MENTAL HEALTH "BIBLE" GETS AN OVERHAUL *page 28*

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May/June 2012 www.ScientificAmerican.com/Mind

SPECIAL REPORT

## Is It Healthier to Be Religious?

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# Who's in Control?

How Physics and Biology Dictate Your "Free" Will

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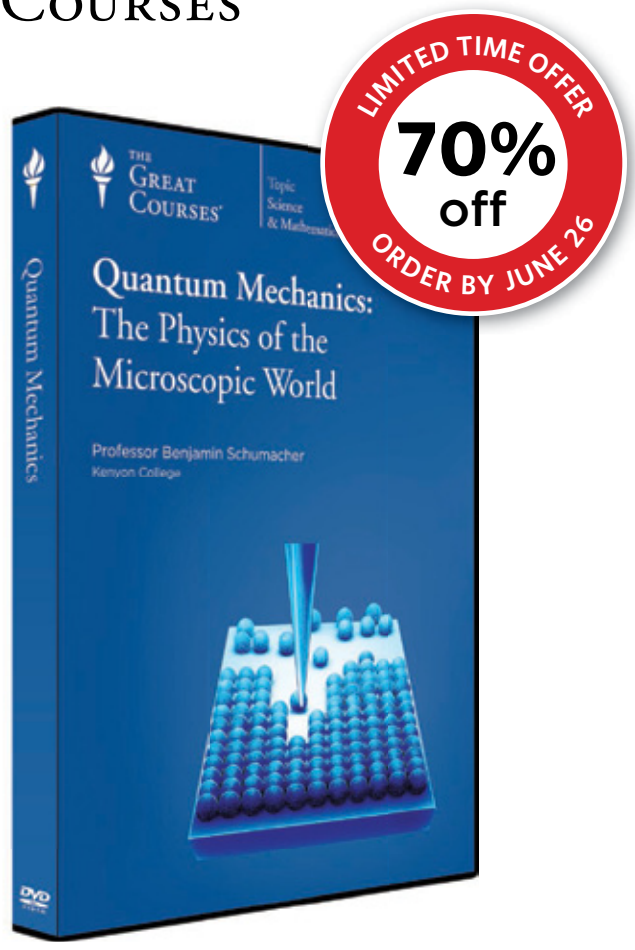


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# Feeling Free

At the end of a long day, I flop down on the couch and close my eyes. I burrow my face into a pillow and enjoy a few moments of silence. Yet one thought creeps into my consciousness. Go to the gym. Find your running shoes. It won't kill you.

This is a familiar battle, one that I wage almost daily. When I do make it to the gym, I anoint myself a hero. What strength of character! Such self-control!

Is that really the case? Or are my thoughts and actions just a natural outcome of the laws of physics? In "Finding Free Will," on page 22, Christof Koch tackles this question with insights from physics, neurobiology and psychology. Although we do not yet have an answer, we can examine one of the vultures preying on our thoughts: our unconscious mind. Ingenious experiments allow us to observe the brain churning out impulses beneath our awareness, which our conscious mind then seeks to justify.

The question of free will is not merely cocktail-party banter. How we hold people responsible for their actions matters both to the legal system and to our day-to-day relationships. Those judgments become particularly challenging if mental illness is involved. For this reason and many others, the upcoming radical update to the premier resource for psychiatrists, the *Diagnostic and Statistical Manual of Mental Disorders,* better known as the *DSM,* has stirred up vigorous debate. Beginning on page 28, Ferris Jabr investigates how the guidebook will add, redefine and eliminate certain disorders, reshaping the landscape of disease diagnoses in the process.

Even in a healthy state of mind, our notions are not necessarily freely chosen. The special report on religious belief, starting on page 52, explores how genetics, upbringing and culture help to shape our attitudes toward divinity. Outside forces, it seems, intrude on just about every mental state.

Yet I can't help but believe I am somewhat in control. At least when it comes to my mental and physical health, I know what to do. And that is to pry myself off the couch, lace up my running shoes and unleash the physical laws of the treadmill.

**Sandra Upson**
**Managing Editor**
**editors@SciAmMind.com**

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## FEATURES

COVER STORY



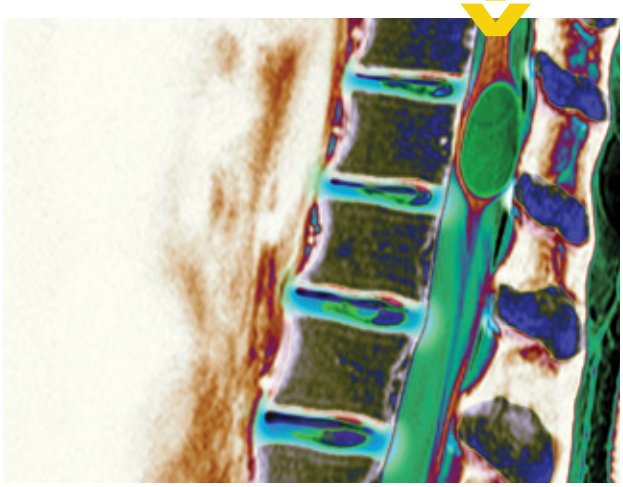




**SPECIAL REPORT** RELIGION

## DEPARTMENTS











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## BAD MEMORIES

**I noticed an ambiguity** between two articles in your January/February issue: "A Feeling for the Past," by Ingfei Chen, and "Trying to Forget," by Ingrid Wickelgren. The first article states that "older adults favored the happy images: half of the images the elders correctly recalled were positive and slightly more than a quarter were negative .... older adults appear to actively manage their emotions by paying less attention to negative things." The second article states that "elderly adults had more trouble than those aged 18 to 25 keeping an experience out of consciousness when reminded of it .... [and] may have particular problems recovering from unpleasantness in life."

These statements seem to contradict. Can you help me out here?

**Heather Dial**
Houston, Tex.

***THE EDITORS REPLY:*** *The answer is in the timing. The process of deciding what to commit to memory in the first place is different than blocking a memory from reaching consciousness after it has been stored. Older adults are better at preventing negative experiences from being committed to memory. But if an elderly person has stored a negative memory, he or she is more likely to have trouble—compared with the average young adult—preventing it from popping up to bother him or her later. The latter requires an inhibitory brain mechanism that declines with age. The former is more of an ability to shift attention in the current moment, and it is very likely to require a different part of the brain.*

## SUPERNATURAL LIMITS

**The implication** of "Wired for Weird," by Richard Wiseman, was that those who believe in paranormal activity, God or spiritual influence are weird. The article also explained that similar phenomena could be demonstrated in a laboratory.

What that basically amounts to, for me, is that because scientists can replicate similar phenomena, the phenomena therefore only exist in reflection of the current scientific ability, tools and knowledge we have developed to date. Any supposition that "extra-phenomena" of a similar nature may exist beyond the scope of these abilities, tools and knowledge is to be ridiculed. This, to me, is an attitude that flies in the face of scientific discovery.

I am grateful for all the efforts of the great scientific minds throughout history that have persevered beyond the techniques of their day to discover an ever widening reality and help provide for our way of life. I hope that rather than ridiculing that which we currently cannot prove, we continue to—let me

**ERRATA** In "Unlocking the Lucid Dream," by Ursula Voss [November/December 2011], the description of the origins of the ocular signaling method was oversimplified because of an editing error. The question of whether Stephen LaBerge or Keith Hearne initially introduced the technique is unresolved.

The answer by Jeannine Stamatakis to "How do our thoughts influence our physical sensations?" [Ask the Brains, January/February 2012] misstated that a diagnosis of ankylosing spondylitis typically affords sufferers a one-in-500 chance of survival. The survival rates of ankylosing spondylitis vary widely, depending on the patient's overall health.

use the word—"believe" there may be more to what we know than we ever dreamed of.

**Roy Henry**
Oak Park, Ill.

## INSECT EMOTIONS

**Regarding** "The Secret Inner Life of Bees," by Jason Castro, it seems to me the typical argument against animal emotions is that we cannot prove their actions are not evolved response systems.

Using that logic, we have never actually proved that humans have emotions. I know I have them—but how do I know that everyone else does not simply have evolved response systems?

That said, perhaps this skepticism is a correct response—we should not make assumptions that two distantly related organisms behave the same way.

I do hope we all will try to be good to all animals, in any case. Give them the benefit of the doubt—that they could, and probably do, have emotions. Even bugs.

**"David N'Gog"**
commenting at
www.ScientificAmerican.com/Mind

## BABY'S MINGLED SENSES

**"Infant Kandinskys,"** by Maria Konnikova [Head Lines], describes how babies' senses are intermingled. This synesthesia looks to me like another example of naive brains lacking the means to differentiate data because they have not yet learned the scenarios and concepts most relevant to their lives.

At six months old infants can recognize faces of different monkeys, as well as those of different humans, and recognize phonetic differences in foreign languages. By 12 months old children can no longer tell monkey faces apart, and they can only recognize phonetic differences in their native language. In addition, a large proportion of children start with absolute pitch and lose it. Only those who practice music or speak tonal languages retain pitch as part of their concept formation.

**"hoamingin"**
commenting at
www.ScientificAmerican.com/Mind

## GOOGLING MEMORY

**I was interested** to read "The Google Effect," by Anne Casselman [Head Lines], which suggests that overreliance on search engines may affect our brain's ability to memorize information. Although it is indeed true that "memory is much greater than memorization," memorizing remains a critical ability and one to actively promote, particularly as the brain ages. There are similar findings on the effects of GPS systems on spatial memory. Decreasing cognitive exercise through technology seems a risky business, especially given what we know about neurodevelopment in adults. Most studies seem to support the old adage: use it, or you might lose it.

**Richard Howlin**
Chelsea, Mich.

**I must respectfully** disagree with Casselman's conclusions. It is not a "new" phenomenon caused by Google "that Internet users have learned to remember how to find a fact rather than the fact itself." I am 60 and my husband 78. We were taught you don't have to know everything, just to "know where to find the information." We were taught to use the library, the dictionary, and so forth. Sadly, these skills are being lost to Wikipedia, spell-check, blogs and many questionable sources of information.

**Annette Reffalt**
Perkinston, Miss.

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## FANATICISM VS. SKEPTICISM

**I question** the premise of the Ask the Brains query "Is there a difference between the brain of an atheist and the brain of a religious person?" answered by Andrew Newberg. "Atheist" is a word invented by theists who see the world in religious terms. I bet the mental processes of religious fundamentalists and doctrinaire Communists and any Scientologists all resemble one another far more than they do either the average Episcopalian or the average empiricist (the word that better describes many so-called atheists).

By the same token, that Episcopalian and that empiricist probably resemble each other more at the process level than either does his putative but more fanatical brethren.

**"Ehkzu"**
commenting at
www.ScientificAmerican.com/Mind

JULIETTE BORDA

>> PSYCHOTHERAPY

## Mental Cleansing

### Abuse victims find relief from feelings of contamination

Survivors of childhood sexual abuse commonly report lingering feelings of being contaminated. This effect can lead to problems with self-esteem and body image, relationship trouble, and behavioral issues such as obsessive washing. Now a study in the January issue of *Behavior Modification* finds that a treatment that appeals to both logic and emotion, via mental imagery, can help relieve these intrusive feelings.

