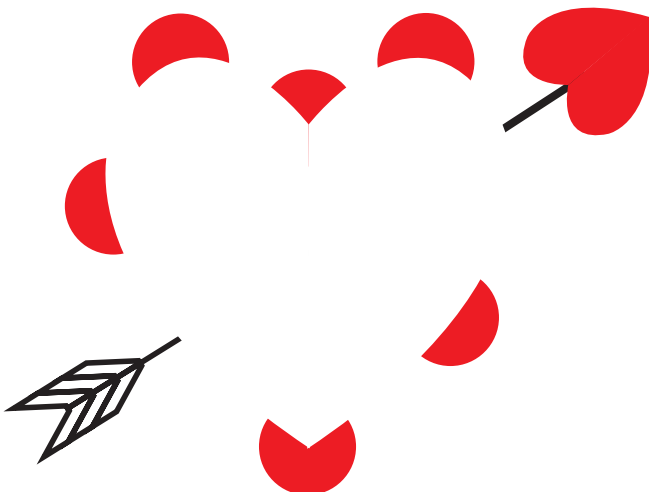
### ILLUSIONS THAT MOVE THE HEART

Your wandering eyes pull at your lover's heartstrings. In this illusion, the heart appears to move and even pulsate as you look around the image. When your eyes move, they shift the retinal images of the black-and-white edges in the pattern, activating the motion-sensitive neurons in your visual cortex. This neural activation leads to the perception of illusory motion. Notice that if you focus your gaze on a single point, the illusory motion slows or stops.



### ILLUSORY NEON HEART

Notice that the yellow fields inside the heart seem paler than the fields forming the contour of the heart, which appear to be a darker shade of yellow-orange. Right? Wrong. Actually all the yellow fields in the figure are identical. Any differences that you see are all in your mind. This effect is called neon color spreading, because it resembles the effect of the light spreading from a neon lamp. The neural underpinnings of this effect are not yet understood.



### IS LOVE AN ILLUSION?

Spanish essayist Miguel de Unamuno said, "Love is the child of illusion and the parent of disillusion." Is this view cynical or biologically based? Illusions are, by definition, mismatches between physical reality and perception. Love, as with all emotions, has no external physical reality: it may be driven by neural events, but it is nonetheless a purely subjective experience. So, too, is the wounded heart we have drawn here. Where the arrow enters and exits the heart, there is no heart whatsoever, only an imaginary edge defined by the arrow.

This effect is called an illusory contour. We perceive the shape of the heart only because our brains impose a shape on a very sparse field of data. Neuroscientist Rüdiger von der Heydt and his colleagues, then at University Hospital Zurich in Switzerland, have shown that illusory contours are processed in neurons within an area of the brain called V2, which is devoted to vision. The illusory heart even looks slightly whiter than the background, although it is actually the same shade. Much of our day-to-day experience is made up of analogous feats of filling in the blanks, as we take what we know about the world and use it to imagine what we do not know.



**A MATCHED SET**

Is it a broken heart or two people kissing? Both, in the case of this two-piece Newman digital audio player. One for him and one for her.

**LOVE AND AMOR**  
Here we see that love and amor are two sides of the same ambiguous object. This sculpture is an ambigram—an artwork or typographical design that can be read from two different viewpoints. Judith Bagai, editor of *The Enigma*, the official journal of the National Puzzlers' League, coined the term by contracting the words “ambiguous” and “anagram” (many ambigrams feature the same word seen from different directions).



**AMBIGUOUS EMBRACES**

Ambiguity is affected by our frame of mind. In the image on the left, *Message of Love from the Dolphins*, adult observers see two nude lovers embracing, whereas young children see only dolphins. If you still can't see the dolphins (we promise you they are there), look for more than two. In the image on the right, a Valentine's Day rose predicts the outcome of the evening's festivities.

BEIJING NEWSMY IDEAL DIGITAL TECHNOLOGY CO., LTD. (top left); FRANCIS TABARY (top right); SANDRO DEL PRETE (bottom left and right)

# (calendar)

## January

### Ending January 2

Artist M. C. Escher famously created “impossible” visual illusions, such as never-ending staircases, perpetually flowing streams and off-kilter perspectives. Such illusions help to reveal how the brain creates its own reality. At the Boston Museum of Science’s **Inside the Mind of M. C. Escher**, visitors can explore these optical phenomena and even try their hand at re-creating an Escher.

Boston  
[www.mos.org](http://www.mos.org)



**15** In 2007 John Cacioppo, a social neuroscientist at the University of Chicago, and his colleagues tried to explain why feeling lonely can make you physically sick—chronic loneliness can trigger changes in the activity of genes linked to diseases, such as cancer and heart disease [see “So Lonely It Hurts,” *Head Lines*; *SCIENTIFIC AMERICAN MIND*, June/July 2008]. At the three-day **First International Society for Social Neuroscience Symposium**, Cacioppo and his fellow researchers from around the world will present their most recent insights on the neuroscience of emotions, decision making and learning.

Shanghai, China  
<http://psychbrain.bnu.edu.cn/teachcms/indexc1.htm>

**26** Most of us know that what we eat changes our bodies, but it is easy to forget that food also shapes our minds, influencing our moods, thoughts and behaviors. For instance, the caffeine in tea and soda makes us alert, the molecule phenylethylamine in chocolate helps to el-

evate our mood, and the chemical myristicin in nutmeg can induce hallucinations at high doses. At the New York Academy of Sciences lecture series, science historian Steven Shapin will explore modern nutrition science in his talk **You Are What You Eat**, delving into the surprising effects foods have on our mind and body.  
New York City  
[www.nyas.org](http://www.nyas.org)

## February

**12** Until the 1970s neuroscientists believed that the human brain stopped developing after a certain age. In the past 40 years, however, researchers discredited this theory, revealing instead how malleable, or “plastic,” the brain is throughout our lives. At the week-long **Winter Conference on Neural Plasticity**, attendees will discuss how our brains change with age and life experience, how learning and remembering result in more neural connections, and how neurological diseases damage these connections.

French Polynesia, South Pacific  
[www.utsc.utoronto.ca/~wcnp](http://www.utsc.utoronto.ca/~wcnp)

### Ongoing

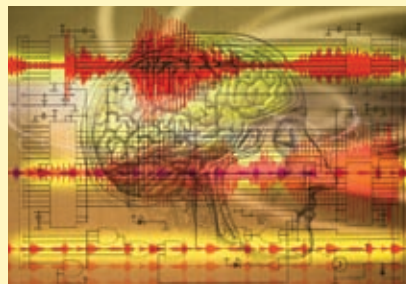
Discover how a bat uses its built-in radar to locate its next meal and peer through the eyes of a model bee head to experience how a bee’s vision allows it to see ultraviolet light reflected off flowers. At **California Science Center’s World of Life** exhibit, you can explore how these animals survive using their instincts.

Los Angeles  
[www.californiasciencecenter.org](http://www.californiasciencecenter.org)



## Roundup: Noises On!

Learn how the brain processes sound in an exhibit, a lecture and a gallery.



### Ending January 23

No matter the style of instrument or the sound it creates, all humans process music in the same way. Music simultaneously activates many brain regions, including areas dedicated to movement, touch and vision. The Metropolitan Museum of Art’s **Sounding the Pacific** is the first art exhibit to exclusively showcase a variety of instruments from Oceania nations such as Australia and the Pacific Islands, including stringed instruments with sounding chambers woven from palm leaves.

New York City  
[www.metmuseum.org](http://www.metmuseum.org)

### February 17

We are wired to remember music. That is what musician and McGill University cognitive scientist Daniel Levitin describes during a lecture series hosted by the **Sage Center for the Study of the Mind** at the University of California, Santa Barbara. Levitin will explain how we can store specific details about melodies long after we hear them. He will also discuss how people acquire musical expertise and why we perceive emotion in music.

Santa Barbara, Calif.  
[www.sagecenter.ucsb.edu/lecture.htm](http://www.sagecenter.ucsb.edu/lecture.htm)

### Ongoing

We depend on covert conversations to tell true friends from potential betrayers. The Chicago Museum of Science and Industry has designed “whispering arches” from a giant metal ellipsoid structure called the **Whispering Gallery**. If you whisper into one of the gallery’s two dishes, the structure conveys your secret across the room, to where a friend awaits.

Chicago  
[www.msichicago.org](http://www.msichicago.org)

● Compiled by Victoria Stern. Send items to [editors@SciAmMind.com](mailto:editors@SciAmMind.com)

MUSEUM OF SCIENCE, BOSTON (Escher); SUSUMU NISHINAGA Photo Researchers, Inc. (bee); MEHAU KULYK Photo Researchers, Inc. (brain)

# Get Attached

**The surprising secrets to finding the right partner for a healthy relationship**

By Amir Levine and Rachel S. F. Heller

A few years ago our close friend Tamara started dating someone new:

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Reprinted from  
*Attached: The New  
Science of Adult  
Attachment and How  
It Can Help You Find—  
and Keep—Love*,  
by Amir Levine, M.D.,  
and Rachel S. F.  
Heller, M.A., with per-  
mission of J. P. Tar-  
cher, a member of the  
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Rachel S. F. Heller.

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*I first noticed Greg at a cocktail party at a friend's house. He was unbelievably good-looking. A few days later we went out for dinner with some other people, and I couldn't resist the glimmer of excitement in his eyes when he looked at me. But what I found most enticing were his words and an implicit promise of togetherness that he conveyed. He said things like, "You can call me any time you like." If I'd only listened carefully, I could have easily heard another message that was incongruent with this promise. Several times he'd mentioned that he'd never had a stable relationship—that for some reason he always grew tired of his girlfriends and felt the need to move on. I figured that Greg was just not ready for a rela-*



PHOTOILLUSTRATION BY AARON GOODMAN

*relationship at the time and that he hadn't met the right person for him. I believed that if he really fell in love with me, he'd want to stick around. But then the strangest thing happened—we did fall in love, but the closer we got, the more he pushed me away. I became so preoccupied with the relationship that I stopped seeing my friends and had a hard time functioning at work. Most of the time my thoughts were directed at him. I hated it, but I also couldn't help it.*

Adults show **patterns of attachment** to romantic partners. This kind of insight can have **astounding implications** for everyday life and might help many people in their romantic relationships.

We were happy at first to see Tamara meet someone new whom she was excited about, but as the relationship unfolded, we became increasingly concerned over her growing preoccupation with Greg. Her vitality gave way to anxiousness and insecurity. Most of the time she was either waiting for a call from Greg or was too worried about the relationship to enjoy spending time with us as she had done in the past. Her work was also suffering. Although she acknowledged that she would probably be happier without him, she was not able to muster the strength to leave.

As experienced mental health professionals, we had a hard time accepting that a sophisticated, intelligent woman such as Tamara had become so derailed from her usual self. Why would somebody we have known to be so adaptive with other life challenges become so powerless with this one? And why would Greg keep her at arm's length, even though it was clear to us that he did love her? We got a sur-

prisingly simple yet far-reaching insight into the situation from an unexpected source—one that we have since learned how to use as a guide for all adults in relationships.

### Early Influences

At about the same time that Tamara was dating Greg, one of us (Levine) was working part-time in the Therapeutic Nursery at Columbia University. Here he used attachment-guided therapy to help mothers create a more secure bond with their children.

Attachment styles were first discovered by an American psychologist, Mary Ainsworth—who collaborated closely with British researcher John Bowlby, the founder of attachment theory. Bowlby proposed that throughout evolution, genetic selection favored people who became attached because it provided a survival advantage. In ancient times, people who were with somebody who deeply cared about them more often than not survived to pass on to their offspring the preference to form intimate bonds.

Ainsworth discovered three distinct ways in which babies and toddlers form attachments with caregivers: secure, anxious and avoidant (a fourth, less common style was later discovered). Infants with a secure attachment style are able to use their mother as a secure base from which to explore the environment, learn and thrive, and derive comfort and reassurance when they are upset or tired. Those who have an insecure attachment style (anxious or avoidant) are too preoccupied with the mother's whereabouts to be easily soothed (anxious) or too seemingly indifferent toward her to use her as a secure base for comfort in times of need (avoidant).

The powerful effect that attachment-guided treatment had on the relationship between mother

#### FAST FACTS

#### Together Forever?

**1»** Researchers have long observed that children have distinct attachment styles to caregivers, which appear to predict certain behaviors.

**2»** More recently, they have begun to appreciate that adults also display attachment styles in romantic settings—and these styles can predict the success of romantic relationships.

**3»** The important lesson is that your love life does not have to be left to chance; understanding your attachment style, and your partner's, can help you find and build a satisfactory relationship.



AGE FOTOSTOCK

and child encouraged Levine to deepen his knowledge of attachment theory. This work eventually led him to fascinating reading material: research findings published in 1987 by Cindy Hazan and Phillip Shaver, both then at the University of Denver, indicated that adults show patterns of attachment to their romantic partners similar to the patterns of attachment that children have with their parents. As he read more about adult attachment, Levine began to notice attachment behavior in adults all around him. He realized that this kind of insight could have astounding implications for everyday life and might help many people in their romantic relationships.

Once Levine realized the far-reaching implications of attachment theory for adult relationships, he called the other one of us (Heller), a longtime friend. He described how effectively attachment theory explained the range of behaviors in adult relationships and asked if she would collaborate with him to transform the academic studies and scientific

data he had been reading into practical guidelines and advice that people could use to actually change the course of their lives.

### Theory and Practice

Attachment theory designates three main styles or manners in which individuals perceive and respond to intimacy in romantic relationships, which parallel those found in children. Basically, secure people feel comfortable with intimacy and are usually warm and loving. Anxious people crave intimacy, are often preoccupied with their relationships and tend to worry about their partner's ability to

### SECURE

in their relationship together, partners can feel comfortable and contented to explore the world. Paradoxically, the more secure we are, the better we are at striking out on our own.

### (The Authors)

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**ANXIOUS**  
attachment style  
craves closeness and  
needs consistent  
reassurance from  
a partner.

love them back. Avoidant people equate intimacy with a loss of independence and constantly try to minimize closeness.

Every person, whether he or she has just started dating someone or has been married for 40 years, falls into one of these categories—or, more rarely, into a combination of anxious and avoidant. Just more than 50 percent are estimated to be secure, around 20 percent are anxious, 25 percent are avoidant, and the remaining 3 to 5 percent fall into the mixed anxious/avoidant category. During the past two decades since Hazan and Shaver's seminal paper on romantic adult attachment, hundreds of scientific studies in a wide range of countries and cultures have carefully delineated the ways in which adults behave in close romantic ties. Understanding these styles is an easy and reliable way to understand and predict people's behavior in any romantic situation.

We saw Tamara's story in an entirely new light now. Greg had an avoidant attachment style—accurate to the last detail. It predicted his distancing, his finding fault in Tamara, his initiating fights that set

back any progress in their relationship and his enormous difficulty in saying "I love you." Research findings explained that although he wanted to be close to her, he felt compelled to push her away.

Tamara was not unique either. Her behaviors, thoughts and reactions were typical for someone with an anxious attachment style. The theory foresaw her increasing clinginess in the face of his distancing: it predicted her inability to concentrate at work, her constant thoughts about the relationship and her oversensitivity about everything Greg did. It also predicted that even though she decided to break up with him, she could never muster the courage to do so.

Tamara and Greg spoke different languages and exacerbated each other's natural tendencies—hers to seek physical and emotional closeness and his to prefer independence and shy away from intimacy. The accuracy with which the theory described the pair was uncanny. Psychological approaches can be somewhat vague, leaving plenty of room for interpretation, but this theory managed to provide precise, evidence-based insights. Wouldn't it be great,

DANI RODRÍGUEZ age Fotostock



Most men and women are **only as needy** as their unmet needs. When their emotional needs are met, they usually **turn attention outward**. This result is sometimes referred to in the literature as the “dependency paradox.”

we thought, if we could help people have some kind of control over their attachments?

### Dependency Paradox

Armed with our new insights about the implications of attachment styles in daily life, we started to perceive people’s actions very differently. But whereas research made it easy to better understand romantic liaisons, how could we make a difference in them? We set out to learn as much as we could about the attachment styles and the ways they intersected in ordinary situations. We interviewed people from all walks of life. We conducted observations of couples in action. We developed a technique that allows people to determine someone

else’s attachment style in everyday life. We taught people how they could use their attachment instincts not only to avoid hopeless relationships but also to uncover hidden pearls worth cultivating.

Attachment principles teach us that most men and women are only as needy as their unmet needs. When their emotional needs are met, they usually turn their attention outward. This result is sometimes referred to in the literature as the “dependency paradox”: the more effectively dependent people are on one another, the more independent and creative they become. Unfortunately, the significance of adult attachment goes unappreciated. Among adults, the prevailing notion is still that too much dependence in a relationship is a bad thing.

**AVOIDANT**  
attachment style  
characteristics include  
expressing independence from the romantic partner and keeping the partner at arm’s length.



CORBIS

Effective communication—the ability to state your feelings and needs in **a simple, nonthreatening manner**—is the quickest way to determine whether your prospective partner **will be suitable** for you.

## What Is Your Style?

**P**eople have different attachment styles: anxious, avoidant or secure (or, more rarely, a combination of anxious and avoidant). The styles can help predict the long-term success of a relationship. Here are sample questions that show how the styles differ.



### Anxious

- When my partner is away, I'm afraid that he or she might become interested in someone else.
- I often worry that my partner will stop loving me.



### Avoidant

- My partners often want me to be more intimate than I feel comfortable being.
- I find it difficult to depend on romantic partners.



### Secure

- I have little difficulty expressing my needs and wants to my partner.
- Sometimes people see me as boring because I create little drama in relationships.