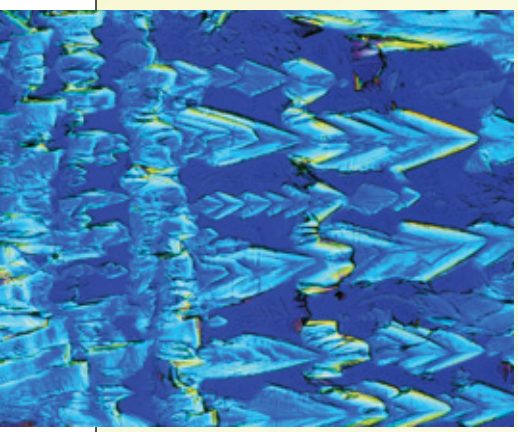
Psychologists at Goethe University Frankfurt in Germany tested a brief treatment consisting of one session and a follow-up "booster" meeting. First, therapists and participants discussed the details of their contamination thoughts—what it feels like, when and where it occurs, and how it affects daily life. Then participants were instructed to research on the Internet how often human skin cells are rebuilt. They also calculated how many times the cells in their trauma-related body regions have been replaced since their last contact with their abusers. (Skin cells rebuild every four to six weeks; mucous membranes more often.) The subjects discussed with the therapists what these facts mean—for instance, "not one of the dermal cells that cover my body now has been in contact with my abuser." Finally, they performed an exercise in which they imagined shedding their contaminated skin.

The results found this treatment to significantly decrease feelings of being contaminated and also—to the researchers' surprise—overall post-traumatic distress scores. Study author Kerstin Jung says the combination of factual information with mental imagery is key because the information alone can leave a patient knowing the facts but not feeling they are true on an emotional level. At that point, "we introduce the imagery technique as a vehicle to transport the rational information from the head to the heart," she says. "Images are much more powerful to change emotions than verbal information." —*Tori Rodriguez*

>> FIRST IMPRESSIONS

# Genetic Gestures

## Unspoken cues communicate which type of "trust hormone" gene we have



A micrograph view of crystallized oxytocin.

When we meet new people, we assess their character by watching their gestures and facial expressions. Now a study in the *Proceedings of the National Academy of Sciences USA* suggests that those nonverbal cues are communicating the presence of a specific form of a gene that makes us more or less responsive to others' needs.

The gene determines which type of receptor a person has for the hormone oxytocin. Oxytocin has been implicated in a variety of positive traits, such as trust, empathy and generosity. The hormone is detected by our body's cells via their oxytocin receptors. In a past study, psychologist Sarina Rodrigues Saturn of Oregon State University and her collaborators found that people who have a certain variation of the receptor gene are more empathetic than those with the alternative form of the gene.

In the new study, Saturn and her team showed volunteers 20-second silent video clips of individuals who were listening to their romantic partner recount an upsetting experience. The study participants watched for nonverbal behaviors, such as head nods and smiles, and rated every individual on a number of character traits. Those with the form of the oxytocin receptor gene associated with empathy were judged by the volunteers as being more trustworthy, compassionate and kind than those with the alternative form of the gene.

"These slight genetic variations do have a big impact on not only how you feel internally but also how people perceive you," Saturn says, adding that impressions based on nonverbal cues can help individuals quickly choose compatible friends or romantic partners.

*—Janelle Weaver*

>> AGING

# Seniors, Think Fast

## Decisions usually take longer for the elderly, but they don't have to

Older adults often take longer to make a decision than young adults do. But that does not mean they are any less sharp. According to research at Ohio State University, the slower response time of older adults has more to do with prizing accuracy over speed.

In the study, published recently in the *Journal of Experimental Psychology: General,* college-age students and adults aged 60 to 90 performed timed tests of word recognition and recall. All participants were equally accurate, but the older group responded more slowly. When the researchers encouraged them to work faster, however, they were able to match the youngsters' speed without significantly sacrificing accuracy. "In many simple tasks, the elderly take longer mainly because they decide to require more evidence to make their decision," says co-author Roger Ratcliff. When an older mind faces a task that requires speed, he says, a conscious effort to work faster can often do the trick.

*—Winnie Yu*

>> APPRECIATION

# Time Well Spent?

## When we think of time as money, leisure activities fall flat

We commonly treat time as a commodity. Or at least we have since Benjamin Franklin said that "time is money." Even so, thinking of time in terms of money keeps us from sitting back and enjoying it, according to new research in the *Journal of Experimental Social Psychology.* Sanford DeVoe and Julian House of the University of Toronto gave subjects a short time to listen to music or putter around on the Internet. The subjects enjoyed their leisure time much less if they had first been asked to calculate their hourly wage at work. This effect resulted from increased impatience, as indicated by a short follow-up survey. If you start equating time with money, you get itchy about any time not spent earning cash. Better to think of time as priceless, at least while on break.

*—Matthew Hutson*

ALFRED PASIEKA *Photo Researchers, Inc. (top, left);* STEWART COHEN AND PAM OSTROW *Getty Images (top, right);* SKIP ODONNELL *iStockphoto (bottom)*

>> CONNECTIONS

Did you just enjoy a delicious meal? **Consider keeping it to yourself.**

Researchers found that describing how good a cupcake tastes makes you enjoy it less and explaining why a movie is horrible makes you hate it less. Recounting an experience may enhance your understanding of it, which then dulls your opinion of the incident.

>> ILLUSIONS

## Brain Trick Relieves Pain

Arthritis pain is reduced by mirror reflections of healthier joints

**Amputees who experience phantom limb pain can sometimes get relief from an optical illusion. This trick involves looking in a mirror at the reflection of a healthy limb from a certain angle, which causes it to appear where the missing limb should be. Seeing the limb move freely fools the brain into relieving the pain. Now a study suggests this technique might also work for arthritis pain.**

**Cognitive scientist Laura Case, working in the lab of Vilayanur S. Ramachandran (a member of *Scientific American Mind*'s board of advisers) at the University of California, San Diego, used a modified version of the mirror technique to superimpose a researcher's healthy hand over a subject's arthritic hand, which was painfully constricted or contorted. Subjects mimicked the slow, purposeful movements of the researcher's hand with their own unseen hand. After experiencing the illusion of their hand moving smoothly, subjects rated their arthritis pain slightly lower than before and had an increased range of motion.**

**The result suggests that the toxic soup of inflammatory molecules bathing an arthritic joint is not the only source of painful sensations. "The brain has learned to associate movement with pain," says Case, who presented her results at the Society for Neuroscience meeting last November in Washington, D.C. The illusion provides the brain with a way to disconnect the sight from the sensation. Next, the group will investigate whether this type of mirror therapy might provide long-term benefits for arthritis, a condition that affects about 50 million Americans.**

***—Stephani Sutherland***

>> ATTENTION

## Think Before You Blink

Eyeblinks reveal what autistic toddlers pay attention to

Tracking eye movements lets scientists figure out what we pay attention to in a scene. When people blink during such experiments, those few milliseconds are usually discarded as junk data. A new study finds that blinking might reveal important information, too. It turns out that the more we blink, the less focused is our attention. In kids with autism, blink patterns appear to offer clues about how they engage with the world around them.

During eye-tracking experiments with toddlers, Warren Jones, a pediatrician at the Emory University School of Medicine, found that the children were strategic about when they blinked. While watching a recorded scene, the toddlers seemed to inhibit their blinking during the moments that sucked them in. "The timing of when we don't blink seems to relate to how engaged we are with what we're looking at," Jones says.

He now uses this discovery as a tool to study attention in autistic children. In a paper published last December in the *Proceedings of the National Academy of Sciences USA*, Jones observed differences in the blinking patterns of autistic and developmentally normal children. Both groups watched a video that included moments of human emotion and sudden action. Developmentally normal children inhibited their blinking before emotional climaxes, as though they were following the narrative and predicting an outcome. Autistic children blinked right through those moments, suggesting they were not following the emotional arc of the story, but they responded sharply when an object suddenly moved.

The results confirm well-established observations of attention in autistic children—namely, they are more interested in action than in emotional phenomena. They also validate eyeblink studies as a powerful research tool, Jones says. The approach could be particularly helpful in exploring the minds of nonverbal children and may help define new subcategories of autism.

*—Morgen E. Peck*

SCOTT CAMAZINE *Photo Researchers, Inc.* (top); J. PARSONS *Getty Images* (bottom)

>> BRAIN IMAGING

# Personality Circuits

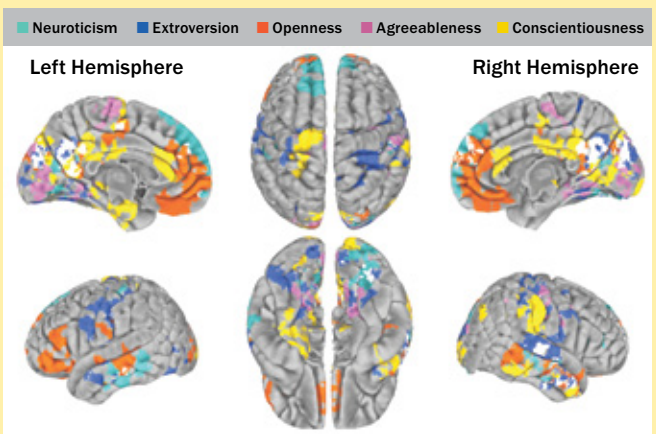
## Patterns of brain activity reflect our character

Your personality says a lot about you. To categorize people by their disposition, psychologists have long relied on questionnaires. Now, however, researchers may be closing in on a tangible view of character in the brain. According to a recent study in *PLoS One,* resting brain activity varies with a person's scores on a well-established personality test. When awake but not engaged in a task, each subject displayed activity patterns distinct from those found in someone with different traits.

Even at rest, the brain hums with neural activity. Researchers think these resting-state patterns reflect how the brain typically operates when we interact with the world. "You can think of it as showing which connections in the brain are on speed dial and which ones aren't," says Michael Milham, a psychiatrist at the Child Mind Institute in New York City, who led the study.

Using functional MRI, the researchers monitored the resting state of 39 healthy participants and looked for regions that tended to activate together. How tightly coordinated the activity was between a pair of regions—completely in sync or only somewhat the same—correlated with scores from one of five personality domains: neuroticism, extroversion, openness to experience, agreeableness and conscientiousness. For example, neuroticism was associated with areas related to self-evaluation and fear. Other results were more surprising, suggesting an unexpected role in personality for the visual cortex and cerebellum—areas better known for visual processing and movement, respectively.