Numerous studies show that once we become attached to someone, the two of us form one physiological unit. Our partner regulates our blood pressure, our heart rate, our breathing rate and the levels of hormones in our blood. Dependence is a fact; it is not a choice or preference. Does this mean that to be happy in a relationship we need to be joined with our partner at the hip or give up other aspects of our life such as our careers or friends? Paradoxically, the opposite is true. The ability to step into the world on our own often stems from the knowledge that there is someone beside us on whom we can rely. If we had to describe the science of adult attachment in one sentence, it would be: If you want to take the road to independence and happiness, first find the right person to depend on and then travel down it together.

What happens when the person we count on most does not fulfill his or her attachment role? In an experiment with functional magnetic resonance imaging, James Coan of the University of Virginia

and his colleagues found that a woman holding the hand of her husband experiences less stress when faced with a mild electric shock than if she holds the hand of a stranger or nobody at all. In another study Brian Baker of the University of Toronto found that if you have a mild form of high blood pressure, being in a satisfying marriage helps keep your blood pressure at healthier levels; if, on the other hand, you are not satisfied with your marriage, contact with your partner will raise your blood pressure whenever you are in physical proximity.

## Elements of Attachment

Bowlby always claimed that attachment is an integral part of human behavior throughout the entire life span. Then, Mary Main of the University of California, Berkeley, and her colleagues discovered that adults, too, can be divided into attachment categories according to the way they recall their relationship with their caregivers, which in turn influences their parental behavior. Hazan and Shaver, independently of Main's work, found that adults have distinct attachment styles in romantic settings as well. They first discovered this by publishing a "love quiz" in the *Rocky Mountain News* in which they asked volunteers to mark the one statement out of three that best described their feelings and attitudes in relationships. The three statements corresponded to the three attachment styles and read as follows:

- I find it relatively easy to get close to others and am comfortable depending on them and having them depend on me. I don't often worry about being abandoned or about someone getting too close to me. [Measurement of secure attachment style.]
- I am somewhat uncomfortable being close to others: I find it difficult to trust them completely and difficult to allow myself to depend on them. I am nervous when anyone gets too close, and often romantic partners want me to be more intimate than I feel comfortable being. [Measurement of the avoidant style.]
- I find that others are reluctant to get as close as I would like. I often worry that my partner doesn't really love me or won't want to stay

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with me. I want to merge completely with another person, and this desire sometimes scares people away. [Measurement of the anxious style.]

How can you improve romantic relationships? The first step is determining your own attachment style. Next, you need to learn how to identify the attachment styles of those around you. Effective communication—the ability to state your feelings and needs in a simple, nonthreatening manner beginning early on in the relationship—is the quickest, most direct way to determine whether your prospective partner will be suitable for you. Your date's response to effective communication can reveal more in five minutes than you could learn in months of dating without this kind of discourse. If the other person shows a sincere wish to understand your needs and put your well-being first, your future has promise. If he or she brushes aside your concerns as insignificant or makes you feel inadequate, foolish or self-indulgent, you can conclude that you may well be incompatible. By spelling out your needs,

you are also making it a lot easier for your partner to meet them. He or she does not need to guess whether something is bothering you—or what that something is.

The most important take-home message is that relationships should not be left to chance. Mismatched attachment styles can lead to a great deal of unhappiness in a relationship, even for people who love each other greatly. But even those with mismatched attachment styles can find more security in their relationships by tapping into the secure mind-set and finding secure role models. **M**

#### ANXIOUS/ AVOIDANT

When someone with an anxious style enters a relationship with someone with an avoidant style, their differing needs for intimacy and closeness may result in a lot of frustration or dissatisfaction.

#### (Further Reading)

- ◆ **Handbook of Attachment: Theory, Research, and Clinical Applications.** Edited by Jude Cassidy and Phillip R. Shaver. Guilford Press, 1999.
- ◆ **An Item-Response Theory Analysis of Self-Report Measures of Adult Attachment.** R. C. Fraley, N. G. Waller and K. A. Brennan in *Journal of Personality and Social Psychology*, Vol. 78, pages 350–365; 2000.
- ◆ **Attachment in Adulthood: Structure, Dynamics, and Change.** Mario Mikulincer and Phillip R. Shaver. Guilford Press, 2007.
- ◆ An online quiz on your attachment style, designed by the authors: [www.ScientificAmerican.com/mind/jan2011/quiz](http://www.ScientificAmerican.com/mind/jan2011/quiz)
- ◆ The authors' informative Web site and blog: [www.attachedthebook.com](http://www.attachedthebook.com)



# The Pain of Exclusion

Even trivial episodes of ostracism can shatter your sense of self. But you can lessen—and learn from—the pain

**By Kipling D. Williams**

**O**ne afternoon in the mid-1980s I was sitting in a park on a blanket beside my dog when a Frisbee rolled up and hit me in the back. I turned around and spotted two guys standing a short distance away with hopeful looks. After standing to return their Frisbee, I moved to sit back down, when, to my surprise, the two strangers threw the disk back to me—an invitation. We formed a triangle on the grass, beginning a spontaneous game of three-way toss. But minutes later, for no discernible reason, they stopped throwing the Frisbee to me. At first, it was sort of funny, but when it became clear that they were not going to include me again, I felt foolish, awkward and hurt. I felt ostracized.

PETER CADE Getty Images



## Even brief episodes of ostracism involving strangers or people we dislike can lead to strong emotional reactions.

Like all social animals, ring-tailed lemurs will ostracize a member of their group if the animal becomes a burden. A lonesome lemur usually does not fare well.



I slunk back to my blanket and dog—and got an idea. As an assistant professor of psychology then at Drake University, I had long wanted to study ostracism, but I never knew how. The scenario in the park had required no conversation, no prior acquaintance and no expectation

of future interaction. Yet it was emotionally powerful. I realized I could re-create my experience in the park as a virtual ball toss or Frisbee game in which certain players are excluded—and thereby take it into the lab.

Cyberball, as I dubbed the computer

game, greatly simplifies the Frisbee incident—stripping away, for example, the precise way the other people look and act—yet manages to capture the emotional essence of ostracism. Today other researchers and I use various tactics to study this condition. We intentionally exclude participants from face-to-face conversations, chat-room discussions or group texting. We examine how people react when others avert their eyes or how participants respond when we tell them that others do not want to work with them. Sometimes we ask participants to recall incidents in which they have been left out and observe the effects of these memories on mood and behavior.

No matter how people are left out, their response is swift and powerful, inducing a social agony that the brain registers as physical pain. Even brief episodes involving strangers or people we dislike activate pain centers, incite sadness and anger, increase stress, lower self-esteem and rob us of a sense of control. Remarkably, we all feel that initial ache about equally, no matter how tough or sensitive we are. Personality traits do, however, influence how well we cope—whether we recover quickly or ruminate endlessly, whether we work to reestablish social ties or lash out in anger.

All social animals use this form of group rejection to get rid of burdensome group members. In nonhuman social animals, an unaccepted member usually ends up dead. Detecting ostracism quickly increases the likelihood that an individual can respond in such a way as to stay in a group and literally or figuratively survive the ordeal.

### The Sting of Silence

Athenians coined the word “ostracism”; they wrote the name of the person they wished to banish on ostraca, shards

#### FAST FACTS

#### The Agony of Ostracism

- 1>> Even brief episodes of ostracism involving strangers or people we dislike activate the brain's pain centers, incite sadness and anger, increase stress, lower self-esteem and rob us of a sense of control.
- 2>> We all feel the pain of ostracism about equally, no matter how tough or sensitive we are. Personality traits do, however, influence how well we cope.
- 3>> Detecting ostracism quickly increases the likelihood that an individual can respond in such a way as to stay in a group and, literally or figuratively, survive the ordeal.

of clay. But the phenomenon appears to have existed for as long as social animals have. Typically the term—defined simply as being ignored and excluded—implies a situation in which a group is shunning an individual, but it could also describe “the silent treatment,” in which one individual ignores another, or a group excludes another group or even an individual rejects a group.

I first became interested in ostracism 32 years ago as a graduate student after watching a documentary about a West Point Academy cadet, James Pelosi. His superiors asked him to leave the academy because he did not put down his pencil at the required moment during an exam. But Pelosi refused to leave, so the unwritten policy of silencing ensued—for almost two years. His roommate moved out, no one talked to him or even looked at him, and when he sat in the cafeteria, everyone at the table would rise and move to another. I was so moved by the power of this silent rejection that I vowed to study it someday.

Of course, social psychologists knew even then that the desire to belong influences many behaviors. People obey, conform, cooperate, engage in groupthink

and may even become reluctant to help others—all to remain part of the gang. But despite a few isolated studies that examined the effects of exclusion, no one was seriously invested in studying ostracism as a subject. Then, about 15 years ago, my colleagues and I began our experiments with ball-tossing games—real ones at first, followed by Cyberball.

In Cyberball, participants toss a virtual ball or disk with what they believe are two other human players represented by animated characters on a computer screen. When the ball is thrown to the participant, represented on screen by an animated hand, he or she throws it back to one of the other players by clicking that player’s cartoon icon. Some of the participants are “ostracized”: they receive the ball once or twice at the beginning of the game—but never again. The other participants—the included ones—get the ball one third of the time, as you would expect in a perfectly egalitarian game of toss.

In one of our early studies, published in 2000, I, along with students Christopher Cheung and Wilma Choi, asked 1,486 participants from 62 countries to play Cyberball online and then surveyed their psychological state using a standard

questionnaire. We found that those who had been cyberostracized for just a few minutes reported unusually low levels of belonging to groups or society, diminished self-esteem, and a lack of meaning in, and control over, their lives. They were also sad and angry. In a separate study, when we asked people to recount real-life incidents in a diary for two weeks, people reported experiencing an average of one such event per day, suggesting that many, presumably insignificant daily occurrences trigger this type of reaction. Moreover, these everyday episodes also increased self-reported measures of sadness and anger and lowered self-esteem and feelings of belonging.

These studies revealed that even subtle, artificial or ostensibly unimportant exclusion can lead to strong emotional reactions. A strong reaction makes sense when your spouse’s family or close circle of friends rejects or shuns you, because these people are important to you. It is more surprising that important instances of being barred are not necessary for intense feelings of rejection to emerge. We can feel awful even after people we have never met simply look the other way.

This reaction serves a function: it

## Just a Game?

Seemingly trivial instances of ostracism provoke outsized emotional reactions. My Purdue University colleagues and I asked people to play a game of computer catch with two avatars, who would, in some cases, refuse to throw them the ball. While they played the game, the participants rated their mood on a dial, moment by moment. Most people who were excluded tried to laugh off the rejection at first but soon grew angry and, finally, despondent. One young man (*right*) first smirked when he failed to receive the ball, but after realizing that he was unlikely to get it again, he flipped off the computer screen. Ultimately he looked resigned to being left out.—K.D.W.



ultimately he looked resigned to being left out.—K.D.W.





Social exclusion crushes self-esteem, because it suggests that you did something wrong. You feel powerless: whatever you do, you will be met with silence. You are invisible, irrelevant and, studies show, in pain.

warns us that something is wrong, that there exists a serious threat to our social and psychological well-being. Psychologists Roy Baumeister of Florida State University and Mark Leary of Duke University had argued in a 1995 article that belonging to a group was a need—not a desire or preference—and, when thwarted, leads to psychological and physical illness. Meanwhile other researchers have hypothesized that belonging, self-esteem, a sense of control over your life

### (The Author)

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and a belief that existence is meaningful constitute four fundamental psychological needs that we must meet to function as social individuals.

I quickly realized that ostracism uniquely threatens all these needs. Even in a verbal or physical altercation, individuals are still connected. Total exclusion, however, severs all bonds. Social rejection also deals a uniquely harsh blow to self-esteem, because it implies wrongdoing. Worse, the imposed silence forces us to ruminate, generating self-deprecating thoughts in our search for an explanation. The forced isolation also makes us feel helpless: you can fight back, but no one will respond. Finally, ostracism makes our very existence feel less meaningful because this type of rejection makes us feel invisible and unimportant.

The magnitude of the emotional impact of ostracism even makes evolutionary sense. After all, social exclusion interferes not only with reproductive success but also with survival. People who do not

belong are not included in collaborations necessary to obtain and share food and also lack protection against enemies.

### Warning Sign

In fact, the emotional fallout is so poignant that the brain registers it as physical pain. In a 2003 study we asked 13 undergraduates to play Cyberball while lying inside a MRI machine. The students thought they were playing with other participants inside other scanners, but in reality their playmates were automated computer characters. As soon as students began to feel ostracized, the scanners registered a flurry of activity in the dorsal anterior cingulate cortex—a brain region associated with the emotional aspects of physical pain [see “When Pain Lingers,” by Frank Porreca and Theodore Price; *SCIENTIFIC AMERICAN MIND*, September/October 2009]. Participants who were included in their games of Cyberball showed no such increased activity in this pain region.



## Even in a verbal or physical altercation, individuals are still connected. Total exclusion, however, severs all bonds.

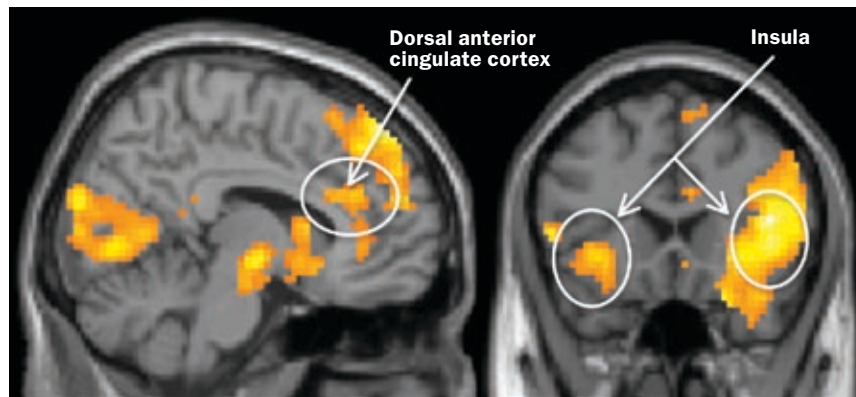
Accordingly, painkillers can reduce the sting of social separation just as they do physical pain. In a 2010 study University of Kentucky psychologist C. Nathan DeWall and his colleagues asked 25 college students to take two extra-strength acetaminophen (Tylenol) or an identical-looking placebo pill twice a day for three weeks. Then the students came to the lab to play Cyberball inside a MRI machine. The ostracized players who had taken acetaminophen showed significantly less activity in the dorsal anterior cingulate cortex (as well as other brain regions associated with emotional responses) than did ostracized players who took placebo pills. In a parallel experiment, the researchers also found that twice-daily doses of acetaminophen over three weeks reduced daily reports of distress and hurt feelings from social rejection in 62 students, compared with the effects of a placebo. Together the findings suggest that social rejection and physical injury are not such different experiences and share underlying neural pathways.

This pain equally affects people of all personality types, no matter how “tough” they seem to be. You might expect, for example, that people who have a lot of social anxiety, who lack self-esteem, or who are introverted, lonely or at risk for depression would suffer greater pain from ostracism. But when we ask Cyberball participants to fill out personality inventories measuring such traits, we find that individual differences have little influence on the intensity of the pain from ostracism. For instance, in a 2006 study University of Sydney psychologist Lisa Zadro and her colleagues found that socially anxious individuals endured no more initial distress from Cyberball ostracism than did those who scored low on social anxiety.

The power of this pain also tran-

sends circumstance and reason. Convincing Cyberball players that a computer rather than a person is excluding them fails to relieve their pain. Being ostracized by people you despise—University of Sydney psychologist Karen Gonsalkorale and I tested reactions to rejection by the Ku Klux Klan—causes as much hurt as being excluded by like-minded people. Even when we, as researchers, provide incentives for being excluded, people still

prompting us to reflect on the situation, determine its meaning and benefit from any mistakes we might have made. Sometimes we are ostracized for a good reason, and the sooner we realize we are behaving inappropriately, the sooner we can correct our behavior. If an individual is left out for slacking off by colleagues at work, for instance, the experience can motivate him or her to be more productive. And the mere fear of being shunned



Being ignored and left out activates the dorsal anterior cingulate cortex, a region linked with the emotional aspects of physical agony, and the insula, an area instrumental in judging pain severity. Taking acetaminophen squelches both these neural responses to ostracism.

feel upset when they are left out: as psychologist Ilja van Beest, then at Leiden University in the Netherlands, and I reported in 2006, people feel bad about not getting the ball even when we tell them they will lose money when they do. And if we tweak the game so participants throw a bomb instead of a ball and tell players that the bomb may explode at any time, “killing” everyone, people still feel excluded and experience pain when the bomb is not thrown to them. This reaction is like feeling bad when you are not invited to play Russian roulette.

### Coping with Exclusion

Yet the pain is functional. It leads to learning that enhances survival by

may motivate us to behave, on a daily basis, in a socially appropriate manner.

Most of us respond to ostracism in real life by slinking away or escaping from the oppressive clique. But an individual may fight back if he or she is, or feels, stuck in a social situation or is given the opportunity to do so. In a 2010 study my graduate student Eric Wesselmann and I asked each of 48 undergraduates to meet with a small group of people whom we collected, and later asked each of them whom they would like to work with on a shared project. We told some of the students that everyone in their group had picked him or her as a partner and others that no one had selected him or her. Then we told all the

participants that because of extenuating circumstances they would be paired with a new student who showed up late for a different experiment.

We then told each pair to complete a food preparation task in which the true participant cooked for the tardy student. Although participants knew that their partner strongly disliked spicy food, those who were told no one wanted to work with them doused the food with a lot (14.35 grams, on average) of hot sauce, compared with just a little (1.75 grams) in

the food from those who thought they were popular. In other studies, ostracized subjects have lashed out by giving perpetrators a negative evaluation for a job or blasting them with noise at the end of a computer game.