Because the brain activity only correlated with the traits, Milham says it is too soon to tell whether the patterns reflect the neural embodiment of personality. The findings, however, add to mounting evidence that studying the brain at rest may be a way to quickly approximate how an individual brain works and to zero in on circuits disrupted in disease. *—Michele Solis*




**Brain areas labeled with the same color are more tightly connected in people who score higher on the personality trait printed above in that color. White areas represent overlapping personality domains.**

FROM "PERSONALITY IS REFLECTED IN THE BRAIN'S INTRINSIC FUNCTIONAL ARCHITECTURE," BY JONATHAN S. ADELSTEIN ET AL., IN *PLOS ONE*, VOL. 6, NO. 11, E27633; NOVEMBER 30, 2011 *(left)*; STEPHEN SIMPSON *Getty Images (right)*

>> GET SMART

People who **meditate regularly** show less activity in brain networks that, when overactive, are linked to anxiety, schizophrenia and some other psychiatric disorders, new research shows.

>> COGNITION

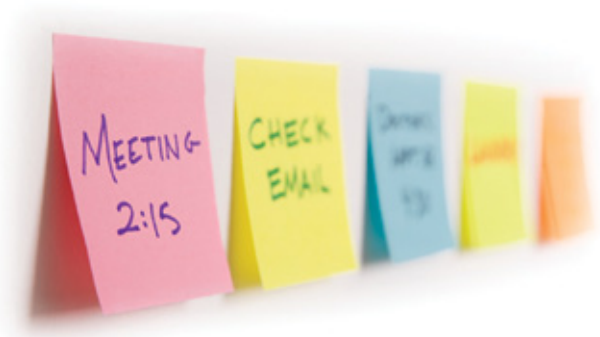
# Sleepy Brains Think Freely

## Creativity peaks at times of mental fuzziness

Early birds, save your creative challenges for just before bed. Your least productive time of day may be the perfect opportunity for a moment of insight, according to a study from a recent issue of *Thinking & Reasoning*.

Mareike Wieth, an assistant professor of psychological science at Albion College, and her colleagues divided study participants into morning types and evening types based on their answers on the Morningness Eveningness Questionnaire (those who scored in the neutral range—about half of initial respondents—were excluded). Wieth instructed them to solve three analytic problems and three insight-oriented ones. No time-of-day effect was found for analytic problem solving, but subjects' performance on tasks requiring creative insight was consistently better during their nonoptimal times of day.

Wieth believes this effect is the result of a reduction in inhibitory attentional control—the ability to filter information that is irrelevant to the task at hand. "This less focused cognitive state makes people more susceptible to think about other, seemingly unrelated information—like things they experienced earlier or their to-do list," she explains. "This additional information floating around in your mind during your nonoptimal time of day ultimately helps you reach that creative aha! moment." *—Tori Rodriguez*




>> REACHING GOALS

## Focused to a Fault

### Planning ahead might make us overlook new solutions

Do you have a plan to save money, exercise more or call your mother? Making those plans concrete might help you achieve those goals but at the cost of some flexibility, according to a study published in the February issue of *Social Cognition*.

E. J. Masicampo, a psychologist at Wake Forest University, studies implementation intentions. These plans take a specific "if-then" form, such as "if I am near a phone, then I will call my mother." In the experiment, he gave volunteers a number of tasks to complete online and asked them to remember to look up actor Bill Murray's birth date when they were done. He instructed some subjects to make an implementation intention to look up the date at a movie-themed Web site, IMDb.com. These individuals were much more likely to remember to do it, underscoring the power of implementation intentions. But if the test ended artificially early, with their computer screens pointing at Wikipedia.org, about two thirds of the subjects who had planned to use IMDb overlooked the alternative right in front of them. Those who had not made such a specific plan were able to adapt and find Murray's birth date on Wikipedia.

Masicampo explains that although having a narrow focus probably will not lead to so obvious a failure in the real world as it did in the laboratory, he thinks being blind to alternative solutions "frequently results in people expending more time, energy and resources on tasks than is necessary." But that should not stop people from making plans, he says. That may be the only way to juggle multiple goals—as long as one remembers to keep an open mind. *—Rachel Kaufman*

>> PERSONALITY

## A Mean Drunk

### Why booze makes some people belligerent

Some people are friendly drunks, whereas others are hostile, potentially endangering themselves and others. The difference may lie in their ability to foresee the consequences of their actions, according to a recent study in the online *Journal of Experimental Social Psychology*.

Brad Bushman, a psychologist at Ohio State University, and his colleagues asked nearly 500 volunteers to play a simple game. The subjects, an even mix of women and men, believed they were competing against an opponent to press a button as quickly as possible. In reality, they were simply using a computer program that randomly decided if they had won or lost. When they lost, they received a shock. When the "opponent" lost, the participant gave the shock and chose how long and intense it should be.

Before playing, the participants completed a survey designed to measure their general concern for the future consequences of their actions. Half the participants then received enough alcohol mixed with orange juice to make them legally drunk, and the other half received a drink with a very tiny amount of alcohol in it. Subjects who expressed little interest in consequences were more likely to administer longer, more intense shocks. In the sober group, they were slightly more aggressive than people who cared about consequences. When drunk, however, their belligerence was off the charts. "They are by far the most aggressive people in the study," Bushman says.

The good news is this trait is malleable. Michael McKloskey, a psychologist at Temple University who treats aggression, explains that people who act on impulse often feel that a frustrating or uncomfortable situation is happening "just to make their life miserable." If they can learn to see the situation more realistically, he explains, "they're able to stay calmer, and they can keep their anger in check." When impulsive people master this technique, he says, they develop a sense of control over their consequences. *—Harvey Black*

ISTOCKPHOTO (*left*); MANDY HB /*Stockphoto (right)*

>> HOT AIR

**Drinking alcohol in excess kills brain cells.**

**Reality:** Even in heavy drinkers, alcohol consumption doesn't kill brain cells. It does, however, damage the ends of neurons, called dendrites, which makes it difficult for neurons to relay messages to one another.

>> ANIMAL BEHAVIOR

# Will You Rat Me Out?

## Rodents sacrifice sweets to jailbreak their friends

Calling someone a rat may be complimentary. According to a study published in the December 9, 2011, issue of *Science,* rats can be surprisingly selfless.

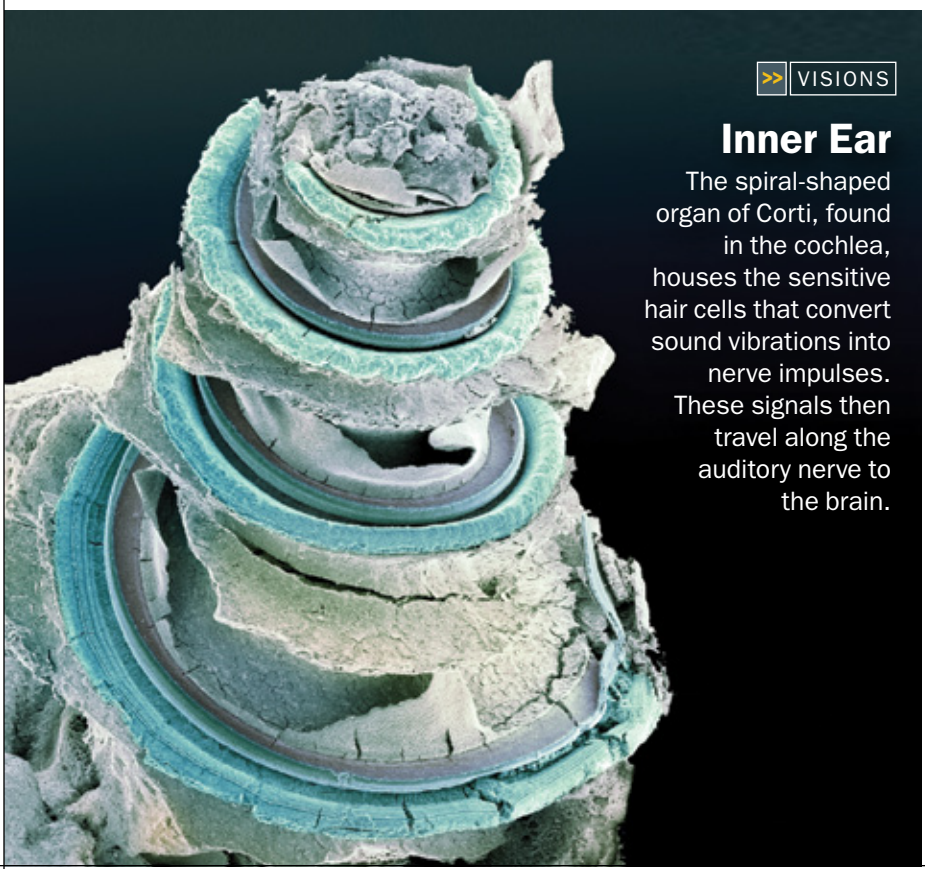
University of Chicago neuroscientist Peggy Mason and psychologists Inbal Ben-Ami Bartal and Jean Decety placed pairs of rats in pens. One rat was caged in the middle of the pen, whereas the other was free to run around. In this experiment, 23 of 30 rats liberated their peers by head butting the cage door or leaning against the door until it tipped over.

To actually test the rodents' selflessness, Mason placed rats in pens with two cages: in one was another rat; in the other was a pile of chocolate chips. The unhindered rats could easily have eaten the chocolate themselves. Instead most of the rodents opened both cages and shared the sweets. "In rat land, that is big," Mason says. This is the first study to show altruistic behavior in rodents.

McGill University psychologist Jeffrey Mogil was impressed with Mason's study, but both he and Mason point out that the jailbreaking rats might only be trying to silence their cohorts' distressing alarm calls. Mason thinks the alarm calls are not frequent enough to motivate the rats; Mogil is not so sure.

Mason's new study is just one in a series of recent experiments that have changed how scientists think about empathy and altruism—namely, that such characteristics are not limited to people, as they once thought. It now seems that many animals have evolved instincts to help others, even at a cost to themselves, and that we inherited these same instincts. "The bottom line," Mason says, "is that helping an individual in distress is part of our biology."

*—Ferris Jabr*



>> VISIONS

## Inner Ear

The spiral-shaped organ of Corti, found in the cochlea, houses the sensitive hair cells that convert sound vibrations into nerve impulses. These signals then travel along the auditory nerve to the brain.

>> BRAIN DRAIN

Male and female brains react differently to mild dehydration. In recent studies, men became less alert and struggled with memory tasks. Women experienced more fatigue, tension and anxiety than men did.

GETTY IMAGES (*top*); DAVID FURNESS *Kelle University/Photo Researchers, Inc.* (*bottom*)

>> ANXIETY

## The Fallacy of Fretting

### Tense people may miss the subtle warning signs of danger

Worrywarts, beware: all that fretting may be for naught. Anxiety has long been interpreted as a symptom of hyperawareness and sensitivity to danger, but a study published last December in *Biological Psychology* turns that logic on its head.