Ostracized people may react with hostility because they feel a need to regain a sense of control or, in cases of overt aggression, because they want to be noticed after being made to feel invisible. They act in this manner even though their verbal or physical abuse

may diminish the chances of being included, at least in that particular group. In real life, overt aggression may come more easily to some people than others, depending on personality factors such as narcissism and extroversion. But almost all people may feel compelled to act out against those who excluded them when there is a good opportunity to do so. In extreme cases, ostracized humans may resort to aggressive or violent acts when they have lost hope of being included in any socially acceptable group. Thus,

## Feelings of ostracism may motivate perpetrators of school shootings and members of extremist organizations.



People who feel totally ostracized from society may resort to violence if they have lost hope of rejoining any socially acceptable group.

CLAY PATRICK MCBRIDE/Getty Images



People who are socially anxious do not feel more initial pain from being ostracized than anyone else does. But they take longer to recover from the experience.

student in my laboratory, and I have found that people who are socially anxious, tend to ruminate or are prone to depression take longer to recover from ostracism than other people do. In their 2006 study Zadro and her colleagues found that socially anxious participants still had not fully recovered from Cyberball ostracism 45 minutes after the

game, whereas the less anxious participants had already dealt effectively with their distress.

### Pain Relief

To avoid acting aggressively in response to ostracism and further degrading your social status, try to escape the scene and thus remove yourself from the chance to be belligerent. Then, distract yourself to cope with the sting. Instead of wallowing in involuntary memories, relentless hypotheticals and self-blame, derail that dark train of reasoning and replace it with thoughts of sports, sex or even the weather. You can also speed healing by inflating your sense of self. Remind yourself of your strengths by telling yourself, for instance, “I am a good father, a good tennis player and a good friend.” Such an internal dialogue helps to counter

ostracism’s threat to your self-esteem.

And instead of becoming belligerent, gain that sense of control by being decisive. If you need to choose a restaurant or movie for an outing with a friend, make a suggestion rather than letting the friend decide. You can even create illusions of control when you have none: if you are flipping a coin, call heads or tails before the other person does. That way, you get what you want, even if it does not matter for the chances of winning the bet. Creating such illusions is actually more empowering than lashing out is. On the other hand, attributing ostracism to factors such as prejudice that are beyond your control works against you, prolonging recovery from the experience, as psychologists Stephanie Goodwin of Purdue University, Adrienne Carter-Sowell, now at Texas A&M University, and I found in a recent study of people playing Cyberball with avatars of different races.

And although being accepted into the group that ostracized you is often difficult, other groups will embrace you if you are especially cooperative, hard-working and agreeable. Rekindling ties to family members or old friends also helps you regain a sense of belonging. When the Frisbee players shunned me in the park that day, I retreated, thereby avoiding a confrontation. Then I tried, perhaps subconsciously, to bolster my social and emotional ties—to my dog. More than usual, I petted and played with her. I had a strong urge to be affectionate toward her so she would show her happiness to be with me. **M**

feelings of ostracism may motivate perpetrators of school shootings and members of extremist organizations such as cults or terrorist cells.

But for most people, ostracism usually engenders a concerted effort to be included again, though not necessarily by the group that shunned us. We do this by agreeing with, mimicking, obeying or cooperating with others. In our 2000 study, for example, Cheung and Choi asked participants to perform a perceptual task in which they had to memorize a simple shape such as a triangle and correctly identify the shape within a more complex figure. Before they made their decision, we flashed the supposed answers of other participants on the screen. Those who had been previously ostracized in Cyberball were more likely than included players to give the same answers as the majority of participants, even though the majority was always wrong. Those who had been excluded wanted to fit in, even if that meant ignoring their own better judgment.

Although personality seems to have no influence on our immediate reactions to ostracism, character traits do affect how quickly we recover from it and how we cope with the experience. Psychologist Jim Wirth of the University of North Florida, along with Katie Poznanski, a

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# Body of Thought

Fleeting sensations and body movements hold sway over what we feel and how we think

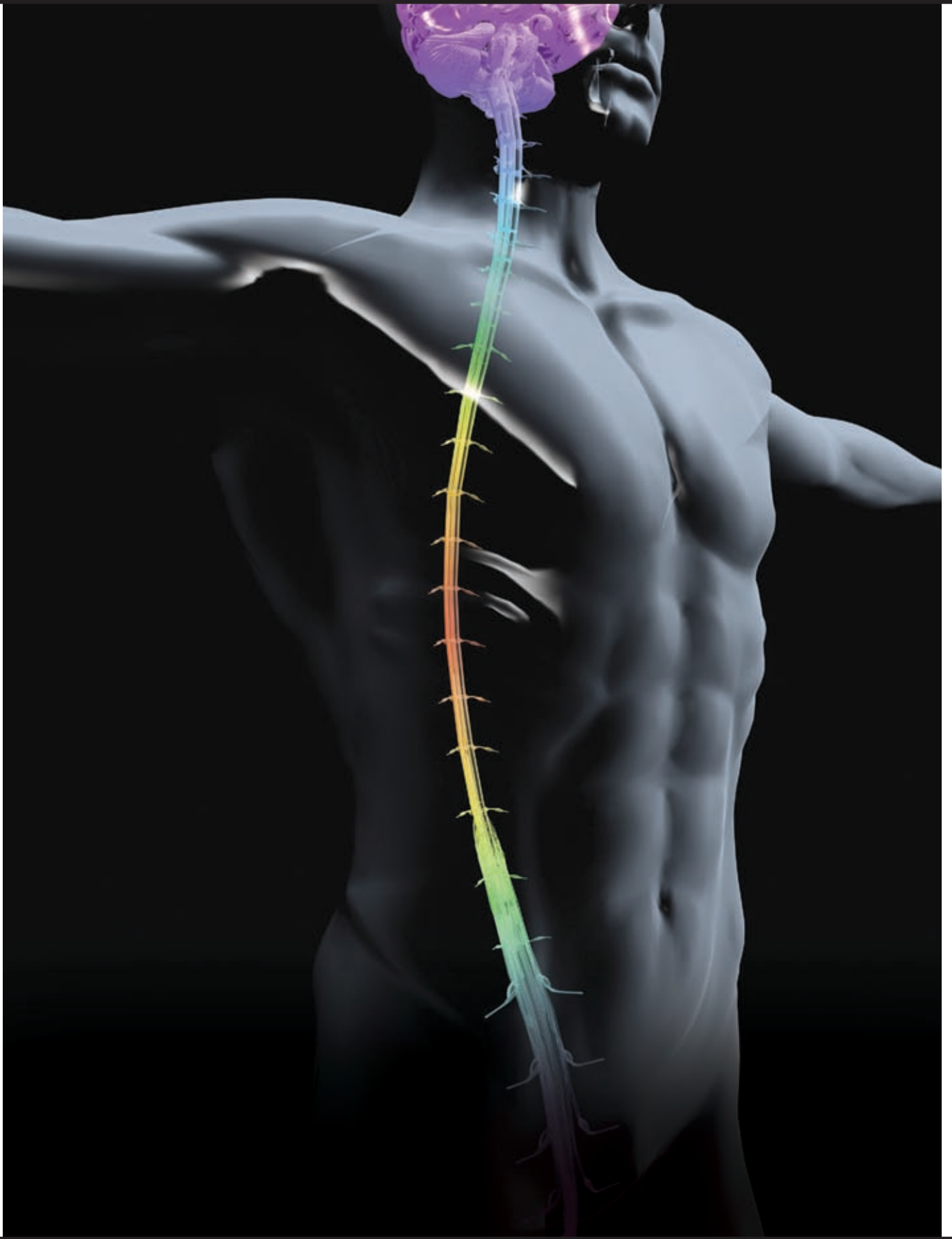
By Siri Carpenter

**W**hy do we look *up* to those we respect, *stoop* to the level of those we disdain and think *warmly* about those we love? Why do we hide *dirty* secrets or *wash* our hands of worries? Why do we ponder *weighty* subjects and feel a load *lift* after we have made a decision? Why do we look *back* on the past and *forward* to the future?

Such turns of phrase, invoking a physical reality that stands in for intangible concepts, might seem like linguistic flights of fancy. But a rapidly growing body of research indicates that metaphors joining body and mind reflect a central fact about the way we think: the mind uses the body to make sense of abstract concepts. Thus, seemingly trivial sensations and actions—mimicking a smile or a frown, holding smooth or rough objects, nodding or giving a thumbs-up—can influence high-level psychological processes such as social judgment, language comprehension, visual perception and even reasoning about insubstantial notions such as time.

The implications seem almost preposterous.

Holding a warm cup of coffee will make me view others more warmly as well? Entering a Wind-scented room will bring out the Good Samaritan in me? Holding a heavy clipboard while responding to a survey will give the issues at hand more gravitas? As far-fetched as such sensory non sequiturs may seem, the evidence for “embodied” or “grounded” cognition is persuasive. “The empirical case is becoming increasingly overwhelming,” says psychologist Lawrence Barsalou of Emory University. “Cognition is emerging, to a significant extent, from all these things—like warmth, cleanliness and weight—that we used to think were irrelevant to cognition.”



AGE FOTOSTOCK



The way you sit or stand can affect how you think, feel and act. An expansive “power” pose leads to riskier decision making. Parking yourself in a hard chair can turn you into a tough negotiator.

Recent research suggests, for example, that the flexing of our facial muscles does not just reflect our emotions but is necessary for our experiencing them. Even less logically, our minds link morality to cleanliness, a connection that underscores just how desperately our processing of abstractions hangs on physical attributes. Even more jarring, people represent the concepts of past and future in a bodily code that includes direction of movement

#### FAST FACTS

### Grasping Concepts

- 1**» The mind uses the body to make sense of abstract ideas. Thus, seemingly trivial sensations and actions—mimicking a smile, holding smooth or rough objects, nodding or giving a thumbs-up—can influence social judgment, language comprehension, visual perception and even reasoning.
- 2**» The flexing of our facial muscles does not just reflect our emotions but is necessary for our experiencing them.
- 3**» People represent the concepts of past and future in a bodily code that includes direction of movement and perception of space.
- 4**» We can now get a grasp of our own feelings and actions by looking beyond our minds to our bodies and the world around us. Such a perspective can point us toward actions that change the way we think and learn.

and perception of space. And our concept of space itself depends on mental simulations of the movements necessary to span that distance.

Such bizarre interactions imply that our brains do not really differentiate between our physical interface with the environment and high-level, abstract thought. The idea that the mind is anchored to the body’s actions and surroundings “gives us a much better way of trying to understand how people work—our social behavior, our emotional lives, our cognitive lives,” says psychologist Arthur Glenberg of Arizona State University. Indeed, armed with this new conception of how thought works, we can now get a grasp of our own feelings, opinions and actions by looking beyond our minds to our bodies and the world around us. Such a perspective can point us toward actions that change the way we think and learn.

### Challenging Dogma

Since the 1960s most cognitive scientists have likened the neural machinery responsible for higher cognition to a freestanding computer, separate from the brain areas that are responsible for bodily sensation and action. According to this idea, the brain receives input about sights, smells, sounds, and so on from the body’s sensory and motor systems, but then converts those raw data into disembodied symbols and rules, in much the same way that a computer converts every piece of information—the color red, a photograph of your grandmother, the word “love”—into zeros and ones. On these symbols, stripped of their raw, physical origins, the brain performs the many complex calculations that we call thought.

Beginning in the late 1980s, however, a few scientists challenged the view that the body is just an input-output device for the brain. They suggested that instead, higher cognitive processes are grounded in bodily experience and in the neural systems that govern the body. In this view, the brain’s low-level sensory and motor circuits do not just feed into cognition; they *are* cognition.

Back then the idea had little scientific backing. “We were totally ridiculed—people didn’t take it seriously,” Barsalou recalls. But by the late 1990s the evidence started trickling—then pouring—in. Just in the past few years studies have shown that holding a hot cup of coffee or being in a comfortably heated room warms a person’s feelings toward strangers; that striking an open, expansive “power pose” prompts people to make bolder decisions; that wearing a heavy backpack makes hills look steeper; that a water bottle looks closer when you

are thirsty; that moving objects upward versus downward speeds recall for positive versus negative memories; and that sitting on a hard chair turns mild-mannered undergraduates into hard-headed negotiators.

That the mind relies heavily on the body for information should not be surprising. After all, the body is our only real tether to the world—all the knowledge you acquire, you get through your senses. Close ties between the body and thought make sense from an evolutionary perspective, too. Over millions of years many cognitive scientists believe, our increasingly powerful cognitive abilities piggy-backed on existing neural systems that evolved for simpler, physical tasks such as visual detection or spatial navigation.

According to this view, thinking is reliving: I cannot reflect on last summer's trip to the Grand Canyon without recruiting some of the same brain cells that recorded the sight of its majestically striped walls. I cannot process the plot of a novel without simulating the sensations the text describes nor judge the height of the hill ahead of me without mentally climbing it. "The brain simulates real experience in order to make sense of the world," Barsalou says.

### Facial Feedback

Anyone who has sweated a job interview or clenched a fist in anger knows that living an emotional experience is a physiological event. This phenomenon is reflected in the idioms we call on



An injection of Botox that paralyzes the muscles needed for frowning can also jam the neural circuits responsible for processing negative emotions, making sad and angry sentences harder to understand.

Results of a now classic study led by psychologist Fritz Strack, now at the University of Würzburg in Germany, show that the simple act of making a facial expression affects both how we feel and how we interpret emotional information. Strack and his colleagues found that people rated *Far Side* cartoons as funnier when they were holding a pen between their teeth, without allowing it to touch their lips (a pose that activates muscles used for smiling), than when they were holding a pen between their lips (which prevents smiling). Those findings indicate that the face sends important

## Words that evoke disgust stimulated increased activity in the muscles that curl the upper lip and wrinkle the nose.

to describe our feelings: your heart sinks, your stomach flips, you jump for joy, you are mad enough to spit nails. "Emotional states are associated with a tendency to action," says psychologist Paula Niedenthal of Blaise Pascal University in France. As a result, people do not say, "I was so mad that I just ... sat there."

In addition to the physiological systems that regulate heart rate, sweating and body movement, the triggering of emotions involves the activation of at least some of the 20 or so muscles of the face that control emotional expression. That fact raises the question of how that peripheral physiology affects thought: Can merely changing the configuration of a person's facial muscles affect how that person thinks about emotion?

feedback to the brain, which it then uses to interpret information about the world.

Many researchers, including Niedenthal, believe that the brain cannot fully think about emotion without reenacting, or physically simulating, that feeling. In a 2009 study she and her colleagues used electromyography to measure facial muscle activity and found that reading emotional words while considering their meaning triggered the same subtle muscle activity that people show when expe-

### (The Author)

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side whether that is an experience I want to seek out or avoid. Otherwise, how could I know?”

What happens when people’s ability to simulate specific emotional expressions is blocked? In 2009 neurologist Bernhard Haslinger and his colleagues at the Munich University of Technology gave participants Botox injections to the forehead, temporarily paralyzing the muscle that is responsible for frowning. The treatment muted activity in the amygdala, a key emotion center, while participants were attempting to mimic unhappy expressions but not when they were mimicking happy faces. The results suggest that by thwarting muscle activity, Botox treatment somehow jammed the neural circuits needed to fully process negative emotion. A 2010 study led by Glenberg and University of Wisconsin–Madison graduate student David Havas bolsters that conclusion, showing that participants who underwent Botox treatment for frown lines were subsequently slower to comprehend sad and angry sentences but not happy ones.

### Clean Hands, Pure Heart

The body plays an equally important role in reasoning about abstractions. Consider, for example, the link between physical cleanliness and moral purity—the relation that Shakespeare’s Lady Macbeth felt so desperately as she tried to scrub away her sins. In a 2006 study psychologists Chen-Bo Zhong of the University of Toronto and Katie Liljenquist of Northwestern University gave research participants the same opportunity (though under less murderous circumstances). They first asked participants to recall doing ethical or unethical deeds, then gave them an ostensibly unrelated word-completion task. Those who had remembered unethical behavior were more likely than those who had summoned up ethical behavior to generate cleansing-related words such as “wash” and “soap,” rather than words such as “wish” and “step.” In a follow-up experiment, 75 percent of people who had recalled unethical deeds later selected an antiseptic wipe (rather than a pencil) as a parting gift, compared with only 37.5 percent of people who had brought to mind ethical deeds.

On the face of it, that the human psyche would tie physical cleanliness and moral purity defies logic—any rational person knows that a bar of soap will not absolve wrongdoing. Yet clearly, the bond runs deep. Water-purification rituals, for example, are a part of most of the world’s major religions. Zhong and Liljenquist speculate that the connection may stem in part from a basic cognitive need to root abstract qualities in bodily experience and in

Our minds tie physical cleanliness to moral purity. The link shows up in our speech: we “wash away our sins” and “keep dirty secrets.” But this visceral connection to morality is embedded deep within our psyches.

riencing those emotions. Words that typically evoke disgust, such as “vomit” and “foul,” stimulated increased activity in the facial muscles involved in curling the upper lip, wrinkling the nose and frowning the brow. Words that connote anger, such as “murder” and “enraged,” also provoked activity in the muscle that furrows the brow. And words that connote joy, such as “smile” and “delighted,” set off the muscles responsible for raising the cheeks and crinkling the eyes into a smile.

In other words, the researchers concluded, when people reasoned about emotional concepts it caused them to simulate a bodily experience of the emotion, evidence that the reasoning and the muscle activity are linked. “If someone asks me to go see a scary movie,” Niedenthal says, “I can reexperience the feeling of fear I have had while watching such movies and de-

ANDREA BRICCO Corbis



part from an evolved disgust toward unclean foods. That primal disgust, some researchers believe, has expanded to take on broader cultural meanings, so that moral violations pose the same kind of threat as physical impurity.

The presence of that connection is obvious in the language we use to describe moral violations—we speak of keeping dirty secrets and yearning for a clean conscience. Our language further suggests that moral cognition is tightly bound to the specif-

lands and his colleagues found that the same left-right association infiltrates not only our visual spatial sense but also our hearing. In the study participants donned headphones and heard time-related words such as “yesterday” and “tomorrow,” along with neutral words such as “identical” and “closet.” The experimenters told them to report whether each word presented was louder in their left or their right ear. When words were presented equally loudly to both ears, listeners nonetheless perceived past-

## People rated hand sanitizer highly after lying via e-mail; mouthwash got higher scores after a voicemail fib.

ic body parts responsible for ethical transgression—say, the mouth for swearing or the hands for groping. “In natural language, when people swear, we say they have a dirty mouth,” observes Spike (Wing Sing) Lee, a psychology graduate student at the University of Michigan at Ann Arbor. “If someone steals something, we might say that they have sticky fingers.”

The specificity of such sayings led Lee and psychologist Norbert Schwarz, also at Ann Arbor, to wonder whether people actually project immoral behavior onto specific body parts. In a 2010 study they asked research participants to role-play a scenario that required them to tell a malevolent lie using either voicemail or e-mail, then rate the desirability of several consumer products. Lee and Schwarz found that people rated hand sanitizer more highly after lying via e-mail rather than voicemail and rated mouthwash more highly after lying via voicemail rather than e-mail. Thus, people did seem to make a subconscious, nonverbal connection between a part of their body and the specific type of unsavory deed.

Just as moral reasoning rests, however illogically, on bodily sensation and action, so does our concept of time. In a 2010 study using motion sensors to detect tiny movements, psychologist Lynden Miles of the University of Aberdeen in Scotland and his colleagues found that thinking about the past caused people to sway about two millimeters backward, whereas thinking about the future caused them to sway imperceptibly forward.

Other research reveals that people think of time as occupying physical space, with the past on the left and the future on the right, a finding consistent with the fact that people in Western cultures write from left to right. In a 2010 study psychologist Gün Semin of the University of Utrecht in the Nether-

related words as louder in the left ear and future-related words as louder in the right ear.

The idea that we process time as flowing from left to right with our ears as well as our eyes is “mind-blowing,” Semin says. “On the surface, there is no reason for this to happen.” Yet, he speculates, the cultural experience of writing from left to right somehow changes our brain architecture, so that the brain represents the past in its right hemisphere, which takes input from the left eye, ear and side of the body, and the future in its left half, which interprets sensory stimuli from the right half of the physical world.

### Taking Measure

Even basic visual perception is susceptible to the whims of the body. In a 2008 study, for example, psychologists Dennis Proffitt of the University of Virginia and Jessica Witt of Purdue University found that participants judged out-of-reach objects

Even the concept of time has a physical presence in our thoughts. It moves from the past, on our left, to the future on our right.



to be closer when they were told they would be able to use a 39-centimeter conductor's baton to reach the objects, compared with participants who had no baton.

Why would simply having a tool with which to reach objects make the objects seem closer? Proffitt argues that when you view an action and your in-

To test whether judging distance actually requires that people simulate the act of spanning that distance, in a second experiment Proffitt and Witt gave participants a baton for reaching out-of-range objects but asked half to squeeze a rubber ball with their reaching hand while making their distance judgments. Results showed that the ball squeezers

## Could surrounding ourselves with smooth and soft textures help smooth our personal relationships?

attention is to reach for it, the extent of your body's reach is your "action boundary"—the limit of your potential action. Having a tool that extends your reach allows you to mentally simulate using that tool for reaching. This causes your action boundary to shift, making you perceive the target as closer. "The only measuring stick that we really have is the body, so what we do, measuring the environment, is to use our bodies," Proffitt says.

perceived the objects as farther away than did those without a ball, indicating that compressing the ball had interfered with their ability to mentally simulate a different action—reaching.

### Acting Out

If bodily states infiltrate cognition so often, why are we so seldom aware of this phenomenon? How is it possible that the temperature of a room could

Having a tool that enables us to nab out-of-reach objects makes the objects seem closer. We estimate distance by our ability to span it using our bodies or extensions of them.



KARIN SMEDS Getty Images

affect how I feel about my companions, or that the hardness of my chair could affect my negotiating ability, or that a disgusting smell could provoke me to behave immorally, all without my knowledge? Sometimes our physical sensations and movements are probably too fleeting or trivial for us to notice their effect on our mental lives. Other times, our failure to recognize the connection between our bodily experiences and our thought processes may arise from the simple fact that it seems preposterous. If I have to perch on a hard chair for a salary negotiation, I may be uncomfortable, but I am unlikely to pay much attention to my discomfort, focused as I am on negotiating. Under those circumstances, if I drive a hard bargain, I am unlikely to credit the chair.

But the weight and expanse of data on embodied cognition suggest that making subtle adjustments to our actions or our physical environments could yield big rewards. Yale University psychologist John Bargh and his colleagues' research shows, for example, that rough textures tend to make social interactions seem rough, too, and that touching hard objects leads us to judge others as more rigid. Could surrounding ourselves with smooth and soft textures help smooth our personal relationships? If I choose to have hot coffee rather than a Coke with a new acquaintance, will I end up feeling more warmly about that person? Will spritzing my home with clean, pure fragrances help me meet my charitable ideals? Embodied cognition theories indicate that such environmental adjustments, along with related attention to the ways in which we hold or shift our bodies, can make a surprising difference in our mental and emotional lives.

Embodied cognition might also have important implications for education. Gesturing while doing math problems helps children learn and retain what they have learned [see "Hands in the Air," by Susan Goldin-Meadow; *SCIENTIFIC AMERICAN MIND*, September/October 2010]. Physical action is equally valuable for children learning to read. In a number of recent studies, Glenberg and his colleagues have shown that elementary school children who, while reading, manipulate toys or pictures on a computer screen to simulate the action in what they are reading demonstrate better reading comprehension and more vocabulary growth.

Building on those findings, Glenberg's team has further learned that simulating action helps kids solve math story problems more efficiently. In one scenario, children read a story problem involving a robot's movements and were asked to calculate the total number of steps the robot took. The catch was



that the text also provided irrelevant numerical information, such as the number of people the robot greeted. The study found that children who were instructed to physically manipulate images on a computer screen to mimic the robot's actions were better able to ignore the irrelevant information. What is more, after learning the physical-manipulation procedure, children got the same benefits just by imagining how they would move images to simulate the action in the story—a technique that may be more practical in classrooms, which are likely to lack props to match every story.

"The idea that language comprehension requires simulation is something that is not taught," Glenberg says. "We're counting on children to make this leap from the written word to the simulation, but some children are not making that leap—they're just saying words." Teaching children to simulate action while reading, he says, may give those who are struggling the boost they need to keep up with their peers. "In my fondest dreams," Glenberg adds, "I see teaching a large number of people to read as my real contribution." **M**

**The temperature of what you drink could influence your social interactions. Clutching a cup of hot coffee makes you feel more warmly about the people around you than does holding a cold beverage.**

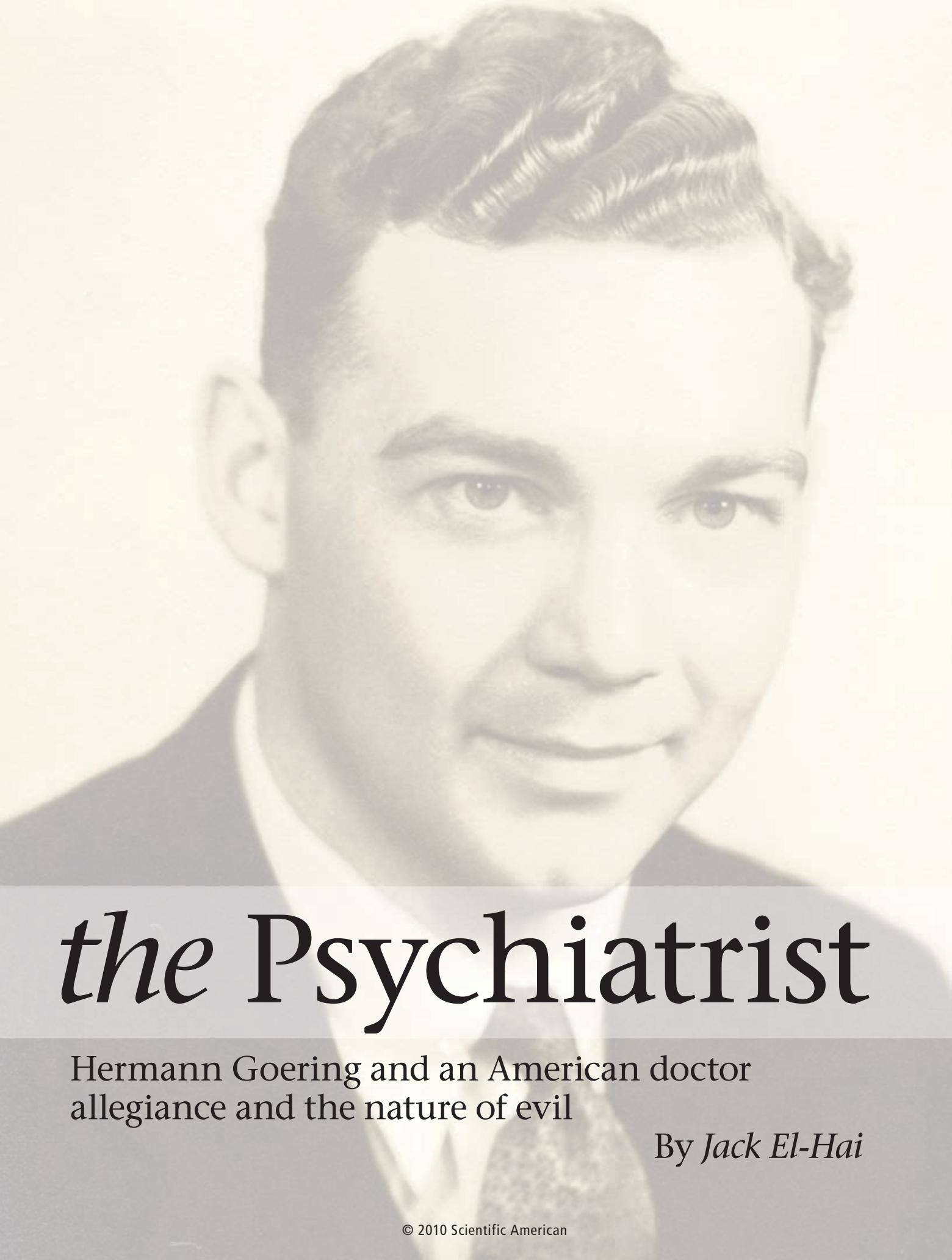
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# The Nazi *and*

Encounters behind bars between Nazi war criminal  
65 years ago raise questions about responsibility,



# *the* Psychiatrist

Hermann Goering and an American doctor  
allegiance and the nature of evil

*By Jack El-Hai*

In the early summer of 1945 a 52-year-old prisoner arrived at Mondorf-les-Bains, a town in Luxembourg that included an American detention center for suspected war criminals. The prisoner, dragging 49 suitcases, gem-encrusted jewelry, gold cigarette cases, precious watches and nearly the entire world's supply of the narcotic paracoedine, had surrendered to Allied officials several weeks earlier. After a dozen years in which he held nearly unchecked power and could demand anything he desired, he now occupied a small cell furnished only with a toilet, bed, chair and table. The bloody collapse of the Third Reich, whose Nazi government he now represented as the highest-ranking captive, had left him a leader without followers, a commander without fighters, and a prisoner accused of murdering millions and committing other crimes against humanity. He acknowledged the right of the victors of World War II to punish the Nazi leadership, but he planned a vigorous defense of his actions at his forthcoming war crimes trial.

This was the situation of Hermann Goering, formerly deputy of Adolf Hitler, president of the Reichstag, commander in chief of the German air force, member of the Secret Cabinet Council and Reich Marshal (along with a slew of other official titles), when a 32-year-old American psychiatrist named Douglas M. Kelley entered his cell for the first of many meetings. Kelley was among the few people—along with other medical personnel, lawyers and guards—allowed access to Goering. During the next six months the prisoner and the psychiatrist would hash over the outcome of the war, the fate of Goering's family and the Reich Marshal's legacy.

For the prisoner, this talk relieved the stress of incarceration. For Kelley, a major in the U.S. Medical Corps from northern California and chief psychiatrist



December 28, 1945: An American sergeant peers into Goering's cell at Nuremberg. Kelley was one of a few people allowed to see the Nazis in solitary confinement.

#### FAST FACTS

### A Trial at Nuremberg

**1»** In the aftermath of World War II, American psychiatrist Douglas M. Kelley worked closely with captured Nazis as their general physician and psychiatric evaluator.

**2»** Despite Kelley's abhorrence of Nazi crimes, he formed a close relationship with the highest-ranking prisoner, Hermann Goering, who impressed Kelley with his intelligence, tenacity, and dedication to his country, family and friends.

**3»** The balancing act Kelley performed—as he tried to remain loyal to his superiors as well as dedicated to his patients' health and wellness—is echoed in the modern dilemmas faced by doctors and psychologists in situations such as the prison at Guantanamo Bay in Cuba.

in the U.S. Army's European Theater of Operations, the stakes were higher. The meetings offered an incomparable look into the mind of one of history's most infamous criminals and an opportunity to analyze the personalities of the high-ranking Nazis being held at Mondorf-les-Bains. After the horror of the war, Kelley wrote, "the near destruction of modern culture will have gone for naught if we do not draw the right conclusions about the forces that produced such chaos. We must learn the why of the Nazi success so we can take steps to prevent the recurrence of such evil." In addition, Goering was the last man standing after the rest of the top echelon of Nazis—Hitler, Heinrich Himmler and Joseph Goebbels—had committed suicide. Kelley hoped to use the information he gathered to break new ground in the study of criminal motivation and the use of the Rorschach inkblot test—a psychological tool he had long championed.

PRECEDING PAGES: COURTESY OF DOUG KELLEY; THIS PAGE: BETTMANN/CORBIS

Kelley grew to admire Goering's forthright stand, and he also respected what he called Goering's "extreme fondness for and tenderness toward his family and friends."

Kelley's personal papers and the medical records he kept, which his family has never previously opened to examination before making them available for this article, show how the psychiatrist doggedly followed his ambitions in Goering's cell as he crossed the boundaries between working as physician, serving as confidante, informing on the prisoner to prosecutors, and developing sobering conclusions on the nature of the Nazi mind. By the time of the trial, Kelley was experiencing the odd mental dissonance that many people who work with criminals report feeling today: despite abhorring the atrocities that Goering committed and commanded, Kelley grew to see him as a captivating—even likable—human being.

In his quest to make sense of Goering's personality, Kelley pioneered the psychiatric evaluation of war criminals. His missteps and blurred boundaries foreshadowed the ethical conflicts that military psychiatrists and psychologists continued to face during the cold war and, more recently, in the wars that spawned the military prisons at Abu Ghraib in Iraq and Guantanamo Bay in Cuba. Questions of allegiance, as well as the confounding dissonance between a prisoner's alleged crimes and the attractions of his personality, still haunt psychological specialists who aid in the interrogation of detainees from the battlefield.

### The Good Doctor

Kelley's official role at Mondorf-les-Bains and at the prison in Nuremberg, Germany, that later held Goering and the 21 other top Nazi leaders for judgment before an unprecedented international tribunal



was to tend to the medical needs of prisoners as he evaluated their mental fitness to stand trial. Born in the rugged mountain town of Truckee in the Sierra Nevada, Kelley by the age of 30 had risen through psychiatry's ranks to a position of responsibility as director of the San Francisco County Psychopathic Hospital. He joined the army and served in the European theater of the war as chief psychiatrist for the 30th General Hospital. That put him in the right place at the right time for the historic trial planned for the war's end in Nuremberg. Although he did not speak German, his ambition, brains and burning curiosity compelled him to take advantage of this unique chance to scrutinize the Nazi leaders.

Kelley's initial impressions of his most notorious subject were memorable. "Each day when I came to his cell on my rounds," Kelley wrote, "he would jump up from his chair, greet me with a broad smile

July 14, 1938: Goering with his wife, Emmy, and their newborn daughter, Edda.

### (The Author)

JACK EL-HAI is author of *The Lobotomist: A Maverick Medical Genius and His Tragic Quest to Rid the World of Mental Illness*. He is currently writing a book about the trial of Nazi doctors that immediately followed the judicial proceedings against Hermann Goering and the other top Nazi leaders in Nuremberg, Germany.



Kelley believed that Goering and his cohorts were commonplace people and that their personalities could be duplicated in “any country in the world today.”

haps require doses of medicine should they ever be withdrawn from a drug habit, he, Goering, being strong and forceful would require nothing.”

With Goering successfully weaned from the narcotic, Kelley turned his attention to his main object: the Nazi’s psychiatric state. Because of his responsibilities to the international tribunal, Kelley had to answer whether Goering was mentally competent to stand trial. Beyond that, he had his own puzzle to solve: What motivated the Nazi and made his personality distinctive? Kelley began by gathering a history of Goering, from his beginnings as a World War I fighter pilot to his friendship with Hitler during the early 1920s and his rise in the Nazi ranks to become commander of the Luftwaffe and the Führer’s heir apparent. From that foundation, Kelley built his psychiatric appraisal.