Tahl Frenkel, a graduate student in psychology at Tel Aviv University, asked 17 students who had anxious personalities and 22 students who were more mellow to identify when they detected fear in a series of increasingly frightened faces. As expected, the anxious group spoke up before their calmer counterparts. The twist, however, came from the volunteers' brain activity, recorded with electrodes on each student's scalp. The brains of anxious subjects barely responded to the images until the frightened face had reached a certain obvious threshold, at which point their brains leapt into action as though caught off guard. Meanwhile nonanxious respondents showed increasing brain activity earlier in the exercise, which built up subtly with each increasingly fearful face. Although their behavioral response was slower, their brain activity suggests that the mellow subjects picked up on subtle differences in the images more quickly.

The result implies that worriers are less aware of potential danger—challenging the common theory that anxious individuals are hypervigilant. Frenkel believes that worrywarts' low sensitivity to external warning signs causes them to be startled frequently by the seemingly sudden appearance of threats, which leaves them in a state of chronic stress. The brain activity in nonanxious subjects, Frenkel explains, may be evidence of an "early subconscious warning mechanism," which keeps them cool, calm and collected. [For more on how to ease chronic worrying, see "Why We Worry," by Victoria Stern; SCIENTIFIC AMERICAN MIND, November/December 2009.]

*—Daisy Yuhas*

>> HOT AIR

## You use only 10% of your brain.

**REALITY:**

No matter what you're doing, your brain is always active. Brain scans show that at times some areas are more active than others, but no region in a healthy brain is simply turned off.

>> LANGUAGE DEVELOPMENT

## Learning to Listen

### To tune their speech, toddlers may rely on different feedback than adults

Like a musician tuning a guitar, adults subconsciously listen to their own voice to tune the pitch, volume and pronunciation of their speech. Young children just learning how to talk, however, do not, a new study suggests. The result offers clues about how kids learn language—and how parents can help.

Past studies have shown that adults use aural feedback to tweak their pronunciation. Ewen MacDonald, a professor at the Center for Applied Hearing Research at the Technical University of Denmark, decided to see if toddlers could do this as well. He had adults and children play a video game in which they guided the actions of a robot by repeating the word "bed." Through headphones, the players heard their own voice every time they spoke—but with the frequency spectrum shifted so they heard "bad" instead of "bed." MacDonald found that adults and four-year-old kids tried to compensate for the error by pronouncing the word more like "bid," but two-year-olds never budged from "bed," suggesting that they were not using auditory feedback to monitor their speech.

Although the toddlers may have been suppressing the feedback mechanism, MacDonald thinks they might not start listening to themselves until they are older. If that is the case, they may rely heavily on feedback from adults to gauge how they sound. Indeed, most parents and caregivers naturally repeat the words toddlers say, as praise and encouragement. "I think the real take-home message is that social interaction is important for the development of speech," MacDonald says. "The general act of talking and interacting with the child in a normal way is the key."

*—Morgen E. Peck*

ROC CANALS PHOTOGRAPHY *Getty Images (top)*; MICHAEL TRAVERS *iStockphoto (bottom)*

**>> STRESS Forget about the gray hairs—the state of your chromosomes might be a better indicator of age. Chronic stress, which is known to hasten aging, appears to injure the protective caps on our chromosomes.**

>> GROUPTHINK

# Emotions in Lockstep

## Moving in unison can encourage aggression

Military leaders have long known that marching in unison makes for a tight-knit platoon. Past research by psychologist Scott Wiltermuth of the University of Southern California Marshall School of Business suggests that this cooperation emerges when the group members' emotions are aligned. Now he finds such synchrony can also encourage aggression, according to a study published in January in the *Journal of Experimental Social Psychology.*

Wiltermuth and his colleagues assigned subjects to groups. The researchers gave each group a set of cups and taught them a choreographed cup-moving routine that they would perform later to music. To create an atmosphere of competition, the researchers tasked them with memorizing a list of cities—they would be tested later, and the highest-scoring groups could win $50. Then all participants put on headphones and performed the cup routine in time to the music they heard. In some groups, participants ended up moving the cups in sync with one another; in other groups, each subject heard music with varying beats and could not coordinate with other participants. After completing the cup activity, the researchers told each group they could select the music a different group would hear during its cup-moving routine. One of the options was a loud, aggravating blast of static. Teams that had moved in sync were more likely to choose the noxious noise than those that had been out of sync. A more tightly knit team, it seems, is a fiercer foe.

In a companion study, to be published in *Social Influence,* Wiltermuth found that members of an in-sync group were also more destructive. The groups were given live pill bugs and told to shoo them into boxes described as "exterminators" (in reality, the boxes held the bugs unharmed). When prompted by a leader, those that had moved in sync earlier drove 54 percent more insects into the extermination boxes than did out-of-sync control subjects.

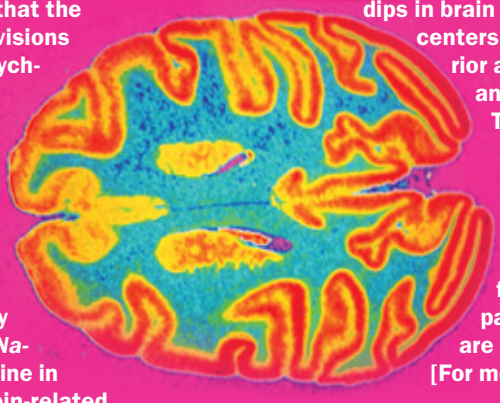
Wiltermuth explains that these findings underscore the importance of questioning our actions and those of our leaders. "We are doing things we wouldn't otherwise do, because we feel an emotional connection to our team," he says.

*—Daisy Yuhas*

>> ALTERED STATES

# Free Your Mind

## Psychedelic drugs may work by dialing down brain activity in control centers



**Researchers have long suspected that the altered perception, kaleidoscopic visions and mood changes produced by psychedelic drugs reflect a jump in brain activity. Not so, say neuroscientists at Imperial College London and elsewhere. They used functional MRI to peek at the brains of 30 participants experiencing a "trip" induced by intravenously delivered psilocybin, a psychedelic found in magic mushrooms. As they reported in the *Proceedings of the National Academy of Sciences USA* online in January, investigators saw psilocybin-related dips in brain activity, particularly in control centers such as the thalamus, the anterior and posterior cingulate cortices, and the medial prefrontal cortex. The more placid these regions appeared in a participant's brain, the more intense the subject's self-reported psychedelic experiences. The scientists conclude that psychedelics temporarily flip off cognition-constraining pathways—including some that are overactive during depression.** **[For more on this study, see page 18.]**

***—Andrea Anderson***

AHMAD FAIZAL YAHYA *iStockphoto (top);* TED HOROWITZ *Corbis (bottom)*

>> CLAIMS & CAVEATS

**Submitting to an MRI scan appears to reduce depression, according to a recent study.** Studies of the phenomenon can't discern whether the change is the result of the machine's electric fields, a placebo effect or perhaps a statistical fluke.

>> NERVE REPAIR

## Helping Neurons Heal

### Researchers uncover a potential new path to spinal cord regeneration

Nerve cells in our limbs can regenerate after injury, but neurons in the central nervous system, which includes the brain and spinal cord, cannot. Figuring out why this is the case is critical to helping brain and spinal cord injuries heal.

A study published in the January 26 issue of *Neuron* may offer a promising solution. Not only did the researchers, Rachid El Bejjani and Marc Hammarlund of Yale University, identify what appears to be a key chemical regulator of neuron repair, but drugs that target this regulator already exist, making the path to clinical treatments easier.

The molecule they identified, called Notch, is a receptor that influences many biochemical pathways inside cells. Scientists used to think that Notch was active only during fetal and childhood development, but increasing evidence suggests that Notch is also involved in neurodegenerative conditions such as Alzheimer's disease and stroke. Using *C. elegans,* a microscopic worm, El Bejjani and Hammarlund showed that Notch impeded neurons from healing themselves. When they blocked Notch's activity with a drug, the neurons' growth improved.

The drug used in the study is already being tested in rodents and humans for potential use in Alzheimer's and other disorders, although whether it can help damaged neurons regenerate in mammals is unclear. "We know that the Notch pathway is conserved in vertebrates, but we don't know if the regeneration mechanism is conserved," Hammarlund says. If Notch stops neurons from growing back in humans as it does in *C. elegans,* it could be a major breakthrough in spinal cord medicine. —*Erica Westly*

PHOTO RESEARCHERS, INC.

>> GET SMART Regular exercise increases glycogen storage in both muscles and the brain, where it helps to fuel neurons. The gains were most dramatic in brain areas critical to learning and memory, a recent rat study showed.

# The Aviator's Dilemma

Military aviators learn to second-guess their senses

BY STEPHEN L. MACKNIK, SUSANA MARTINEZ-CONDE AND ELLIS C. GAYLES

MAJOR PAUL "Goose" Gosden, U.S. Marine Corps, piloted his UH-1 Huey close air support helicopter across the Kuwait-Iraq border through the night's oily blackness. His aircraft was first to cross into Iraqi airspace in the second Gulf War, in support of Cobra attack helicopters tasked to destroy observation posts on Safwan Hill, near the infamous Highway of Death. Their mission was the opening salvo of Operation Iraqi Freedom, designed to kick in the door for the U.S. Army's Third Infantry Division, which would follow in a ground assault from Kuwait into Iraq. The Iraqi forces, however, anticipated the aerial sortie and had begun to destroy oil fields, filling the night air with oil smoke and haze so thick that it blinded the marines.

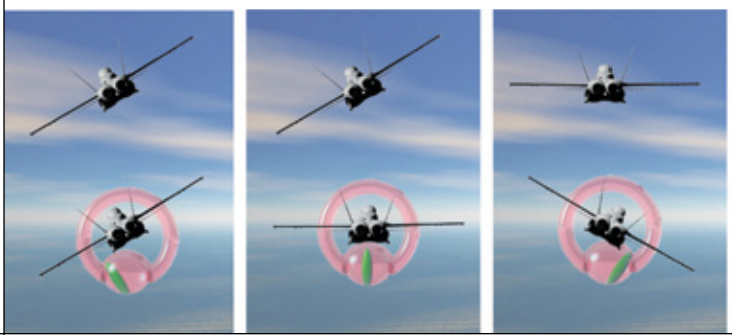
Military flight training ingrains night flying so deeply that pilots can do it practically in their sleep. Flying through an oil cloud at night, on the other hand, definitely ups the pucker factor. "Saddam had exploded the oil rigs to fill the air with oil. I couldn't see the Cobra in front of me or the stars or the moon. It was just black," Gosden recalled. To give yourself an idea of this feeling, start a mission in the helicopter combat Xbox game Apache (which one of us, Macknik, diligently toiled over as "research" for this article). Fly very high over enemy territory, then turn off your television (but not the Xbox) and try to land your helicopter blind as the bad guys begin to shoot at you. Remember, to simulate the experience of Gosden and his crew, you would have to commit to actually killing yourself if your simulated copter crashes; otherwise it's just a game.

## Spatial D and the Leans

Gosden told his hair-raising story at the Aviation Survival Training Center in Marine Corps Air Station Miramar near San Diego, Calif., during a course one of us (Gayles) teaches. This air station was the storied home of the U.S. Navy's ("Top Gun") Fighter Weapons School, featured in the 1986 Tom Cruise movie.