### The Nazi Personality

Kelley believed the Rorschach test, developed by Swiss psychiatrist Hermann Rorschach after World War I, was crucial to his understanding of Goering and the other prisoners. The test offers 10 abstract images for subjects to describe and spin stories from. Kelley was considered an expert evaluator of subjects’ personalities by this method of focusing on various aspects of their responses to the inkblot images. He weighed such things as whether subjects considered the entire Rorschach picture or just details and the logical sense of their interpretations. (During the 1950s and 1960s Rorschach remained the most popular personality test in use, although today it is large-

and outstretched hand, escort me to his cot and pat its middle with his great paw. ‘Good morning, Doctor. I am so glad you have come to see me. Please sit down, Doctor. Sit here.’ Then he would ease his own great body ... down beside me, ready to answer my questions.” Even through a translator, Kelley found him charming (when Goering chose to be so), smart, eloquent and imaginative. Goering had a childish enthusiasm for showing off the wartime loot he was able to keep with him in prison: huge rings, one set with a massive platinum-mounted ruby, others with emeralds and blue diamonds, as well as an enormous unset emerald.

Kelley initially had to focus on improving Goering’s health by ending his longtime drug dependency. At the time of his capture by the Allies, Goering was taking a large daily dose of paracodeine, a narcotic then produced only in Germany for the treatment of pain. His addiction dated back to dental work of the 1930s. Goering gradually ended his pill-popping with some psychological manipulation from Kelley. “Goering was very proud of his physical prowess and his ability to withstand pain,” the psychiatrist wrote. “Consequently, it was simple to suggest to him that while weaker men ... would per-



ly discredited, and many psychologists do not recommend using it to diagnose mental disorders.) Although his Rorschach results for Goering never made it into court, Kelley was convinced they could reveal the psychological workings of the deposed leader.

By this time Goering had been moved to the Palace of Justice in bombed-out Nuremberg, where he and an assortment of the top Nazis snared by the Allies (including German Army Chief of the General Staff Alfred Jodl, Foreign Minister Joachim von Ribbentrop, former Deputy Führer Rudolf Hess, Nazi Party philosopher Alfred Rosenberg and Hitler Youth Head Baldur von Schirach) were held in solitary confinement through their trial. The Nuremberg warden, Colonel Burton Andrus, had brought in an American psychologist, Gustave M. Gilbert, to assist Kelley in evaluating the prisoners. Kelley did not welcome Gilbert's help, and their relationship was often strained. Together, however, they completed the Rorschach testing of nearly all the war crimes defendants.

Kelley found Goering's results surprising, given the wartime propaganda that the Nazi leaders had to be madmen. Goering's responses to the Rorschach images demonstrated "normal basic personality," Kelley wrote, although they also revealed "marked egocentricity and powerful emotional drives." They showed nothing seriously wrong with Goering's mind. Nevertheless, Kelley considered the test results a good first step toward gaining insight into Goering's thinking. He used intelligence testing to assign Goering an IQ of 138, third highest among the incarcerated Nazis. (This score delighted the vain Goering.)

Kelley further noted that the prisoner was "cynical and filled with a mystic fatalism," which explained why he would not take responsibility for such wartime conduct as his murder of political opponents and complicity in genocide. In his initial neurological and psychiatric report on Goering (a record hidden among Kelley's personal papers for the past 65 years), the psychiatrist observed Goering's emotional volatility and narcissistic fixation on what the prisoner perceived as the beauty and strength of his body. Kelley, concerned about the health of Goering's heart, took advantage of this latter obsession to convince Goering to trim down. "When I pointed out that he would make a better appearance in court should he lose some weight, he agreed and ate abstemiously," Kelley wrote.

More forbiddingly, Kelley learned that Goering displayed a terrible flip side to the charm and eloquence he showed on first impression. This man who, as Reich Forestry and Hunting Master, had

repeatedly condemned cruelty to animals and drafted humane laws to preserve wildlife, also ordered the 1940 bombing of the defenseless city of Rotterdam in the Netherlands that flattened the city center and left 85,000 people homeless. After Goering matter-of-factly recounted the murder of a close associate that he had once set into motion, Kelley asked how he could bring himself to demand his old friend be killed. "Goering stopped talking and stared at me, puzzled, as if I were not quite bright," Kelley recalled. "Then he shrugged his great shoulders, turned up his palms and said slowly, in simple, one-syllable words: 'But he was in my way....'"

And Kelley's conclusions from all this? For the international war crimes tribunal, he pronounced the Nazi legally sane, free of psychosis and fit for trial. As part of his private study of Goering's personality, Kelley declared, "He was undoubtedly the most ruthless human being that I have ever experienced."



Using Rorschach inkblots, Kelley concluded that the Nazis were not insane, as wartime propaganda popularly suggested. Kelley was considered an expert evaluator of people's personalities by analyzing their responses to the abstract inkblots. This method has since fallen out of favor among psychiatrists.

### A Growing Admiration

Instead of repelling Kelley, Goering's brutality heightened the psychiatrist's determination to reach some understanding of the captive's personality. Over time, Kelley built an unusually close relationship with Goering. The two men spent hours discussing German politics, war strategy and the likely outcome of the forthcoming trial. Goering frequently emphasized that he undertook many of the alleged war crimes, including the deliberate breach of international treaties, to build up Germany, to help his nation reach its destiny. "Of course, we rearmed," he said. "We rearmed Germany until we bristled. I am only sorry we did not rearm more. Of course, I considered treaties as so much toilet paper. Of course, I wanted to make Germany great. If it could be done peacefully, well and good. If not,

that's just as good.... When they told me I was playing with war by building up the Luftwaffe, I replied I certainly was not running a finishing school."

In more candid moments, however, he admitted to Kelley other impulses. "In intimate talks on the bunk of his cell ... he sometimes confessed that his basic motive had been that single, driving ambition—to achieve for Hermann Goering supreme command of the Third Reich," Kelley remembered. Alternatively, Goering sometimes claimed self-preservation as a motive. When Kelley asked why Goe-



**1946: Goering on trial. During the proceedings, Goering confided in Kelley about his defense strategies, which Kelley then reported to his superiors. The court eventually sentenced Goering to hang.**

ring had always been Hitler's yes-man, even for the Führer's most ill-fated schemes when the war was going poorly for Germany, Goering sardonically replied, "Please show me a 'no-man' in Germany who is not six feet under the ground today."

In their conversations, Goering stated that as the last remaining member of his government's leadership, he "felt great responsibility, not for its crimes, but for its evaluation by history," Kelley noted. Goering planned his courtroom strategy accordingly. "Time and again," Kelley wrote, "he said to me boastfully: 'Yes, I know I shall hang. You know I shall hang. I am ready. But I am determined to go down in German history as a great man. If I cannot convince the court, I shall at least convince the German people that all I did was done for the Greater German Reich. In 50 or 60 years there will be statues of Hermann Goering all over Germany. Little statues, maybe, but one in every German home.'" Goering bemoaned the last-minute wavering of some of his fellow Nazi defendants. "Not me!" he declared. Kelley frankly admired this forthright stand, and he also respected what he called Goering's "extreme fondness for and tenderness toward his family and friends."

No amount of admiration, though, diminished Kelley's feelings of responsibility toward his own government. In frequent memos to General William "Wild Bill" Donovan, founder of the soon-to-be CIA who was then assisting Nuremberg's chief prosecutor, Kelley shared information gleaned from his conversations with Goering that surely would have been considered confidential in a normal doctor-patient relationship. In a memo from November 11, 1945, Kelley revealed Goering's trial defense strategy and his idea to call Britain's Lord Halifax as a witness to

**Goering's suicide, "emphasizing the impotence of the American guards," Kelley wrote, "was a skillful, even brilliant, finishing touch."**

testify to Goering's willingness to pursue negotiated settlements before the outbreak of war. Two weeks later Donovan learned through Kelley that Goering took full responsibility for Germany's Four Year Plan of the 1930s, a set of economic and military reforms that violated terms of the Versailles Peace Treaty settling World War I. But Kelley's sympathy for Goering showed through, too: Kelley asked Donovan to cushion the hard, wooden defendants' benches in the Nuremberg courtroom in deference to the age and health of Goering and others on trial.

### **Conflicting Interests**

Through his own doing, Kelley had worked himself into a professional knot. Was he Goering's physician, conversation partner, psychiatric observer or informant? Never before had a psychiatrist been in such intimate contact with an important enemy detainee. To whom did Kelley owe his insights and loyalty?

That knot would tighten. Eventually Goering came to see Kelley not just as a doctor and sounding board but also as a well-connected fixer. And Goering had problems that needed fixing. He

YEVGENY KHALDEI Corbis

claimed that on his arrest Allied authorities promised that his wife, Emmy, and his young daughter, Edda, would be adequately cared for. By November 1945, however, the two were living separately: Emmy in a civilian internee camp near Regensburg, Germany, and Edda miles away in a nursery school in the city of Neuhaus. Goering wished to write to them, and he wanted them reunited. Kelley agreed to intercede with Donovan on his behalf and to personally deliver Goering's letters to his wife. In a note that Kelley saved among his papers, Goering wrote to Emmy, "Today I can send you a letter direct; Major Kelley, the doctor who is treating me and who has my fullest confidence, is bringing it to you. You can also talk to him freely." And after Kelley's appeal to bring together the mother and daughter succeeded, Goering gratefully asked Kelley to adopt Edda and raise her in the U.S. as his own daughter if Emmy died. Kelley's response is unknown, although Edda remained in Germany.

Goering's appreciation was enormous, and he offered Kelley one of his colossal rings in recompense. According to Kelley's son, Douglas Kelley, Jr., the psychiatrist replied, "No, you're a prisoner—you can't give that to me." So Goering responded, "Then I'll give you something even better and more valuable, a signed photograph." That framed portrait of a proud Goering in full military regalia, autographed and inscribed in the Reich Marshal's sinuous script with fading ink, remains among the senior Kelley's papers.

From November 1945 to January 1946 Kelley observed the initial weeks of the trial. He and Gilbert had originally planned to co-author a book on the psychology of the Nazi leaders, but Kelley abruptly withdrew from the agreement and returned to the U.S. He took with him many of the notes and psychological test scores the two men had gathered together. Months later the court handed Goering a death sentence, which surprised no one. Goering, however, planned an act of defiance that caught everyone unawares. Hours before his scheduled hanging in October 1946, guards found his body in his Nuremberg cell. He had swallowed a vial of cyanide that someone, probably a sympathetic jailer, had smuggled to him. "His suicide, shrouded in mystery and emphasizing the impotency of the American guards, was a skillful, even brilliant, finishing touch, completing the edifice for Germans to admire in times to come," observed Kelley, his continuing esteem plain.

### The Banality of Evil

When Kelley published his findings about Goering and the other Nazi defendants a couple of

years later, he drew from the essentially normal Rorschach results he had interpreted. He believed that Goering and his cohorts were commonplace people and that their personalities "could be duplicated in any country of the world today." In the years before and during World War II, the opportunity to obtain power led them to embrace a chilling political philosophy. In other words, the Holocaust and the war's other heinous crimes were the products of healthy minds. [For more recent research on the nature of evil, see "The Psychology

**June 23, 2006:** Iraqi prisoners at Abu Ghraib. Allegations of misconduct by psychologists and doctors there raise questions about allegiance that echo the dilemmas Kelley faced in Nuremberg.



of Tyranny," by S. Alexander Haslam and Stephen D. Reicher; *SCIENTIFIC AMERICAN MIND*, October/November 2005.]

Kelley, who went on to teach at the University of California, Berkeley, and work as a consulting criminologist for the city of Berkeley police, eventually spun off balance. He began drinking and frequently lost his temper during arguments with his wife. After one such fracas on New Year's Day in 1958, Kelley, aged 45, clenched a cyanide capsule between his teeth and threatened to bite down. Then he did bite down—his son, Doug, a witness, believes it was an accident—and died within seconds. The death he shared with Hermann Goering may be coincidental. **M**

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# Your Brain on **Blueberries**

Chemical compounds common to berries, tofu, tea and other foods can shore up memory and boost brainpower

**By Mary Franz**

**W**hat is blue, sweet and juicy and may help ward off those nagging memory lapses? If you guessed blueberries, you would be right. Americans apparently cannot get enough of the delicious fruit. In 2008, the latest year that data are available, per capita blueberry consumption in the U.S. reached an all-time high of 12.3 ounces, roughly the size of one standard supermarket carton—an increase from 9.2 ounces in 2007. Whether we are eating more blueberries because they are good for us or just taste good is anyone's guess, but now there is even more reason to load up the shopping cart with plump *Vaccinium cyanococcus*: they may protect our brain.

Emerging research suggests that compounds in blueberries known as flavonoids may improve memory, learning and general cognitive function, including reasoning skills, decision making, verbal comprehension and numerical ability. In addition, studies comparing dietary habits with cognitive function in adults hint that consuming flavonoids may help slow the decline in mental facility that is often seen with aging and might even provide protection against

disorders such as Alzheimer's and Parkinson's.

Researchers once assumed that flavonoids worked in the brain as they do in the body—as antioxidants that protect cells from damage caused by ubiquitous unstable molecules known as free radicals. Now, however, new research demonstrates that the power of flavonoids to bolster cognition results mainly from interactions between flavonoids and proteins integral to brain-cell structure and function.

To date, scientists have identified more than 6,000 different flavonoids, which come in a variety of types [see table on page 57]. These compounds are widely distributed in fruits and vegetables, cereal grains, cocoa, soy foods, tea and wine. Thus, overdosing on blueberries alone is not necessary to keep your mind in good shape.

## **Memorable Diets**

As powerful antioxidants, flavonoids protect us from the cellular damage caused by free radicals, which are formed by our bodies during metabolism, and are also spawned by pollution, cigarette smoke and radiation. As a result, researchers have for decades investigated the potential of these compounds

for boosting immunity, staving off cancer and reducing excess inflammation; flavonoids also appear to help regulate blood flow and blood pressure.

About 15 years ago chemist Ronald Prior and the late neuroscientist James Joseph of the Department of Agriculture's Agricultural Research Service were measuring the antioxidant, disease-fighting potential of various foods when Joseph heard about preliminary data hinting that people who ate modest amounts of fruits and vegetables performed better on cognitive tests than those who consumed little or none of these foods. The researchers were intrigued and wanted to test the idea that an antioxidant-rich diet might improve brain function.

Prior and Joseph fed chow enriched with extracts

meals was responsible for the animals' superior performance. Noting that all the test foods were rich in flavonoids, Prior and Joseph speculated that these compounds might be behind the cerebral tune-up.

Meanwhile studies of humans were also indicating that eating meals full of flavonoids might have cognitive benefits. In a study published in 2007 epidemiologist Luc Letenneur and his colleagues at INSERM in France asked 1,640 cognitively healthy older adults to fill out a questionnaire about their dietary habits and take a test of their cognitive function. They followed the subjects for 10 years, repeating the questionnaire and test four times during that decade. At each testing period, the investigators quantified the subjects' consumption of five

## Those who regularly consumed wine, tea and chocolate lowered their risk of a poor cognitive score by 70 percent.

of strawberry, spinach or blueberries to 19-month-old, middle-aged rats for eight weeks, equivalent to about a decade in the human life span. At the end of the eight weeks the now aging rats fed regular food did significantly worse on learning and motor skills such as walking elevated planks, climbing poles, balancing on rotating rods and swimming through mazes, reflecting normal mental decline. In contrast, rats eating the supplemented diet performed *better* at these tasks than they had at the start of the study. (The rats fed the blueberry helpings got an extra boost in motor function; for reasons that remain unclear, they were much more adept than even the rats eating strawberries and spinach at maintaining their balance in the plank and rod tests.)

This was an "aha!" moment for the scientists: something in the fruit- and vegetable-enriched

different flavonoids and correlated those amounts with their cognitive test scores, controlling for other health habits known to affect cognition such as exercise, smoking and obesity.

Subjects with the highest levels of flavonoid intake at the start of the study also performed best on thinking skills such as the ability to do simple arithmetic, recall items in different categories, repeat words and phrases, and identify time and place. In addition, their performance on such tests tended to be more stable over time than that of individuals whose diets included very low levels of flavonoids, whose thinking skills tended to decline over time. Those with the best scores in this study were eating between 18 and 37 milligrams of flavonoids a day, which translates to about 15 blueberries, a quarter of a cup of orange juice and half a cup of tofu.

Other studies correlating flavonoid intake with cognition have hinted at benefits from particular flavonoid-rich foods. In an investigation published in 2009 a research team led by nutritionist Eha Nurk at the University of Oslo in Norway asked 2,000 adults in their early 70s to fill out food-frequency questionnaires and then tested them on measures of mental agility such as their memory of events in their lives, speed at naming objects, and ability to quickly come up with words beginning with a particular letter of the alphabet. Individuals who reported that they regularly consumed wine, tea and chocolate—which are especially rich in flavonoids—performed significantly better on these cognitive dimensions than those who consumed these items only rarely. The adults who did not con-

### FAST FACTS

#### Fruit for Thought

- 1>> Compounds in blueberries known as flavonoids may improve memory, learning and general cognitive function—and could slow age-related decline in mental function.
- 2>> Scientists have identified more than 6,000 different flavonoids. These chemicals are widely distributed in fruits and vegetables, cereal grains, cocoa, soy foods, tea and wine.
- 3>> Researchers now believe flavonoids affect cognition by interacting with proteins that are integral to brain-cell structure and function.

# Flavors of Flavonoids

Scientists have discovered thousands of different flavonoids, chemical compounds that may lead to improved memory, thinking and coordination. These compounds are known as polyphenols because they contain multiple “rings,” each of which is attached to an alcohol (OH) group. Flavonoids come in several flavors, or subgroups, the most widely studied of which, along with their most common food sources, appear in the table.