Gosden—coincidentally "Goose" is the call sign of Cruise's wingman in *Top Gun*—continued, "We all had 'spatial D' or were suffering from 'the leans.'" Spatial D is short for spatial disorientation, a catchall term to describe the summed result of the various perceptual illusions and degraded sensory perceptions that may occur on a mission. It is the total failure of situational awareness and, shockingly, the most common cause of crashes in the navy, accounting for almost 80 crashes between 1990 and 2008. Performance fails because pilots can no longer pay attention to what is happening—everything is off-kilter. All they can do is scan the instruments continually to give themselves as much factual information about the aircraft as possible, to counteract the false information from deceitful bodily senses.

The leans is not a colorful military term for gastrointestinal distress, although the two phenomena are, unsur-



GETTY IMAGES (*top*); COURTESY OF LCDR BRIAN D. SWAN, USN (RET.) (*bottom*)

**The leans, one of the most common vestibular illusions, occurs when the inner ear organ responsible for balance, the semicircular canal (*pink rings*), fails to continue to detect movement during a lengthy turn. As the aircraft turns, at first the endolymph fluid in the canal lags behind the turn, bending a hair cell (*green*), which signals the movement to the brain (*left*). In a prolonged turn, however, the vestibular system no longer detects the inertial difference between the canals and their fluid and no longer transmits the turning information to the brain (*center*). As the plane rolls out of the turn, the inertial difference between the fluid and canal reemerges but causes the misperception of turning in the opposite direction.**

prisingly, often experienced together. Rather the leans is a type of somatogyral illusion you feel in flight when your vestibular system (the inner ear organ responsible for balance and your sense of traveling through space) and your somatosensory system (skin and other bodily positioning sensors) together fail to provide you with an accurate description of where gravity indicates is down. The illusion happens when you come out of a tight acrobatic turn and the fluid in your vestibular semicircular canals system continues to flow even though you are no longer turning. As a result, you may feel like you are flying straight when in fact you are in a turn, something that investigators concluded happened when John F. Kennedy, Jr.'s plane crashed at Martha's Vineyard in 1999. Technically, the leans is the name of a solution to the problem: leaning your head until your instruments match your perception. Even so, most pilots use the term to relay the problem rather than the solution.

To get an idea of how critical your vestibular system is to your vision, hold up one finger in front of you at arm's length, then look at it as you rotate your head back and forth. Fine, no problem: your finger is nice and clear. Your vestibular system tracked the turning of your head and gave your eyes the information to stay on target. Now hold your head still and move your finger back and forth while following it with your eyes. Now there is no vestibular input because your head is stationary, so your finger becomes blurry. Motion sickness arises from a mismatch between vision and vestibular perception and is a major component of spatial D.

## Iraqi Nightlife

Gosden survived his mission by virtue of using his aircraft's forward-looking infrared (FLIR) optical array, which gave him the ability, in tandem with skill and luck, to notice a line of infrared lights marking a column of American light armored vehicles (LAVs) on the ground. He could not see the ground, but the LAVs gave him just enough information about the landscape to allow him to land "safely"—that is, behind enemy lines in the middle of the desert surrounded by a high-speed battle.

As important as visual input is for a pilot, **eyes can lie.** False horizons are everywhere.

**The fog—or dust—of war can have pilots fighting their own senses and reliant on instruments, which are also badly degraded by a brownout.**

"I knew that the ground behind those LAVs must be flat, meaning we could land there. We knew our position was behind enemy lines. But we didn't care—we had completed our flying for the evening. The other pilot on my helicopter, Captain Rodney 'Dino' Dean, was suffering from vertigo, which had the opposite result to what was happening to me [the leans]. It was a miracle we got down," Gosden said. "After landing, we got our weapons and set up a perimeter around the aircraft. When the sun came up, we could see well enough to fly out."

## Training to Survive

Night-vision devices such as personal goggles or the FLIR viewing system that Gosden used can ameliorate spatial D at night, but their performance is highly dependent on illumination, terrain contrast and particulates in the air. For instance, these devices offer little help during brownout conditions, where dust can severely degrade visibility. The main defense that pilots have against the dangerous misperceptions and illusions reviewed here is simply the awareness that they can happen.

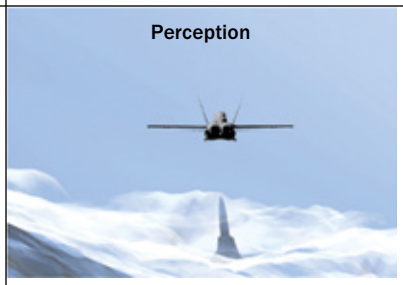
Back at the Miramar station, the architecture of the training facility is vintage 1950s U.S. military, the lobby festooned with uniformed mannequins in ejection seats. The lecture hall decor is exactly what you would find on the Boat (navy lingo for an aircraft carrier): over-engineered steel recliner-size seats bolted to the floor, padded generously with genuine Naugahyde coverings. Flight suits abound.

"When naval aviation was young, we were crashing two planes a day," Gayles says, "mostly caused by inevitable equipment failures. Now we crash 20 planes a year or so, and every crash is a very big deal, covered by the press, and reported throughout the military. Most crashes are no longer the result of maintenance or equipment failures. Those problems have been reduced to the point that the main issue is human error. Pilots sometimes fly perfectly good aircraft into the ground."

Why does that happen among the most highly trained pilots in the world? The answer: every sensory and cognitive system is highly taxed when flying military aircraft. Visual illusions alone accounted for about 20 crashes from 1990 to 2008, making the combined contribution of illusions of all types twice as high as the next biggest crash cause: fatigue.

This challenge is why Gosden and this group of aviators are here today, to receive their once-every-four-years refresher in situational awareness, aviation physiology and crash-survival training. They are lectured, questioned and then dunked unceremoniously into a huge, cold saltwater pool inside a crash simula-

FROM "A DUAL-MODE SENSOR SOLUTION FOR SAFE HELICOPTER LANDING AND FLIGHT ASSISTANCE," BY YAN CHRISTIAN VENOT AND PETER KIELHORN, IN *MICROWAVE JOURNAL*; JANUARY 17, 2008





**Pilots have a natural tendency to consider any straight line in the cloud deck as a false "horizon" (*left*). Unfortunately, the illusion that a cloud deck is the true horizon can overwhelm the senses, requiring pilots to concentrate on instruments; coastlines, ridge lines and even well-lighted highways can also cause this dangerous effect.**

tor while wearing a blindfold. It's scary, and the only people having fun are the two of us (Martinez-Conde and Macknik) on the side of the pool looking in.

## Shifting Horizons

As important as visual input is for a pilot, eyes can lie. For example, when flying above a cloud deck, there is a natural tendency to perceive any relatively straight line in the visual field as a horizon—which can lead to very undesirable results in a fast-moving aircraft.

False horizons are everywhere around you in the clouds. Your aircraft's attitude may seem level, even if you are tilted and in a turn. Mountain ridges might lead you astray as well, and at night the combination of clouds, stars, mountains and lights on the ground can produce impossibly confusing percepts that lead the aircraft away from the safety of true straight and level flight.

Don't think that you are safe from your own perception, however, just because you are flying above water on a clear day. A fixed horizon can still put you in the drink. Consider what may happen if you approach the beach from over the horizon. You may line up the beach in your sights and then keep it there in anticipation of going "feet dry" (flying from over sea to over land), but if so you will never reach land: the beach is fixed, unlike a true horizon, and the only way to keep it stationary in your sight is to point your aircraft progressively downward.

**Beaches make a particularly insidious false-horizon illusion. Because they are in a fixed location, the pilot will tend to point the aircraft ever downward to maintain the horizon ahead.**



Choosing a fixed horizon in proximity to wires or cables stretched across a valley is especially problematic. As you approach the fixed horizon (such as where a valley floor and mountain wall meet), you slowly and unnoticeably nose down. As you descend, the approaching wires will appear to rise as if they will pass well above you, whereas in fact they remain well below the aircraft. If you don't spot the wires until they are very close (because of mountain haze or the fog of war), your natural reaction may be to push the stick forward to dive under the wires. This reaction is what happened to the U.S. Marine pilots of an EA-6B Prowler aircraft on a training mission in 1998 near an active Italian ski resort in the Alps. The aircraft sliced through two wires, which held a cable car holding 20 skiers 370 feet above the ground. None survived.

One might think that objective information from instruments is the logical solution to subjective sensory illusions. The proliferation of instrumentation is part of the problem, however, because of mounting attentional demands on the pilots, which cause cognitive overload during combat and other stressful flight scenarios. This kind of mental distress is an important contributor to spatial D. New avionics are designed with simplicity, not complexity, in mind, and pilots learn how to scan their instruments at just the right times, under conditions of simulated duress. Systematic instrument scanning demands discipline, which may be one of the first casualties of battle, but until we learn better ways to overcome insidious in-flight illusions, it is one of the main techniques that keep pilots and crews safe. M

STEPHEN L. MACKNIK and SUSANA MARTINEZ-CONDE are laboratory directors at the Barrow Neurological Institute in Phoenix. They serve on *Scientific American Mind*'s board of advisers. Their forthcoming book, *Champions of Illusion,* will be published by Scientific American/Farrar, Strauss and Giroux. Lieutenant Commander ELLIS C. GAYLES is a U.S. Navy aerospace physiologist who trains naval and marine corps aircrew in the aeromedical aspects of flight, performance enhancement and mishap and in combat survival techniques.

*We would like to thank LCDR Brian Swan, USN (Ret.), CDR Tyson Brunstetter, USN, and CDR Fred R. Patterson, USN (Ret.), for their ideas and contributions to this article.*

## (Further Reading)


- **Spatial Orientation in Flight.** A. J. Parmet and W. R. Ercoline in *Fundamentals of Aerospace Medicine.* Fourth edition. Edited by Jeffrey R. Davis, Robert Johnson, Jan Stepanek and Jennifer A. Fogarty. Lippincott Williams & Wilkins, 2008.
- **Let's Keep You Flying.** Capt. Nick Davenport, USMC, in *The Navy and Marine Corps Aviation Safety Magazine,* Vol. 55, No. 1, pages 3–5; January/February 2010.


COURTESY OF LCDR BRIAN D. SWAN, USN (RET.) (*top*); COURTESY OF LCDR BRIAN D. SWAN, USN (RET.), SOURCE: CDR FRED PATTERSON, USN (RET.) (*bottom*)

# This Is Your Brain on Drugs

To the great surprise of many, psilocybin, a potent psychedelic, reduces brain activity

BY CHRISTOF KOCH

IN THE 1954 foundational text of the Age of Aquarius, *The Doors of Perception,* Aldous Huxley describes his encounters with mescaline, a psychoactive substance derived from the peyote cactus and traditionally used by Native Americans for religious purposes. Huxley's experiences include profound changes in the visual world, colors that induce sound, the telescoping of time and space, the loss of the notion of self, and feelings of oneness, peacefulness and bliss more commonly associated with religious visions or an exultant state: "A moment later a clump of Red Hot Pokers, in full bloom, had exploded into my field of vision. So passionately alive that they seemed to be standing on the very brink of utterance, the flowers strained upwards into the blue.... I looked down at the leaves and discovered a cavernous intricacy of the most delicate green lights and shadows, pulsing with undecipherable mystery." Yet remarkably these enhanced percepts are not grounded in larger but in reduced brain activity, as a recent experiment reports. More on that in a moment.

Mescaline, together with psilocybin, another natural psychoactive compound produced by "magic" mushrooms, and lysergic acid diethylamide (LSD or, simply, acid), a potent synthetic psychedelic drug, became widely popular in the 1960s counterculture. The striking similarities between the reports of LSD users and symptoms of acute psychosis led researchers to postulate that serotonin, a chemical-signaling compound or neurotransmitter released by certain groups of neurons in the brain stem, helped to mediate both types of experiences. Indeed, it is now quite certain that the characteristic subjective and behavioral effects of psychedelics are initiated via stimulation of serotonin 2A receptors (known as 5-HT2A) on cortical neurons.

All these hallucinogens were declared controlled drugs in the late 1960s and early 1970s for a variety of medical, political and cultural reasons. Their use moved underground, and research on their psychological, physiological and neuronal effects all but ceased. With the realization of possible therapeutic benefits of psychedelics to reduce anxiety and chronic pain, however, the societal taboos against scientific research on their neurobiology have somewhat relaxed. A number of well-controlled European studies have carefully explored the action of hallucinogens on the brains of normal volunteers [see "Psychedelic Healing?" by David Jay Brown; SCIENTIFIC AMERICAN MIND, December 2007/January 2008].

Functional brain-imaging experiments done at the end of the past century using positron-emission tomography (PET) found marked activation in the frontal lobe of volunteers who had taken hallucinogens, in particular in the prefrontal cortex (PFC), anterior cingulate cortex (ACC) and the insula cortex. This was in line with the expectation that the intensification of ordinary experiences and the consciousness-expanding aspects that are so widely associated with psychedelics would be reflected in higher than usual brain activity. Now comes a study from David Nutt, a psychopharmacologist at Imperial College London, and his colleagues that completely upends this view.

## Turn On, Tune In and Drop Out

The British scientists injected either a harmless saltwater concoction (a placebo) or two milligrams of psilocybin directly into the veins of 30 volunteers while they were lying inside a magnetic scanner. As expected, the subjects expe-

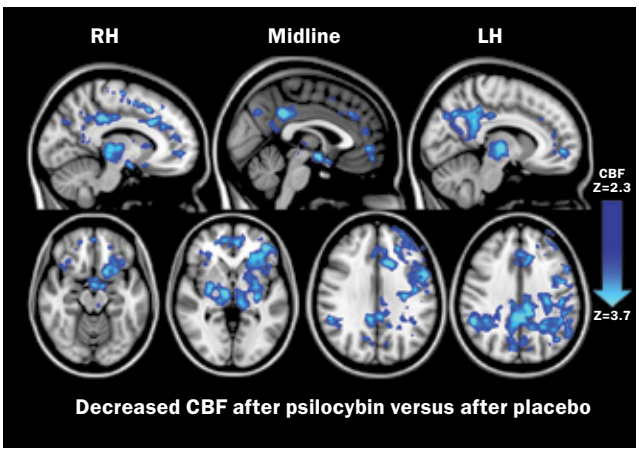
CHRISTOF KOCH (*Koch*); PAUL SALE VERN HOFFMAN *Aurora Photos (background)*; ISTOCKPHOTO (*head*)

## Expanding your mind by taking **magic mushrooms** turns many brain circuits down rather than up.

rienced within a minute or two the effects of the drug. During their short "trip," their brains were scanned with one of two different functional MRI techniques. Both gave consistent but very surprising results.

Brain activity was widely reduced! That is, these mind-altering drugs decreased hemodynamic activity, including blood flow, in selected regions, such as the thalamus, the medial prefrontal cortex (mPFC), the ACC and the posterior cingulate cortex (PCC). Activity in these regions dropped by up to 20 percent, relative to before the injection. Even more striking, the deeper the reduction in activity in the ACC and mPFC, the stronger the subject felt the effects of the hallucinogen. Nowhere did activity show an increase. Furthermore, the communication between the PFC and cortical regions in the back of the brain was also disrupted. The surprise is not that reduction of hemodynamic activity in specific sectors of the brain is unheard of. Nor was the activity completely turned off—that would lead within minutes to permanent damage and brain death.

Hemodynamic activity as registered by fMRI scanners is tightly linked to neuronal activity. A standard reading of Nutt's fMRI data seems to imply that expanding your mind by taking magic mushrooms turns many brain circuits down rather than up. Suddenly, Timothy Leary's famous admonition to hippies to "turn on, tune in and drop out" acquires a whole new meaning.




**Blue areas show where there has been decreased cerebral blood flow (CBF) after psilocybin as compared with after saline (placebo). Remarkably, no significant increase in blood flow was detected in either the left hemisphere (LH) or the right hemisphere (RH).**

FROM "NEURAL CORRELATES OF THE PSYCHEDELIC STATE AS DETERMINED BY FMRI STUDIES WITH PSILOCYBIN," BY ROBIN L. CARHART-HARRIS ET AL., IN *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES USA*, VOL. 109, NO. 6; FEBRUARY 7, 2012

The ACC and parts of the mPFC inhibit limbic and other structures. Thus, their downregulation, or reduction in response, would allow the content of the limbic systems that process emotion and perhaps sensory cortices to play a relatively more dominant role. It is not that enhanced hemodynamic, or even neuronal, activity by itself gives rise to perception and thought. After all, epileptic seizures are hypersynchronized discharges that engulf the entire cortex in massive rhythmic activity that renders the patient unconscious. It is the pattern of spiking across heterogeneous populations of neurons that carries the specific information, the messages, that are represented in consciousness.

At this point, this is all pure speculation because the detailed biophysical mechanisms and the effects of psilocybin on different neurons remain to be worked out.

Any such remarkable finding needs to be replicated by other groups before it becomes part of textbook knowledge. Moreover, the discrepancy with the earlier PET experiments needs to be explained. Two major differences are the mode of taking the drug (intravenously versus orally) and the time of measurement (immediately versus an hour later).

What is intriguing is that the regions that show the strongest reduction in activity are among the most heavily interconnected in the brain. They act like traffic circles or hubs that link disparate regions. Thus, the brain on psilocybin becomes more disconnected, more fragmented, which might explain some of the dissociative aspects of acid trips. Yet why this state should cause the mind-expanding effects that are the prime reason these drugs are treasured is utterly unclear. The study once again highlights how elusive our knowledge of the mind-brain hinge remains. M

CHRISTOF KOCH is chief scientific officer at the Allen institute for Brain Science in Seattle and Lois and Victor Troendle Professor of Cognitive and Behavioral Biology at the California Institute of Technology. He serves on the board of advisers for *Scientific American Mind*.

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# The Perils of Paying for Status

Knowing when to pass on that luxury limo or overpriced pen

BY DAISY GREWAL


MARIO WAGNER

WE ALL YEARN to feel important, powerful and popular. The desire for social status is one of the most important factors driving human behavior—our rung on the social ladder can determine whom we marry and how long we live, among other things. Recent research suggests, however, that some of our attempts to boost our place in the social hierarchy can backfire: our actions may make us feel better temporarily, but they increase the chances we will be stuck with lower status in the long term.

A feeling of powerlessness or lack of influence, recent studies suggest, may prompt us to pay more for products or services. It may even make us eat more. Doing so repeatedly could end up making us poorer or less attractive, diminishing our status instead of raising it. Knowing how and when status influences our decisions might help us break the vicious cycle.

## Expensive Taste

Stereotypes, such as racial or cultural ones, often cast certain groups as lower status. A commonly used tool in psychology is to remind study participants of a certain stereotype and then observe if and how their behavior changes in response. In an experiment published in 2011 psychologist Aarti Ivanic of the University of San Diego, along with her colleagues, recruited 113 African-American and Caucasian shoppers at a mall. They showed half of the African-Americans a list of 10 stereotypical characteristics of their race, including "high athletic ability" and "low performance on an academic test," and asked them to indicate how much each one applied to them personally.

The participants then received a description of high-end headphones and reported how much they would be willing to pay for them. African-Americans who had been reminded of racial stereotypes offered to pay nearly twice as much for the headphones as either Caucasians or African-Americans who had not been asked about stereotypical traits. The groups did not differ in their interest in actually buying the headphones. Therefore, the researchers concluded that racial typecasting may lead African-Americans to pay more as a way of coping with feelings of lower status. Unfortunately, this finding also hints that African-Americans may be regularly parting with more money than necessary.

This overpayment seems to occur in a variety of situations. In a second study, Ivanic and her colleagues asked 344 participants to imagine that they were planning a vacation, using a fictitious travel Web site. A $200-per-night standard room was the default travel package, but

luxury rooms were also available. Participants were asked how much above the standard rate they would pay for the upgrade. African-Americans who had been reminded of their race (in a manner similar to that used in the previous study) offered to pay twice as much as Caucasians for the more costly room. The researchers speculated that African-Americans may attach a higher cash value to luxury because of a greater need to elevate their perceived place on the social ladder.

Widespread feelings of low rank may engender even more unfairness. After all, consumers who are known to pay more are very likely to be charged more, and investigators have found that prices are indeed sometimes higher for African-Americans. For example, in a 2007 study researchers at New York University determined that African-American home buyers in New York City were more likely than Caucasians to be offered mortgages with higher interest rates. The result held even after controlling for median household income.

## Lighter Wallets, Wider Waists

No matter our race, we are all potentially vulnerable to feelings of low status, whether those perceptions result from losing a job, the breakup of a romantic relationship or receiving a bad performance review at work. In 2008 psychologists Derek Rucker and Adam Galinsky of Northwestern University reported that manipulating people's feelings of status in various ways also changes the amount that people will pay for products. The researchers told individuals to write about a time they felt either powerful or powerless and then asked them how much they would be willing to pay for different products. Subjects who had written about feeling powerless offered to pay significantly more for luxury items such as a stylish pen or fur coat. Yet the desire for a quick fix for lowly feelings may put those who regularly feel as if they lack influence at greater risk of amassing debt—or at least of making some questionable investments.

Aside from lightening our wallets, feelings of inferiority can also lead us to gain weight. Marketing professor David Dubois, also at Northwestern, and his colleagues have repeatedly demonstrated that when people feel unimportant, they are more likely to opt for an extra-large coffee or smoothie. The researchers did not know, however, whether consumers make this choice because size confers status or because they want to consume more when they are feeling low. To answer this question, Dubois and his colleagues designed an experiment in which they instructed participants to imagine themselves as either a high-ranking boss or a lowly employee. Then they asked people to choose between a small or large container in which to eat a serving of a constant size, either a slice of pizza or a smoothie.