Flavonoid Group	Example Compounds	Food Sources
Flavonols	Quercetin, kaempferol	Spinach, peppers and onions
Flavones	Luteolin, apigenin	Parsley and celery
Flavanones	Eriodictyol, hesperetin	Citrus fruits
Flavanols	Catechin, epicatechin	Tea, cocoa and wine
Anthocyanidins	Cyanidin, peonidin	Berries, grapes and wine
Isoflavones	Genistein, daidzein	Soy foods such as tofu



Tea contains compounds called flavonoids that studies suggest are active in the brain. Flavonoids, which are also present in many fruits and vegetables, can improve our memory and thinking skills.

sume any wine, tea or chocolate scored worst of all. Individuals who reported drinking wine regularly (but in moderation) had about a 45 percent lower risk of poor cognitive performance, defined as a score in the lowest 10th percentile on the test. The corresponding benefit for tea or chocolate was a 10 to 20 percent diminished risk. Those who regularly consumed all three items decreased their chances of a poor score by 70 percent.

## Soy, Pine Bark and Cocoa

In addition to associating flavonoid consumption with improved cognition, researchers in recent years have tested the effects of adding flavonoids to people’s diets, the rough human equivalent of the work with rats. Although it is hard to control people’s base diets—humans are not all eating the same chow—adding flavonoids to your diet might preserve or improve memory, thought processing and other cognitive capacities. In 2009 nutrition re-

searcher Anna Macready and her colleagues at the University of Reading in England published a review of 15 small dietary intervention trials in which researchers tested this thesis by asking people to add flavonoid-containing foods to their meals. The flavonoids came from either soy products, supplements (*Ginkgo biloba* or pine bark extract) or, in one case, a beverage containing cocoa.

Although interpretation of the findings was complicated by inconsistencies in the types of cognitive testing, the authors concluded that flavonoid consumption from any of the sources examined improved aspects of cognition such as verbal comprehension, simple reasoning and decision making, object recall, and recognition of numerical patterns. Flavonoids also seemed to hone fine motor skills such as finger tapping. Consuming the equivalent of about one and a half cups of tofu or two and a half cups of soy milk a day was enough to produce the improvement, as was taking 120 mg (one to two capsules) of ginkgo, 150 mg (about three capsules) a day of pine bark extract or 172 mg of flavonoids from the cocoa drink. The latter is equivalent to about seven 1.5-ounce squares of dark chocolate.

Among flavonoid-containing foods, our beloved blueberries may provide particularly strong protection for the human brain. In a study published in 2010 psychiatry researcher Robert Krikorian of the University of Cincinnati and his colleagues gave memory tests to nine adults older than 75 who had mild memory loss. The participants then drank two cups of wild blueberry juice (simi-

## (The Author)

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CORBIS

# Parsley, Sage, Rosemary and Thyme

**W**e can spice up our minds not only by choosing which foods we eat but also by seasoning our savory dishes in specific ways. Spices and herbs, including sage, oregano and thyme, are chock-full of brain-boosting compounds called flavonoids, and recent research suggests that these compounds may have powers over our mood as well as our mental faculties.

After ingesting the oil of common sage and Spanish sage, people immediately perform better on tests of word recall as compared with those who took a placebo, several studies have shown. Individuals who swallowed a capsule containing sage oil also report increases in their alertness, calmness and contentedness. Now psychologists at Northumbria University in Newcastle, England, have found that simply smelling the extract of sage can reproduce some of these effects. In July 2010 the researchers reported that people who took a computerized battery of tests in a room infused with the aroma of common sage demonstrated, on average, a more accurate memory than people who took the same tests in an unscented room. They also reported feeling more alert.

These and other studies of sage have employed the essential oil, a concentrated extract from the plant used for aromatherapy, rather than the familiar dried or fresh sage leaves used in cooking. Yet researchers believe that eating sage regularly in its leaf form may produce similar, albeit milder, memory-enhancing effects.

These studies did not attempt to pin down which component of the plant was responsible for the memory effects, but flavonoids very likely play a role. Sage is high in hispidulin, a flavonoid that has been shown in cell culture studies to interact with brain cell receptors for gamma-aminobutyric acid (GABA), a neurotransmitter that affects cognition and mood.

Flavonoids from spices other than sage can also produce observable changes in mood, at least in rodents. In June 2010 pharmacologists at Federal University of Cear in Fortaleza, Brazil, reported that the flavonoid carvacrol, which makes up the bulk of oregano and thyme oils, has an antidepressant effect in mice. After drinking a solution of dissolved carvacrol, the rodents tried harder to escape from a swimming tub—an experimental setup used to assess depression in the animals.



By blocking different chemical pathways in the brains of the mice, the researchers showed that carvacrol's effects depend on its interaction with dopamine, a neurotransmitter known best for governing feelings of reward. It is unclear whether eating small amounts of oregano and thyme would boost mood, but the scientists hope that isolating and studying carvacrol could lead to new antidepressant drugs.

Beyond herbs familiar in the kitchen, many traditional medicinal herbs contain flavonoids that seem to have a protective effect on the brain. One such herb is *Epimedium brevicornum Maxim*, better known in the U.S. by its unfortunate nickname: "horny goat weed." In November 2010 microbiologists at the Korea Institute of Science and Technology and at Peking University in Beijing showed that rats with the rodent equivalent of Alzheimer's disease, marked by protein clumps in the brain, learn and remember better if their chow is supplemented with the most prominent flavonoid in horny goat weed: icariin. This compound apparently prevents the clumps from causing brain cells to commit suicide—suggesting that icariin might one day be useful as a treatment for Alzheimer's. —Karen Schrock

lar to about five cups of blueberries) every day for 12 weeks, after which they received a repeat test on their ability to recall words and pairs of objects. The blueberry drinkers performed about 30 percent better on average than did a comparison group of seven elderly adults who drank a flavonoid-free, sweetened beverage resembling blueberry juice. Despite the small sample size, the trial strongly suggested that adding blueberries to your diet can

boost your memory, at least if you are older, Krikorian says. He also speculates that regular blueberry consumption may stave off the cognitive decline that often comes with aging.

## Brain-Cell Snacks

How might flavonoids influence cognition? By examining brain tissue from rats that ingested flavonoid-containing foods, researchers have shown

ISTOCKPHOTO



within the past decade that some classes of flavonoids cross into the brain from the blood. Once in the brain, the compounds could influence cognition by acting as antioxidants, but recently scientists have questioned this theory. Data suggest that flavonoids are present in the brain in much smaller quantities than other antioxidants, such as vitamin C. Thus, compounds other than flavonoids are likely to be doing the bulk of free-radical scavenging there. Instead scientists have found that flavonoids change the chemistry of neurons in other ways.

Joseph and his colleagues discovered early on that four-month-old juvenile mice fed blueberry-enriched chow for eight months displayed higher levels of enzymes called kinases in their brain cells than did those who ate the standard chow. Although scientists do not know how flavonoids might spur kinase production, many types of kinases are essential to learning and memory; thus the additional enzyme could help boost cognition.

More recently, Jeremy Spenser, a nutritional biochemist at Reading, has outlined ways in which flavonoids may influence the actions of proteins critical to thought. Flavonoids may, for example, help to regulate the activity of kinases as well as that of enzymes called phosphatases; the correct balance of these is critical for maintaining the integrity of the synapses, or junctions, between neurons and thereby sustaining normal patterns of brain-cell activity.

Soy isoflavones may improve memory by acting like weak estrogens, binding to and stimulating estrogen receptors on neurons. Exciting these receptors is known to trigger changes in both neuronal shape and chemistry in the hippocampus, a structure involved in memory and whose function most likely diminishes with age. These changes may facilitate communication between neurons and thereby improve memory. Some flavonoids may even spur the growth of new nerve cells in the hippocampus.

Flavonoids may even defend neurons from damage and death and so combat neurodegenerative diseases such as Alzheimer's and Parkinson's. Animal and cell culture data suggest that flavonoids may ameliorate the effects of neurotoxins such as glutamate—a neurotransmitter that at high concentrations damages neurons—by preventing these toxins from binding to their receptors on neurons. Flavonoids also may oppose the action of enzymes called secretases that are involved in the destruction of nerve cells and that may be elevated in neurodegenerative disorders.

In the future, imaging technologies such as functional magnetic resonance may enable researchers



to see how consuming flavonoids alters brain activity in real time. For example, in a study published in 2006 researchers used fMRI to detect increased cerebral blood flow during a letter-digit matching test in subjects consuming a flavonoid-rich cocoa drink. Such findings may guide the development of dietary interventions for reversing or preventing cognitive decline.

The science does not yet reveal which flavonoid-containing foods have the greatest potential for enhancing learning and memory. But eating flavonoid-rich foods is probably better than taking supplements. Processing may destroy or reduce the actual flavonoid content of supplements, and intact fruits and vegetables are likely to contain the amounts and combinations of these compounds that are most beneficial to the brain. Following the current USDA dietary guidelines—which call for eating two cups of fruit and two and a half cups of vegetables every day—will ensure that you get a generous variety of these health-bestowing compounds. Indeed, taking such advice just might help you remember where you put your car keys. **M**

**Mind-boosting flavonoids, which are found in wine and blueberries, among other foods, are thought to stave off the decline in cognition that often accompanies aging.**

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# A Losing Personality

Being neurotic boosts your chances of losing weight—  
lusting for adventure does not **By Winnie Yu**

**L**osing weight has never been an easy endeavor, as anyone who has ever tried knows. Among the challenges: changing ingrained habits that led to the weight gain. Everyone attributes his or her success to different strategies and programs, be it Weight Watchers, gastric bypass surgery or sheer willpower, but all tend to agree that eating less and moving more are at the heart of any successful effort.

But what makes one person able to put that simple formula into action, whereas another fails in the attempt? Only about one fifth of people who lose at least 10 percent of their weight keep it off for at least a year, according to a 2005 study in the *American Journal of Clinical Nutrition*. Of course, numerous biological factors play a role in weight loss, includ-

ing the size of your body, its muscle and fat content, and your metabolic rate. In recent years psychologists have begun looking at personality traits as critical variables in the dieting equation.

Personality is important because it shapes our behavior. In fact, your personality may well be the strongest predictor of how likely you are to shed pounds, says psychiatrist C. Robert Cloninger of the Washington University School of Medicine in St. Louis. Personality traits affect your motivation to reduce portion sizes, to avoid fatty foods, to exercise, and the like. In particular, research suggests that your tendency toward optimism, neuroticism and novelty seeking has a big influence on your ability to slim down. “[Personality] does not act alone, but it is a moderator of people’s motivations and attitudes toward what and how much they eat and how much they exercise,” Cloninger says. And although you cannot completely alter your character, you can temper certain aspects of it and sidestep traits that get in the way of weight loss.

## The Pollyanna Pitfall

Research into personality and weight loss is relatively new. In 1995 Cloninger became one of the

### FAST FACTS

#### Lean Traits

**1**» Numerous biological factors play a role in weight loss, but in recent years psychologists have begun looking at personality traits as critical variables in the dieting equation.

**2**» Characteristics often considered detrimental for mental well-being may actually improve a person’s chances of losing weight—and some otherwise positive traits can make dieting an uphill battle.

**3**» To rein in impulsiveness, try becoming more self-aware as you go about your day. Meditate, write in a journal, or simply reflect on what is most important and satisfying to you.



Having an agreeable personality increases the likelihood that you will give in to social pressures to eat. If your friend hands you a piece of chocolate cake, you are inclined to accept it.

first to study the effect of personality on lifestyle choices. Although some studies have not shown a strong connection between specific personality traits and weight loss—pointing instead to a person’s resolve to lose weight and expectation of success—more recent studies are suggesting that some personal qualities do play an outsize role.



Character traits often considered detrimental for mental well-being may actually improve a person’s chances of losing weight—and some otherwise positive traits can make dieting an uphill battle. In work published in 2007 clinical psychologist Hitomi Saito of Doshisha University in Japan and her colleagues gave personality assessments to participants starting a weight-loss program at the university, measuring their weight before and after six months. They found two personality traits, in particular, to be strongly associated with weight loss (albeit in opposite ways): neuroticism and agreeableness. The participants who were the most neurotic and the least agreeable lost more weight than those who scored lower on neuroticism and higher on agreeableness. The more neurotic you are, the researchers reasoned, the more you may worry about your health and the more willing you are to

make sacrifices to meet that goal. And the less agreeable you are, the less likely you may be to give in to social pressures to eat, even if you have to hurt Mom’s feelings by saying no to her apple pie.

More recently, Saito and her colleagues have learned that another positive personality trait—optimism—can similarly impede efforts to lose. In a study published in 2009 the team examined the psychological characteristics of 101 obese patients in a six-month weight-loss program at the center’s obesity clinic to identify the traits that encourage people to adopt healthier eating habits and exercise more. They also wanted to see how psychological counseling, offered as part of the program, altered some of these characteristics.

The researchers found that people who scored high on optimism were less likely to slim down. Being overly optimistic, it appears, may cause you to underestimate your risk for developing a serious disease such as diabetes and make you more likely to assume that you will be okay regardless of your actions. “Being too optimistic could harm weight-loss efforts because patients become careless about their disease,” Saito says. That attitude, she adds, “may prevent them from controlling their behavior.” In other words, if someone is too optimistic, he or she may be more apt to grab that extra doughnut or skip the morning walk, thinking everything will work out just fine anyway.

Those who lost the most weight also scored high on a psychological “ego” state characterized by skill at self-monitoring. People who are adept at self-monitoring have a penchant for gathering facts, considering alternatives and being objective. Such individuals are more likely to collect information about portion sizes and calories and to use those data to select healthy meals. They may also be more apt to create a realistic exercise schedule and stick to it. Performing these activities—and watching the pounds come off—will in turn boost that individual’s confidence in his or her ability to achieve a healthy way of life.

### Novel Solutions

Like optimism, a need for novelty and adventure may also be incompatible with successfully slipping into those skinny jeans. In a study published in 2006 Cloninger and his colleagues gave a standard personality questionnaire to 264 lean and 56 obese individuals living in St. Louis, along with 183 obese patients in the university’s weight-loss program, which included weekly group behavioral therapy and diet education sessions. The questionnaire measured seven basic traits: novelty seeking,

### (The Author)

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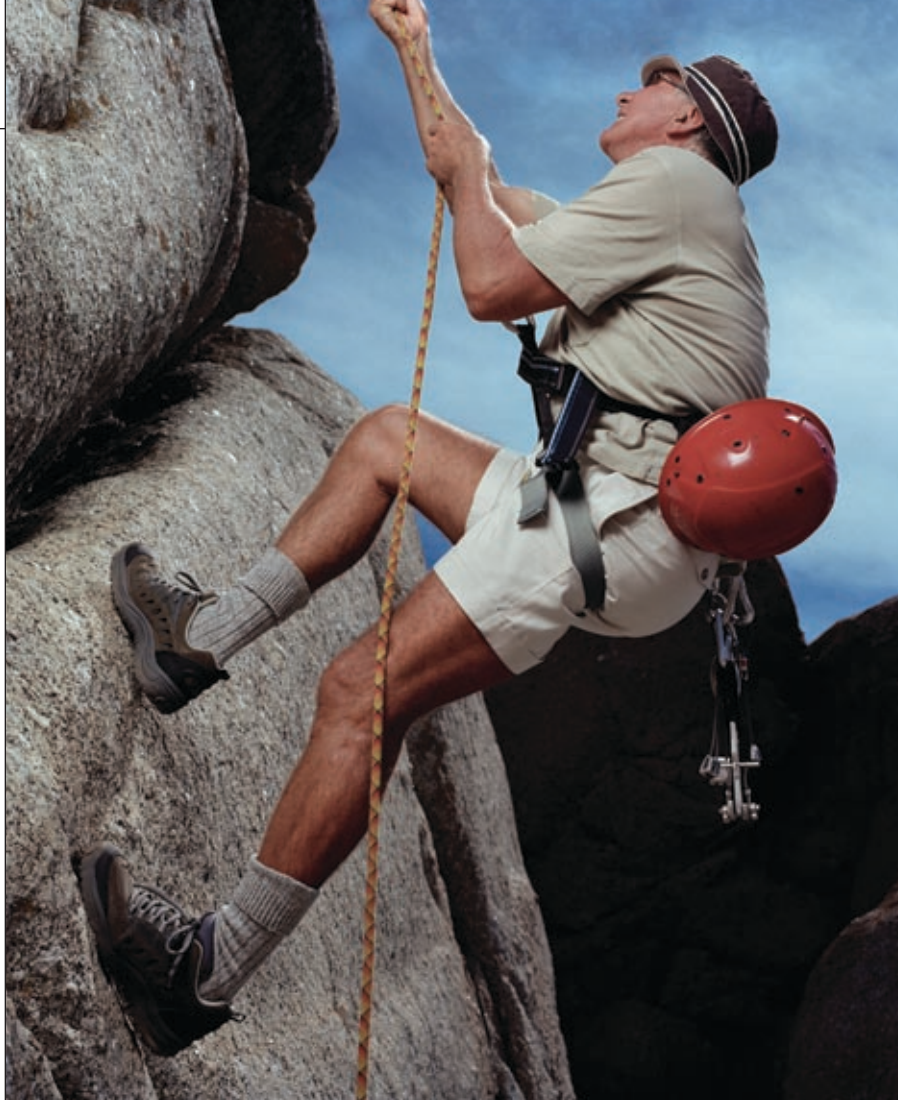
harm avoidance, reward dependence (bias toward and sensitivity to social rewards for behavior), persistence, self-directedness, cooperativeness and self-transcendence (the ability to reach beyond yourself to find meaning in life experiences).