The imaginary employees were significantly more likely than the pretend bosses to pick the large container, even though the amount of food was the same in all cases. The researchers conclude that big things may signal higher status, and thus powerless people buy more food because it comes in physically larger packages. Of course, the additional calories collected in these packages could also play a role in real life. Either way, a side effect of buying bigger food products may be weight gain, which, of course, can affect not only health but also the way others perceive us.

When we are plagued by painful feelings of low status, our judgment may become clouded. We may focus more on being happier in the moment than on figuring out how our behavior will affect us in the long run. For example, the perceived link between power and portion size may help explain, at least in part, why obesity has increased most rapidly among Americans who are underprivileged.

The good news is that manipulating what signals high status could steer people toward better choices. When Dubois and his co-workers told people that choosing minimal portions was a high-status move, they picked smaller appetizers. Simply being aware that your behavior may be under the influence of feelings of low status may improve your judgment. When you are in line at a deli, tempted by the extra-large latte or jumbo fries, reflect on your emotional state. If something just happened that made you feel less than vaunted, you may "want" the big size for reasons other than hunger.

The next time that you are making a purchase, be aware of your motives. If you harbor feelings of insecurity, you might want to come back later, when you feel a little cockier. You might get a better deal. M

> People who had written about feeling powerless offered to shell out significantly more for **extravagant items** such as a fur coat.

DAISY GREWAL is a researcher at the Stanford University School of Medicine. She holds a Ph.D. in social psychology from Yale University.

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# FINDING FREE WILL

## Physics and neurobiology can help us understand whether we choose our own destiny

**By Christof Koch**

In a remote corner of the universe, on a small blue planet gravitating around a humdrum sun in the outer districts of the Milky Way, organisms arose from the primordial mud and ooze in an epic struggle for survival that spanned aeons.

Despite all evidence to the contrary, these bipedal creatures thought of themselves as extraordinarily privileged, occupying a unique place in a cosmos of a trillion trillion stars. Conceited as they were, they believed that they, and only they, could escape the iron law of cause and effect that governs everything. They could do this by virtue of something they called free will, which allowed them to do things without any material reason.

Can you truly act freely? The question of free will is no mere philosophical banter; it engages people in a way that few other metaphysical questions do. It is the bedrock of society's notions of responsibility, praise and blame. Ultimately it is about the degree of control you exert over your life.

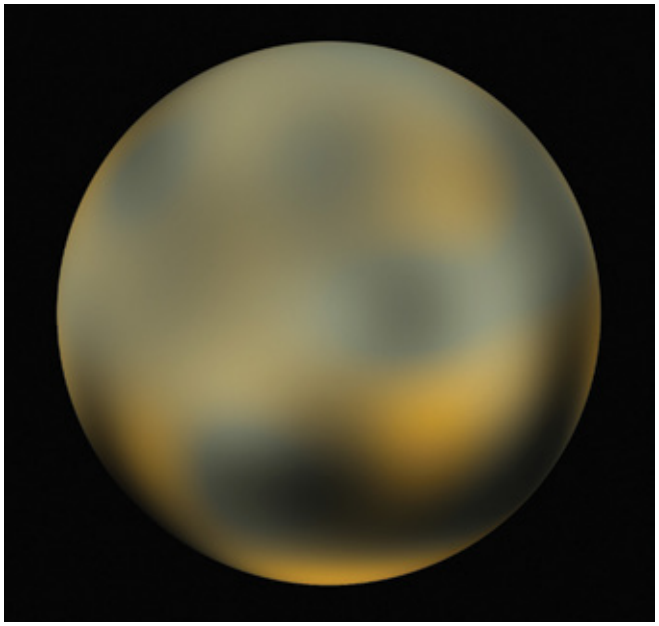
Let's say you are living with a loving and lovely spouse. A chance meeting with a stranger turns this life utterly upside down. You begin talking for hours on the phone, you share your innermost secrets, you start an *affaire de coeur*. You realize perfectly well that this is all wrong from an ethical point of view; it will wreak havoc with many lives, with no guarantee of a happy and productive future. Yet something in you yearns for change.

Such gut-churning choices confront you with the question of how much say you really have in the matter. You feel that you could, in principle, break off the affair. Despite many attempts, you somehow never manage to do so.

In my thoughts on these matters of free will, I neglect millennia of learned philosophical debates and focus on what physics, neurobiology and psychology have to say, for they have provided partial answers to this ancient conundrum.



DAVID MORGAN *iStockphoto (dice)*; PHOTOILLUSTRATION BY AARON GOODMAN *(right)*



UNPREDICTABLE PLUTO: Because of Pluto's small size, the former planet's orbit is subject to tiny gravitational fluctuations. As a result, scientists cannot predict where Pluto will be aeons from now.

## Shades of Freedom

I recently served on a jury in United States District Court in Los Angeles. The defendant was a heavily tattooed member of a street gang that smuggled and sold drugs. He was charged with murdering a fellow gang member with two shots to the head.

As the background to the crime was laid out by law enforcement, relatives, and present and past gang members—some of them testifying while handcuffed, shackled and dressed in bright orange prison jumpsuits—I thought about the individual and societal forces that had shaped the defendant. Did he ever have a choice? Did his violent upbringing make it inevitable that he would kill? Fortunately, the jury was not called on to answer these irresolvable questions or to determine his punishment. We only had to decide, beyond a reasonable doubt, whether he was guilty as charged, whether he had shot a particular person at a particular place and time. And this we did.

FAST FACTS

### Uncertain Freedom

1» **Most of us believe that we are free because, under identical circumstances, we could have acted otherwise. Determinism—the idea that all particles in the universe follow set trajectories—challenges this idea.**

2» **Theories to explain the potential origins of free will draw on physics, including Heisenberg's uncertainty principle.**

3» **Whether or not free will exists, psychology and neuroscience are beginning to explain why we feel as if we can influence our destiny.**

If uncertainty holds for a planet, a person, a tiny insect or an itsy-

According to what some call the strong definition of free will, articulated by René Descartes in the 17th century, you are free if, under identical circumstances, you could have acted otherwise. Identical circumstances refer to not only the same external conditions but also the same brain states. The soul freely chooses this way or that, making the brain act out its wishes, like a driver who takes a car down this road or that one. This view is the one most regular folks believe in.

Contrast this strong notion of freedom with a more pragmatic conception called compatibilism, the dominant view in biological, psychological, legal and medical circles. You are free if you can follow your own desires and preferences. A long-term smoker who wants to quit but who lights up again and again is not free. His desire is thwarted by his addiction. Under this definition, few of us are completely free.

It is the rare individual—Mahatma Gandhi comes to mind—who can steel himself to withhold sustenance for weeks on end for a higher ethical purpose. Another extreme case of iron self-control is the self-immolation of Buddhist monk Thich Quang Duc in 1963 to protest the repressive regime in South Vietnam. What is so singular about this event, captured in haunting photographs, is the calm and deliberate nature of his heroic act. While burning to death, Duc remained in the meditative lotus position, without moving a muscle or uttering a sound, as the flames consumed him. For the rest of us, who struggle to avoid going for dessert, freedom is always a question of degree rather than an absolute good that we do or do not possess.

Criminal law recognizes instances of diminished responsibility. The husband who beats his wife's lover to death in a blind rage when he catches them in flagrante delicto is considered less guilty than if he had sought revenge weeks later in a cold, premeditated manner. Norwegian Anders Breivik, who shot more than 60 people in a cold-blooded and calculated manner in July 2011, is a paranoid schizophrenic who was found to be criminally insane and will probably be confined to a psychiatric institution. Contemporary society and the judicial system are built on such a pragmatic, *psychological* notion of freedom.

But I want to dig deeper. I want to unearth the underlying causes of actions that are traditionally thought of as "free."

PHOTO RESEARCHERS, INC.

moving under a sole force, gravitation, what does it portend for bitsy nerve cell, all of which are swayed by countless factors?

## A Clockwork Universe

In 1687 Isaac Newton published his *Principia*, which enunciated the law of universal gravitation and the three laws of motion. Newton's second law links the force brought on a system—a billiard ball rolling on a green felt table—to its acceleration. This law has profound consequences, for it implies that the positions and velocities of all the components making up an entity at any particular moment, together with the forces between them, unalterably determine that entity's fate—that is, its future location and speed.

This is the essence of determinism. The mass, location and velocities of the planets as they travel in their orbits around the sun determine where they will be in a thousand, a million or a billion years from today, provided only that all the forces acting on them are properly accounted for. The universe, once set in motion, runs its course inexorably, like a clockwork.

A full-blown setback for the notion that the future can be accurately forecast was revealed in the form of deterministic chaos. The late meteorologist Edward Lorenz came across it while solving three simple mathematical equations characterizing the motion of the atmosphere. The solution predicted by his computer program varied widely when he entered starting values that differed by only tiny amounts. This is the hallmark of chaos: infinitesimally small perturbations in the equations' starting points lead to radically different outcomes. In 1972 Lorenz coined the term "butterfly effect" to denote this extreme sensitivity to initial conditions: the beating of a butterfly's wings creates barely perceptible ripples in the atmosphere that ultimately alter the path of a tornado elsewhere.

Remarkably, such a butterfly effect was found in celestial mechanics, the epitome of the clockwork universe. Planets majestically ride gravity's geodesics, propelled by the initial rotation of the cloud that formed the solar system. It came as a mighty surprise, therefore, when computer modeling in the 1990s demonstrated that Pluto has a chaotic orbit, with a divergence time of millions of years. Astronomers cannot be certain whether Pluto will be on this side of the sun (relative to Earth's position) or the other side 10 million years from now! If this uncertainty holds for a planet with a comparatively simple internal makeup, moving in the vacuum of space under a sole force, gravitation, what does it portend for the predictability of a person, a tiny insect or an itsy-bitsy nerve cell, all of which are swayed by countless factors?

Chaos does not invalidate the natural law of cause and effect, however. It continues to reign supreme. Planetary physicists aren't quite sure where Pluto will be aeons from now, but they are confident that its orbit will always be completely in thrall to gravity. What breaks down in chaos is not the chain of action and reaction, but predictability. The universe is still a gigantic clockwork, even though we can't be sure where the minute and hour hands will point a week hence.

## Origins of Uncertainty

The deathblow to the Newtonian dream—or nightmare, in my opinion—was the celebrated quantum-mechanical uncertainty principle, formulated by Werner Heisenberg in 1927. In its most common interpretation, it avers that any particle, say, a photon of light or an electron, cannot have both a definite position and a definite momentum at the same time. If you know its speed accurately, its position is correspondingly ill defined, and vice versa. Heisenberg's uncertainty principle is a radical departure from classical physics. It replaces dogmatic certainty with ambiguity.

Consider an experiment that ends with a 90 percent chance of an electron being here and a 10 percent chance of it being over there. If the experiment were repeated 1,000 times, on about 900 trials, give or take a few, the electron would be here; otherwise, it would be over there. Yet this statistical outcome does not ordain where the electron will be on the next trial. Albert Einstein could never reconcile himself to this random aspect of nature. It is in this context that he famously pronounced, "*Der Alte würfelt nicht*" (the Old Man, that is, God, does not play dice).