The researchers found that obese people in the community were more likely to score high on novelty seeking—a trait associated with being quick-tempered and impulsive—than the lean folks were, a result that jibes with other work suggesting that novelty seekers are more likely to be overweight. In fact, Cloninger says, novelty seeking is correlated with body mass index (BMI) in the general population: the higher a person's BMI, the higher that person tends to score on the trait.

Cloninger's team also tied novelty seeking to pounds lost. Obese patients in the weight-loss program who dropped more than 10 percent of their weight in 22 weeks were less likely to score high on novelty seeking than those in the program whose weight fell less than 5 percent. Apparently the novelty seekers among us value exploration more than the comfort of familiar habits and the rules that often accompany a weight-loss regimen. Exploring often requires letting go of inhibitions and fears, the kind of temperament that can trip up dieters. "Novelty seeking involves the pursuit of sensual gratification," Cloninger says. "People who are high in novelty seeking give in to their cravings and appetites, so novelty seeking is increased in people who are impulsive, substance abusers, bingers or obese."

Does this mean that novelty seekers inclined to joyful optimism are doomed to remaining overweight? Not at all, Saito says. In fact, some optimism may even be helpful if it is offset by the right traits. If you tend to look on the bright side but can still remain realistic and self-aware, then you can make behavioral changes that lead to weight loss. Being so optimistic that you ignore reality, however, may make you less inclined to adopt the necessary habits.

Although altering your personality might be a difficult weight-loss strategy, you can tailor your diet to your personality type, minimizing the effects of detrimental traits. If you hunt for what is new, for instance, look for different ways to exercise. "People who are high on novelty seeking like to be active, so exercise can be a good way to increase awareness of one's body and burn calories at the same time," Cloninger advises. Novelty seekers should also train themselves to eat slowly. Learning to savor the taste, texture and smell of food is more likely to appeal to the person who enjoys sensual gratification.



In some cases, personality changes might be worth trying to make. To rein in impulsiveness, for example, try becoming more self-aware as you go about your day. Meditate, write in a journal, or simply reflect on what is most important and satisfying to you. Adopting a calm and thoughtful mind-set enables you to make more considered decisions and helps buffer you from external temptations such as commercials for food. Making this kind of psychological change might, in fact, be one of the most successful strategies not just for achieving short-term weight loss but also for staying slim and fit over the long haul. **M**

To counteract their tendency to pack on pounds, novelty seekers can indulge in adventurous forms of exercise such as rock climbing.

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# The Insanity Verdict on Trial

The insanity defense, rarely used, is widely misunderstood

BY SCOTT O. LILIENFELD AND HAL ARKOWITZ

ON JUNE 20, 2001, Andrea Yates, an ex-nurse from Houston with a history of severe postpartum depression, drowned all five of her children (aged six months to seven years) in a bathtub. Following a conviction in 2002 that was overturned on appeal, Yates was acquitted in 2006 as not guilty by reason of insanity. Yates's attorneys, backed by expert testimony, contended that she thought she was being persecuted by Satan and needed to protect her children from eternal damnation by killing them.

Forty-six U.S. states have some version of the insanity defense on the books, with Utah, Montana, Idaho and Kansas disallowing it. This defense is designed to protect people who are incapable of understanding or controlling their criminal actions and to help them get treatment. Nevertheless, the idea of offenders being deemed legally innocent is hard for the public to swallow. In the case of Yates, radio talk-show host Mike Gallagher captured the sentiments of many: "So now," Gallagher opined, "officially and formally, Andrea Yates did not drown her five children, is that it?" Similarly, after the 1982 acquittal of John W. Hinckley, Jr., for the attempted assassination of President Ronald Reagan, an ABC News poll revealed that 76 percent of Americans believed that Hinckley—who was deemed delusional—should have been convicted.

Although excusing the violence of Yates and Hinckley may seem wrong, the insanity defense is actually tailored to such situations. The concept of criminal "guilt" refers to more than whether a defendant committed the crime; in almost all states, it also requires that the person be deemed of sound mind when the act was performed. And although many believe the plea dumps dangerous felons back on the streets, in fact attorneys at-



tempt the defense only rarely and typically fail in the attempt. Even when the defense succeeds, the acquitted usually end up with sentences similar to or longer than those for convictions. The main difference between an acquittal and conviction: those acquitted on the basis of insanity are usually sent to psychiatric hospitals rather than prisons.

## Origins of a Plea

In 1843 Daniel McNaughton went to 10 Downing Street in London with a plan to kill the British prime minister,

Robert Peel. Mistaking Peel's secretary for Peel, McNaughton shot the secretary, who died five days later. McNaughton was acquitted on the grounds that he believed the government was plotting against him, but the verdict had no clear precedent and rested on fuzzy legal grounds. Reacting to public anger to the verdict, a panel of judges fashioned a guideline for insanity, now called the McNaughton rule: to be declared insane, defendants must either not have known what they were doing at the time or not have realized their actions were wrong.

COURTESY OF SCOTT O. LILIENFELD (Lilienfeld); COURTESY OF HAL ARKOWITZ (Arkowitz); ROBERT DALLY/Getty Images (man in straitjacket)

**Only about 1 percent** of criminal cases involve the insanity plea, and only 15 to 25 percent of those result in acquittals.

The McNaughton rule, which many U.S. states adopted, hinges on cognitive factors, excusing people from legal responsibility because they lacked understanding of the crime's meaning. Some states now employ the looser guidelines set out by the American Law Institute in 1962, which broadened the insanity defense to also include cases in which a person cannot control his or her impulse to act because of a psychiatric disorder. Proponents of the defense, in either guise, regard it as a needed exception for the rare cases in which people are unable to inhibit their destructive behaviors. Most advocates believe that it is inhumane to punish individuals who did not adequately grasp what they were doing. Instead, they say, we should try to rehabilitate or least treat them.

But critics contend that excusing individuals for a crime that they unquestionably committed makes no sense. To them, the insanity defense confuses the question of whether a person should be found guilty of a crime with that of what punishment he or she should receive. Most skeptics believe that all defendants who commit a crime should be found guilty but that those with severe mental illness should sometimes receive lessened sentences.

Catering to this view, about 20 states have introduced the verdict of "guilty but mentally ill," which holds a person legally accountable for a crime but permits mental illness to be considered as a mitigating factor in sentencing. This verdict is supposed to enable an ill individual to receive the treatment he or she needs. In reality, those deemed guilty but mentally ill sometimes fail to receive adequate therapy. What is more, the verdict has not led to a clear-cut reduction in the number of insanity acquittals.

### Judicious Use?

Whether or not the insanity defense is justified, it is intended only for the rare

instances in which a bona fide mental disorder has obliterated the psychological brakes most of us use to stop ourselves from acting immorally. Yet many Americans perceive the insanity defense to be widely invoked and commonly successful. In a 2007 study psychologist Angela Bloechl of the University of Wisconsin-Oshkosh and her colleagues found that college students estimate that the defense is used in 30 percent of criminal cases and succeeds 30 percent of the time.

Yet data from multiple studies show that only about 1 percent of cases involve the plea, and only 15 to 25 percent of those result in acquittals. Although notorious insanity plea acquittals, such as those of Yates and Hinckley, garner outside media attention, scores of other defendants, including Jack Ruby (who killed Lee Harvey Oswald, John F. Kennedy's assassin), David Berkowitz ("Son of Sam"), Jeffrey Dahmer (serial killer) and Lee Boyd Malvo (one of the two Beltway snipers), have been convicted after pleading insanity.

Many people also believe that those acquitted on the basis of insanity get a quick and easy pass out of prison. "A few years of treatment in a mental hospital, then presto! She's all better now, free to be released into an unsuspecting public," Gallagher speculated about



**Andrea Yates (top) and John W. Hinckley, Jr. (bottom), were deemed innocent of their crimes by reason of insanity. Their acquittals provoked public outrage.**

Yates. But only about 1 percent of those who use the insanity defense successfully are released immediately, and the average length of hospital stays for people let off because of insanity is about three years. Indeed, as of this writing, Yates remains institutionalized in a mental hospital in Kerrville, Tex., more than four years after her acquittal. Moreover, data collected in 1995 by sociologist Eric Silver, then at Policy Research Associates in Delmar, N.Y., suggest that those deemed not guilty by reason of insanity often remain in institutions just as long as people convicted of comparable crimes do; in some states, such as New York and California, they stay longer.

Thus, the insanity defense is far from a quick passage to freedom. Citizens and policy makers must understand the plea for what it is: an extremely rare exception that proves the rule that almost all individuals should be held legally responsible for their criminal actions. **M**

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Send suggestions for column topics to [editors@SciAmMind.com](mailto:editors@SciAmMind.com)

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# The Midnight Ride Effect

How imagining a different past increases our appreciation for the present

BY WRAY HERBERT



WITH THE COUNTRY on the verge of civil war in 1860, Henry Wadsworth Longfellow wrote a patriotic poem about Paul Revere, a little-known Massachusetts silversmith and minor hero of the Revolutionary War. “Paul Revere’s Ride” played fast and loose with the facts of the now famous 1775 events, but the narrative had the psychological effect the author intended. It got Americans wondering how history might have turned out differently without that heroic act—and how the country might never have come to exist. By focusing on the nation’s precarious origins, the poem bolstered nationalism at a time when it was sorely needed.

“What if” thinking is always a bit tricky. Too much focus on “what might have been” can mire us in regret and feelings of powerlessness or keep us from savoring our good fortune. But is it possible that a bit of such thinking might save us from complacency about our circumstances? Some scientists are beginning to think that imagining an alternative reality might have ironic and tonic effects. Indeed, it might be a practical tool for strengthening commitment to country, workplace and relationships.

One of the first studies to explore this effect looked at people’s satisfaction with their romantic partnerships. Social psychologist Minkyung Koo, then at the University of Virginia, and her colleagues asked individuals in committed relationships to write for 15 to 20 minutes about how they might have never met or gotten to know their partners. Others wrote the story of how their meeting really happened, and still more people wrote about a typical day’s activities or a friendship. After the exercise, the people who had imagined not knowing their partner displayed the biggest increase in relationship satisfaction. When Koo and her co-workers reported this phenomenon in



Imagining an alternative version of American history makes citizens feel more patriotic.

2008, they called it the George Bailey effect, after the protagonist in the classic film *It’s a Wonderful Life* who finds renewed appreciation for his life after seeing how past events would have played differently had he not been born.

More recently, Northwestern University psychological scientist Hal Ersner-Hershfield and his colleagues were inter-

ested in how, psychologically, the George Bailey effect might work. They were curious about the “near loss” experience—specifically the feelings of poignancy that occur when what we cherish disappears. When we feel we are losing something—that time is becoming scarce, for example—the bittersweet mix of happy and sad emotions can reinforce our ap-

MATT MENDELSON (Herbert); GLOWIMAGES/CORBIS (flags)



To increase worker loyalty, an organization should simply tell its corporate story in a way that **emphasizes its precarious origins.**

preciation of what we have. The scientists wondered whether the same phenomenon might explain why we feel more strongly about things when we imagine that they might never have come to exist in the first place. Here's how they tested the idea in the lab.

The researchers had a group of American volunteers write “alternative universe” essays—stories about how the key events and players in early American history might have been completely different—no Paul Revere, no George Washington or Valley Forge, no signature by John Hancock. Others simply wrote down a brief history of the country's origins—the version familiar to every American child. Then the scientists used a standard test to measure all the volunteers' political attitudes, including patriotism.

Those who had reflected on an alternative history of the U.S. scored significantly higher on patriotism. That was clear, but the simple experiment raised many questions. *How* did “what if” thinking bolster nationalism? What was the chain of cognitive events in between? They suspected that poignancy was the mediator and ran another experiment to see. In this one, they had volunteers reimagine not their homeland but their company—to think of all the possible reasons why the company might not be the company it is today. Others simply wrote about the company's history. The scientists measured several traits of the volunteers: in addition to their commitment to the organization, they measured feelings of poignancy on leaving the com-



When people think about how historical events such as Paul Revere's ride might not have happened, they feel a sense of poignancy. This emotion then increases gratitude for the way things did play out.

pany and also their vision of the company's future success.

Again, those who had reflected on what might have been were more committed to the company than those who merely recited history. As reported in the online version of the journal *Psychological Science*, these workers also had higher hopes

for the company's continued success into the future. But most important, it appeared that it was indeed a strong sense of poignancy—that strange mix of happiness and sadness in the same moment—that linked “what if” thinking with company loyalty. They also discovered, in a slightly different version of the study, that these “what if” thinkers felt their connection with the company was “meant to be”—inevitable, a matter of fate.

These findings have practical implications for organizations. To increase worker loyalty, the scientists say, an organization should simply tell its corporate story in a way that emphasizes its precarious origins. This strategy might at some point benefit the organization more than the worker, however: “what if” reflections could produce too rosy a view of the present and future, causing loyalists to stay too long on a sinking ship. **M**

➤➤ For more insights into the quirks of human nature, visit the “We're Only Human...” blog and podcasts at [www.psychologicalscience.org/onlyhuman](http://www.psychologicalscience.org/onlyhuman)

WRAY HERBERT is senior director for science communication at the Association for Psychological Science.

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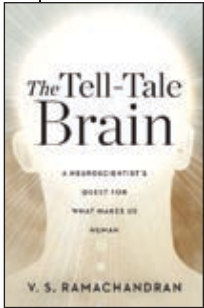
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books

HUMAN LEAPS

The Tell-Tale Brain: A Neuroscientist's Quest for What Makes Us Human

by V. S. Ramachandran. W. W. Norton, 2011 (\$26.95)



While giving a lecture at a hospital in Chennai, India, Vilayanur S. Ramachandran met a young man with a strange problem.

"What brings you to our hospital?" asked Ramachandran, a professor of psychology and neuroscience at the University of California, San Diego.

"I am a corpse—I can smell the stench of rotting flesh," the young man replied.

"Are you saying you are dead?" Ramachandran pressed.

"Yes. I don't exist," the man confirmed.

After performing an EEG—which measures and records the electrical activity of the brain—Ramachandran concluded the man must be suffering from Cotard syndrome or "walking corpse syndrome," a rare neuropsychiatric disorder in which people hold the delusional belief that they are dead.

Cotard syndrome is one of many unusual mental afflictions Ramachandran

discusses in his new book, *The Tell-Tale Brain*. He also looks at Capgras syndrome (when a person believes those around him have been replaced by imposters), apraxia (when a person cannot mimic simple gestures), and telephone syndrome (when a person is comatose but can somehow converse on the phone).

Gleaning insights from these rare and intriguing neurological disorders, Ramachandran reveals how the human brain has evolved unique functions that separate us from other primates. He proposes that around 150,000 years ago our brain started to change, allowing us to learn to perform new tasks. "All the same old parts were there," he writes, "but they started working together in ways that were far more than the sum of their parts," giving humans distinctive traits, such as language, empathy and morality.

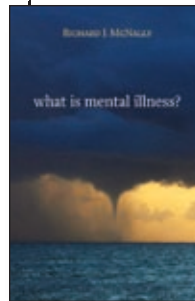
Take mirror neurons, nerve cells that are activated when we perform an action or when we observe someone else performing an action. These neurons appear to help animals and humans imitate the behaviors they observe. Ramachandran theorizes that this sophisticated system of mirror neurons not only evolved to create awareness of others but also brought about self-awareness in humans. He fittingly dubbed these neurons "empathy neurons." Based on this theory, he suggests that Cotard syndrome may result from damage to mirror neuron circuits, causing a person to lose that self-awareness.

Such bold leaps may make some scientists uneasy, but they are also what make Ramachandran so provocative and his book such an entertaining read. —Frank Bures

THIN LINE

What Is Mental Illness?

by Richard J. McNally. Belknap Press of Harvard University Press, 2011 (\$27.95)



When a breakup is one-sided, the rejected party's behavior and mental state

often change dramatically. A veil falls upon the world. Sleep becomes elusive. Food and sex are suddenly strangers to pleasure. Concentration dwindles to a rare resource. Intrusive memories and spiraling pessimism worm their way into every moment of consciousness.

These changes are an expected response to loss. Sometimes, however, they are also symptoms of major depression. In his new book, *What Is Mental Illness?*, experimental psychopathologist Richard J. McNally explores how to identify the line that separates an appropriate response to loss from a dysfunctional one. In other words, how do we distinguish mental distress from mental disorder? "There is a fuzzy

Roundup: Gender Bender

In three new books, learn how gender shapes language and development and discover the truth behind gender stereotypes.

Gender is a complex and never-ending story written over the course of a lifetime, according to neurobiologist Donald W. Pfaff in *Man and Woman: An Inside Story* (Oxford University Press, 2010). Male and female brains develop differently, starting in the womb. Studies show, for example, that male mice fetuses are bathed in the sex hormone testosterone, making them more aggressive than females.

In *Conversation and Gender* (Cambridge University Press, 2011), psychologists Susan Speer and Elizabeth Stokoe pull together evidence from domestic telephone calls, police-suspect interviews and psychiatric assessments to help explain how the sexes use language differently. For instance, some studies suggest that, on average, women tend to be better with words, exhibiting more diverse vocabularies and a keener eye for textual analysis.



Every year another work of popular psychology tries to convince readers that the male and female brains are as different as G.I. Joe and Barbie. *Delusions of Gender* (Norton, 2010), by cognitive neuroscientist Cordelia Fine, exposes the flaws in many studies that have provided a scientific foundation for stereotypes about gender differences.

—Ferris Jabr

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► TUNING IN

**Theory of My Mind**

by the Amygdaloids. Knock Out Noise, 2010 (\$10.99)

Many rock songs are inspired by love or pain, or some heart-wrenching combination of the two. But it seems only fair to dedicate a few songs to the organ that makes music possible: the brain. Enter the new album, *Theory of My Mind*,

by the Amygdaloids, a band that comprises three neuroscientists and one biologist from New York University.

The songs plumb our deepest emotional experiences—appropriate, given that the group’s name refers to the amygdala, the brain region responsible for emotional processing that the band members study. The style is reminiscent of 1960s and early 1970s rock—imagine the Beach Boys meet the Doors. Insightful lyrics deal with topics in neuroscience, including fear, anger, imagination, memories and dreams. For instance, lead singer Joseph E. LeDoux maps how traumatic memories form, and drummer Daniela



Schiller focuses on how the brain responds to fear and manages it.

The dark tracks are some of the most compelling. One example is “Fearing,” a song based on a poem by Emily Dickinson and performed by LeDoux. “’Tis harder knowing that fear is due than knowing it is here,” he sings, capturing the distress and apprehension fear brings.

“Crime of Passion,” a song featuring Roseanne Cash on backing vocals, explores the nature of impulsivity through the story of a man who kills his wife in an angry rage. And perhaps the most evocative song, “Brainstorm,” uses haunting guitar riffs and poignant lyrics to delve into the strange paranoid feelings that may afflict someone suffering a mental breakdown.

In a way, *Theory of My Mind* seems like its own research project. Part of understanding our emotions is experiencing them. As the Amygdaloids explore emotions in their songs, the band evokes equally powerful feelings in their listeners—a near impossible feat to accomplish in the lab.

—Melinda Wenner Moyer

boundary, but mental illness has properties that mental distress does not have,” McNally says.

Although McNally asks a direct and important question, he never gives a straightforward answer. Instead of clearly outlining exactly how mental illness and mental distress differ, he swims through eight chapters in which he tries to answer a series of new and daunting questions. For instance, the chapter “Are We Pathologizing Everyday Life?” asks whether we misdiagnose our reactions to stressful events, such as going through a breakup or getting a speeding ticket, as more grave than they actually are. And in the chapter “Is It in Our Genes?” McNally tries to parse out to what extent our biology dictates our mental health. When we arrive at the final chapter, “So What Is Mental Illness Anyway?” we can only conclude that the most succinct and accurate response is, “Well, it depends.”

In the end, that is actually McNally’s main point. Understanding mental illness requires context, and when making a diagnosis, we cannot simply tick off criteria on a checklist. We need to consider the symptoms and the causes as well as our biology, genes and culture.

If you are looking for definitive answers to complex questions, this is not the book for you. If you want to delve into the complexities of mental illness,

however, then join McNally in grappling with some of the toughest issues facing psychology today.

—Ferris Jabr

► BRIGHT BULBS

**Where Good Ideas Come From: The Natural History of Innovation**

by Steven Johnson. Riverhead Books, 2010 (\$26.95)

Protecting our ideas from others may mean they never see the light, according to Steven Johnson in his new book, *Where Good Ideas Come From*. By sharing these thoughts, however, we can connect with our peers and contribute to powerful networks that “shape the flow of information and inspiration.” Take the invention of GPS. This handy navigation system was originally invented because scientists were trying to determine the precise location of the Russian satellite Sputnik at any moment as it traveled.

Johnson argues that although we tend to think that good ideas emerge from our mental prowess, our environment provides an equally crucial influence. If we isolate ourselves from the intellectual influence of others, good ideas rarely develop. Johnson illustrates this point by discussing research by psy-



chologist Kevin Dunbar, who studied how scientists work in the laboratory. Dunbar set up cameras to watch and listen in and found that the most important ideas were not generated by individuals but by groups of scientists who exchanged information in lab meetings.

Johnson also tells us that eureka moments are rare. The best new ideas develop by gradually adding bits of complexity to older ideas. For instance, the Web has become increasingly complex since it was invented 20 years ago. From just a few thousand Web sites, the network has ballooned to more than 100 million sites with 25 billion pages of information.

Sometimes, however, ideas can be too advanced for their time. Charles Babbage, for instance, spent 30 years developing the Difference Engine, which 100 years later would become the basis for the modern computer. The problem, Johnson tells us, is that Babbage had envisioned a tremendously complex machine in the middle of the steam-powered age. He had no one to share and combine ideas with, which, according to Johnson, stalled the birth of his innovation.

Johnson successfully synthesizes the main point of this book when he likens ideas to neurons in the brain. A single neuron firing alone produces nothing. It is when thousands of neurons fire in sync that an idea is born.

—David DiSalvo

# asktheBrains

## Why do I get a slump in mental energy after eating a meal?

—Pranati Kapadia, via e-mail



**Paul Li**, lecturer of cognitive science at the University of California, Berkeley, offers an explanation:

**FALLING ASLEEP** at your desk after that heaping bowl of pasta? You may be experiencing what people commonly refer to as a “food coma.” Medically known as postprandial somnolence, a food coma isn’t an actual coma but rather a lack of mental energy that people often experience after eating a large meal. Symptoms include drowsiness, lethargy and a lack of motivation. But not to worry—this postmeal phenomenon is harmless and can strike anyone who pigs out on foods loaded with carbohydrates, fats or sugars.

What is the link between eating a big meal and feeling sleepy? The process begins as food hits the stomach and small intestine. Eating stimulates activity in the parasympathetic nervous system, which tells your body to slow down and digest. The more food you consume, the more the parasympathetic nervous system revs up, causing your body to focus the bulk of its energy on digestion.

Although large quantities of any food can cause a food coma, common table sugar, or sucrose, found in desserts tends to be the main culprit. As food breaks down into glucose—the simplest form of sugar, which the body uses for fuel—you will experience a surge in blood sugar. To counter this spike, your body releases the hormone insulin. Insulin helps to mop up the excess glucose in the blood and returns levels to normal. The increase in insulin also causes your brain to produce more serotonin and melatonin—two neurochemicals that can leave you feeling drowsy. Luckily, this sleepy sensation does not last long—it usually passes after an hour or so.

## How long does it take for your brain to realize you have started to wear a hearing aid?

—Eugene Rice, via e-mail



**Kelly Tremblay**, associate professor of speech and hearing sciences at the University of Washington, responds:

**THE ANSWER** is “instantly.” The brain is able to detect amplified sounds immediately after the insertion of a hearing aid, as long as the damage is not too significant.

Normally when sound enters the ear, acoustic information is relayed from the ear to the brain via nerve cells, called neurons. As the sound gets louder, more neurons fire simultaneously, which in turn allows the brain to detect the change in volume.

A hearing aid acts as a microphone, magnifying sounds that enter the ear. Hearing aids are mostly used in people who suffer from hearing loss because of damage to hair cells, the small sensory cells in the inner ear. Healthy hair cells can detect the magnified sounds from a hearing aid and convert them into neural signals. But the greater the damage to a person’s hair cells, the more severe the hearing loss and the more the hearing aid will need to make up the difference.

Hearing aids are able to help millions of people decipher sounds they could not access before, but these devices do not help everyone to the same degree. That is because although hearing aids make sounds louder, they do not repair or compensate for the damage that has taken place in the ear and the brain. As a result, hearing aids help the signals reach the brain, but the brain may not be able to process the signals, making the hearing aid less effective. **M**

Have a question? Send it to [editors@SciAmMind.com](mailto:editors@SciAmMind.com)

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# Head Games

Match wits with the Mensa puzzlers

## 1 ADD IN

Fill in the missing digits to make the arithmetic problem true. All the numbers from 0 to 9 appear once and only once.

$$\begin{array}{r}
x \times 7 \\
+ 8 \times x \\
\hline
x, \times 0 \times
\end{array}$$

## 2 FIND THE QUOTE

The following puzzle consists of a brief quotation from a famous author. The letters have been removed from the spaces and are listed alphabetically below the columns they belong in. The dash indicates a broken word. Choose the correct letter for each space to reveal the quotation followed by its author.



O	H	A	B	E	A	K	E	S	H	E	A	Q	E	E	S	B	E					
T	N		S	H	I	O	R	T	N	E	T	R	T	O		T	I					
T	O		T			S			P	O		U										

## 3 MAXIM MAZE

Find the good advice jumbled up below by starting at any letter and moving up, down and sideways (not diagonally) to spell out the sentence.

**F L M N C**  
**O O E O E**  
**E M A H S**  
**O O E M A**  
**N N M E H**  
**Y O L M S**  
**O O T E E**  
**U F W I C**

## 4 MINGLING

The following three lines each consist of three words that have had their letters interspersed. All the letters are in the right order, and all the words concern the same subject matter. Find the six words.

**C M A A O U N Z S A A T D M R B I A Q A U L I E A**  
**P A M A D R R R I O S M I E D**  
**A A S F I R A I E C U R O A P E**

## 5 MEET YOUR MATCH

These matchsticks spell out an equation that is wrong. Correct it by moving only two matches.



## 6 CONFOUNDING COMPOUNDING

The same four-letter word can be placed in front of each of the words below to make a new word. Find the four-letter word.

\_\_\_\_\_ **PLATE**    \_\_\_\_\_ **WORK**    \_\_\_\_\_ **MARK**    \_\_\_\_\_ **RACK**

## 7 ROWS AND COLUMNS

Fill in the square at the right so that each row of four (across, down and diagonally) contains exactly one star, one diamond, one circle and one dash. Some symbols are filled in to help you get started.

◇		*	
	◇		
		◇	

## 8 DEDUCTION

Find the five-digit number in which the first digit is three times the last digit, the second digit is four less than the first, and the third is five less than the first, in which the sum of the second and third digits equals the first and in which the fourth digit is two more than the third and three more than the last digit.

## 9 TRIAL BY FIRE

After enrolling in Logic and Puzzlement 101, your first hurdle is figuring out when the class starts. Today is Friday. The class starts two days after the day before the day after tomorrow. What day of the week does the class start?

## Answers

7. 

◇	—	◇	*
*	◇	—	—
◇	—	*	◇
◇	*	—	◇

8. 95,463.

9. Monday.

4. Canada, Mozambique, Australia; Paris, Rome, Madrid; Asia, Africa, Europe.

5.

6. BOOK.

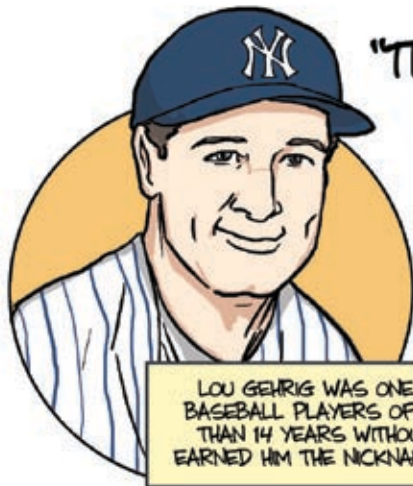
1. 347

2. TO BE OR NOT TO BE THAT IS THE QUESTION; SHAKESPEARE.

3. FOOL ME ONCE SHAME ON YOU; FOOL ME TWICE SHAME ON ME.

4. 1,206

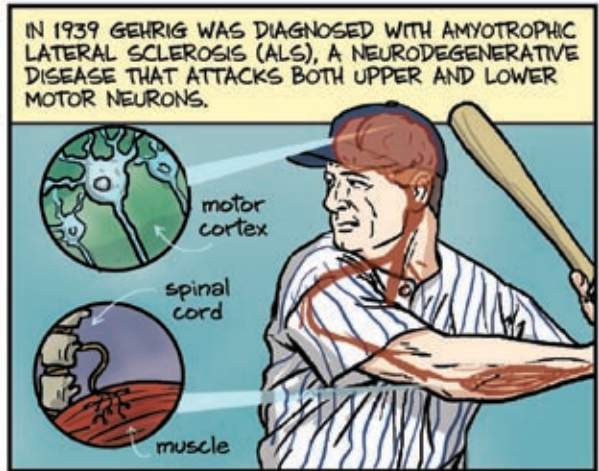
5. 
$$\begin{array}{r}
1,206 \\
+ 859 \\
\hline
347
\end{array}$$



# "THE IRON HORSE"

BY DWAYNE GODWIN AND JORGE CHAM

LOU GEHRIG WAS ONE OF THE GREATEST BASEBALL PLAYERS OF ALL TIME. HIS MORE THAN 14 YEARS WITHOUT MISSING A GAME EARNED HIM THE NICKNAME "THE IRON HORSE."



THE EXACT CAUSE OF ALS IS UNKNOWN, BUT IN ABOUT 2% OF THE CASES, A GENETIC LINK HAS BEEN FOUND:

A MUTATION OCCURS IN THE GENE THAT PRODUCES THE ANTIOXIDANT ENZYME, "SUPEROXIDE DISMUTASE."

THE ENZYME IS A PROTEIN THAT FOLDS A PARTICULAR WAY TO COMBAT HARMFUL FREE RADICAL MOLECULES.

AS MORE NEURONS DIE BECAUSE OF THIS, THE MUSCLES THEY CONNECT TO BEGIN TO TWITCH, THEN WEAKEN COMPLETELY.

THE MUTATION CAUSES THE ENZYME TO MISFOLD, RESULTING IN DAMAGE TO THE NEURONS' MITOCHONDRIA.

THE DISEASE AFFECTS ONLY MOTOR NEURONS, LEAVING HIGHER MENTAL FUNCTIONS INTACT.

PHYSICIST STEPHEN HAWKING HAS LIVED WITH THE DISEASE FOR OVER 46 YEARS, A VERY RARE CASE (MOST PATIENTS DIE WITHIN 2 TO 4 YEARS AFTER DIAGNOSIS).

AFTER STRUGGLING MOST OF THE SEASON, GEHRIG FINALLY TOLD HIS MANAGER, "I'M BENCHING MYSELF... FOR THE GOOD OF THE TEAM."

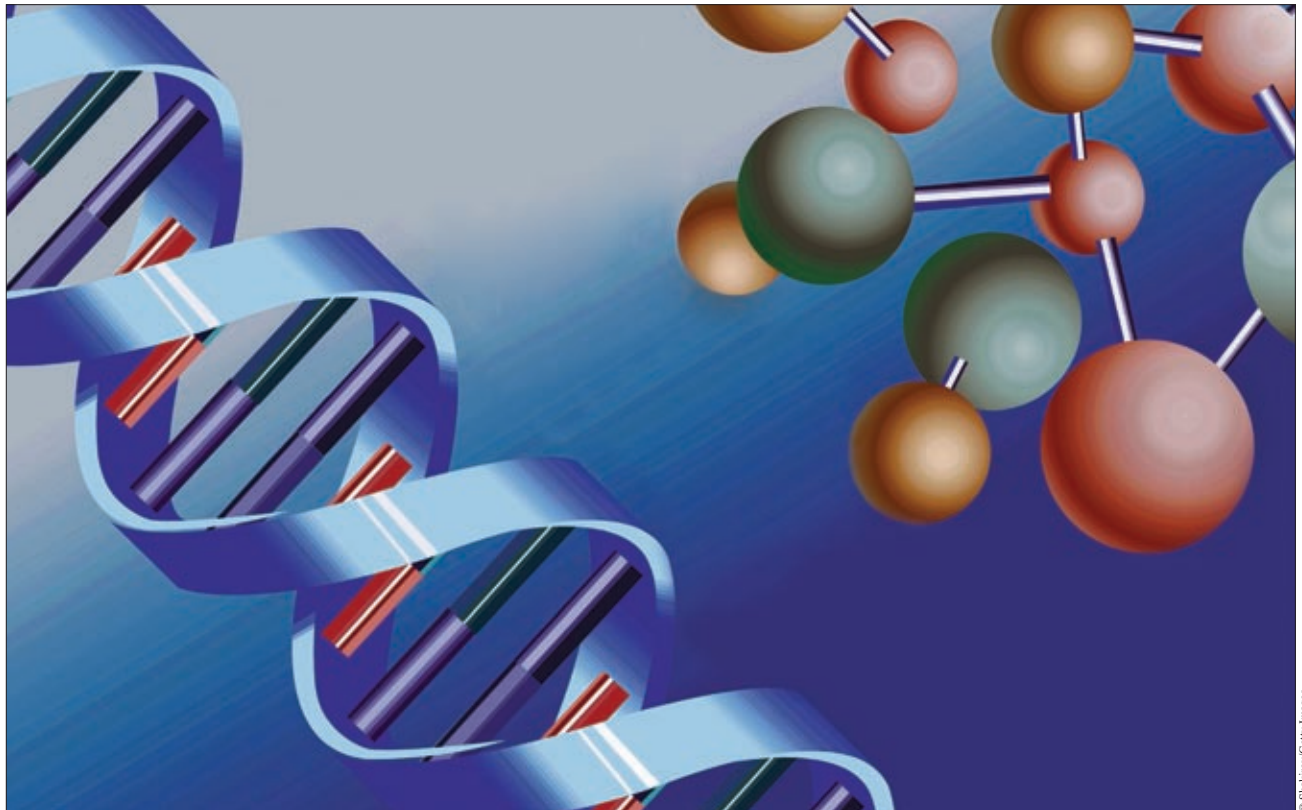
HE DIED IN 1941.

RECENTLY REPEATED HEAD INJURY HAS BEEN LINKED TO SOME FORMS OF MOTOR NEURON DISEASE, AND WHILE GEHRIG WAS HIT IN THE HEAD BY NUMEROUS BALLS IN HIS CAREER...

...WE MIGHT NEVER KNOW WHETHER THIS CONTRIBUTED TO HIS ALS.

REGARDLESS, ALS IS A TERRIBLE DISEASE, AND RESEARCHERS ARE WORKING AS TIRELESSLY AS THE IRON HORSE TO FIND TREATMENTS AND A CURE.

● 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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