The universe has an irreducible, random character. If it is a clockwork, its cogs, springs and levers are not Swiss-made; they do not follow a predetermined path. Physical determinism has been replaced by the determinism of probabilities. Nothing is certain anymore.

But wait—I hear a serious objection. There is no question that the macroscopic world of human experience is built on the microscopic, quantum world. Yet that does not imply that everyday objects such as cars inherit all the weird properties of quantum mechanics. When I park my red Mini convertible, it has zero velocity relative to the pavement. Because it is enor-


### (The Author)

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mously heavy compared with an electron, the fuzziness associated with its position is, to all intents and purposes, zero.

Cars have comparatively simple internal structures. The brains of bees, beagles and boys, by comparison, are vastly more heterogeneous, and the components out of which they are constructed have a noisy character. Randomness is apparent everywhere in their nervous system, from sensory neurons picking up sights and smells to motor neurons controlling the body's muscles. We cannot rule out the possibility that quantum indeterminacy likewise leads to behavioral indeterminacy.

Such randomness may play a functional role. If a housefly pursued by a predator makes a sudden, abrupt turn midflight, it is more likely to see the light of another day than its more predictable companion. Thus, evolution might favor circuits that exploit quantum randomness for certain acts or decisions. Both quantum mechanics and deterministic chaos lead to unpredictable outcomes.

## The brain acts before the mind consciously decision to move by

### Afterthought to Action

Let me return to solid ground and tell you about a classical experiment that convinced many people that free will must be an illusion. This experiment was conceived and carried out in the early 1980s by Benjamin Libet, a neuropsychologist at the University of California, San Francisco.

The brain and the sea have one thing in common—both are ceaselessly in commotion. One way to visualize this is to record the tiny fluctuations in the electrical potential on the outside of the scalp, a few millionths of a volt in size, using an electroencephalograph (EEG). Like the recording of a seismometer, the EEG trace moves feverishly up and down, registering unseen tremors in the cerebral cortex underneath. Whenever the person being tested is about to move a limb, an electrical potential builds up. Called the readiness potential, it precedes the actual onset of movement by one second or longer.

Intuitively, the sequence of events that leads to a voluntary act must be as follows: You decide to raise your hand; your brain communicates that intention to the neurons responsible for planning and executing hand movements; and those neurons relay the appropriate commands to the motor neurons that contract the arm muscles. But Libet was not convinced. Wasn't it more likely that the mind and the brain acted simultaneously or even that the brain acted before the mind did?

**BREAKING FREE:** While scientists and philosophers struggle to resolve what free will is, we can learn from psychologists' findings.

ISTOCKPHOTO (*top left*); NATALIA LUKIYANOVA *iStockphoto* (*top right*); PHOTOILLUSTRATION BY AARON GOODMAN (*bottom*)

decides. Electrical signals in the brain precede the at least half a second and often by much longer.

Libet set out to determine the timing of a mental event, a person's deliberate decision, and to compare that with the timing of a physical event, the onset of the readiness potential after that decision. He projected onto a screen a point of bright light that went around and around, like the tip of the minute hand on a clock. With EEG electrodes on his or her head, each volunteer had to spontaneously, but deliberately, flex a wrist. They did this while noting the position of the light when they became aware of the urge to act.

The results told an unambiguous story, which was bolstered by later experiments. The beginning of the readiness potential *precedes* the conscious decision to move by at least half a second and often by much longer. The brain acts before the mind decides! This discovery was a complete reversal of the deeply held intuition of mental causation.

## The Conscious Experience of Will

Why don't you repeat this experiment right now: go ahead and flex your wrist. You experience three allied yet distinct feelings associated with the plan to move (intention), your willing of the movement (a feeling called agency or authorship), and the actual movement. If a friend were to take your hand and bend it, you would experience the movement but neither intention nor agency; that is, you would not feel responsible for the wrist movement. This is a neglected idea in the debate about free will—that the mind-body nexus creates a specific, conscious experience of "I willed this" or "I am the author of this action."

Daniel Wegner, a psychologist at Harvard University, is one of the trailblazers of the modern study of volition. In one experiment, Wegner asked a volunteer to wear gloves and stand in front of a mirror, her arms hanging by her sides. Directly behind her stood a lab member, dressed identically. He extended his arms under her armpits, so that when the woman looked into the mirror, his two gloved hands appeared to be her own. Both participants wore headphones through which Wegner issued instructions, such as "clap your hands" or "snap your left fingers." The volunteer was supposed to report on the extent to which the actions of the lab member's hands were her own. When she heard Wegner's directions prior to the man's hands carrying them out, she reported an enhanced feeling of having willed the action herself, compared with when Wegner's instructions came after the man had already moved his hands.

The reality of these feelings of intention has been underscored by neurosurgeons, who must occasionally probe brain tissue with brief pulses of electric current. In the course of such explorations, Itzhak Fried, a surgeon at U.C.L.A., stimulated the presupplementary motor area, which is part of the vast expanse of cerebral cortex lying in front of the primary motor cortex. He found that such stimulation can trigger the urge to move a limb. Michel Desmurget of INSERM and Angela Sirigu of the Institute of Cognitive Science in France discovered something similar when stimulating the posterior parietal cortex, an area responsible for transforming visual information into motor commands. Patients commented, "It felt like I wanted to move my foot. Not sure how to explain," or "I had a desire to roll my tongue in my mouth." Their feelings arose from within, without any prompting by the examiner.

## Free the Mind

I have taken two lessons from these insights. First, I have adopted a more pragmatic conception of free will. I strive to live as free of constraints as possible. The only exception should be restrictions that I deliberately and consciously impose on myself, chief among them restraints motivated by ethical concerns: do not hurt others and try to leave the planet a better place than you found it. Other considerations include family life, health, financial stability and mindfulness. Second, I try to understand my unconscious motivations, desires and fears better. I reflect deeper about my own actions and emotions than my younger self did.

I am breaking no new ground here—these are lessons wise men from all cultures have taught for millennia. The ancient Greeks had "*gnothi seauton*" ("know thyself") inscribed above the entrance to the Temple of Apollo at Delphi. The Jesuits have a nearly 500-year-old spiritual tradition that emphasizes a twice-daily examination of conscience. This constant internal interrogation sharpens your sensitivity to your actions, desires and motivations. This will enable you not only to understand yourself better but also to live a life more in harmony with your character and your long-term goals. M

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DSM-I
DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS

DSM-II
DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS

DSM-III
DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS

DSM-IV
DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS

DSM-5
DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS

5

# REDEFINING MENTAL ILLNESS

Psychiatry's diagnostic guidebook gets its first major update in 30 years. The changes may surprise you

**By Ferris Jabr**

Illustrations by Patrick George

In February 1969 David L. Rosenhan showed up in the admissions office of a psychiatric hospital in Pennsylvania. He complained of unfamiliar voices inside his head that repeated the words "empty," "thud" and "hollow." Otherwise, Rosenhan had nothing unusual to report. He was immediately admitted to the hospital with a diagnosis of schizophrenia.

Between 1969 and 1972 seven friends and students of Rosenhan, a psychology professor then at Swarthmore College, ended up in 11 other U.S. hospitals after claiming that they, too, heard voices—their sole complaint. Psychiatrists slapped them all with a diagnosis of schizophrenia or bipolar disorder and stuck them in psychiatric wards for between eight and 52 days. Doctors forced them to accept antipsychotic medication—2,100 pills in all, the vast majority of which they pocketed or tucked into their cheeks. Although the voices vanished once Rosenhan and the others entered the hospitals, no one realized that these individuals were healthy—and had been from the start. The voices had been a ruse.

The eight pseudopatients became the subject of a landmark 1973 paper in *Science*, "On Being Sane in Insane Places." The conclusion: psychiatrists did not have a valid way to diagnose mental illness.

Rosenhan's experiment motivated a radical transformation of the essential reference guide for psychiatrists: the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM*), published by the American Psychiatric Association (APA). The revamped *DSM*, dubbed *DSM-III* and published in 1980, paired every ailment with a checklist of symptoms, several of which were required for a diagnosis to meet the book's standards. Earlier versions of the *DSM* contained descriptive paragraphs that psychiatrists could

## Psychosis Revisited

Schizophrenia is characterized by a tenuous grasp of reality, difficulty thinking and speaking clearly, and unusual emotional responses. In today's diagnostic manual, the *DSM-IV,* this complex disorder is split up into the following "types":

- *Paranoid:* delusions and auditory hallucinations but normal speech and emotional responses.
- *Disorganized:* erratic speech and behavior and muted emotions.
- *Catatonic:* unusual postures and movements or paralysis.
- *Residual:* very few typical symptoms but some odd beliefs or unusual sensory experiences.
- *Undifferentiated:* none of the other types.

Yet another form of the illness is shared psychotic disorder: when someone develops the same delusions as a friend or family member with schizophrenia.

Soon you can forget all these variants. As with certain personality disorders, there is little evidence for the existence of these discrete categories. Catatonia, for instance—an intermittent "freezing" of the limbs—also accompanies bipolar disorder, post-traumatic stress disorder and depression. Therefore, psychiatrists say it makes little sense to call it a form of schizophre-

FAST FACTS

### A New Guide to Your Psyche

1» The fifth version of psychiatry's bible, the ***Diagnostic and Statistical Manual of Mental Disorders,*** slated for publication in May 2013, represents the first substantial change to psychiatric diagnosis in more than 30 years.

2» In 2010 the American Psychiatric Association debuted a draft of the new manual on their Web site that has so far received 50 million hits from about 500,000 individuals, many of them critics.

3» The revised manual will very likely scrap psychiatry staples such as Asperger's syndrome and paranoid personality disorder.

4» Additions to the diagnostic menu are likely to include an ailment for children marked by severe temper tantrums and for adults a type of sex addiction.

The *DSM-5* framers are scrapping certain disorders, such as Asperger's, and adding brand-new ones, including addiction to gambling.

nia. Catatonia also does not respond well to the antipsychotic medications used to treat schizophrenia.

Even as it sheds these subtypes, the *DSM-5* embraces novel forms of psychosis. The most contentious is attenuated psychosis syndrome, a cluster of warning signs that some researchers think precede the frequent delusions and hallucinations that characterize the full-blown disorder. Its purpose is to catch young people at risk and prevent this insidious progression. Critics contend, however, that two thirds of the children who qualify for the at-risk criteria never develop real psychosis and may unnecessarily receive powerful drugs [see "At Risk for Psychosis?" by Carrie Arnold; Scientific American Mind, September/October 2011]. After all, about 11 percent of us sometimes hear voices or engage in moments of intense magical thinking with little or no distress.

Another controversial addition is disruptive mood dysregulation disorder, a diagnosis for kids that carries less stigma than its predecessor, childhood bipolar disorder. Since about 2000, diagnoses of pediatric bipolar disorder have jumped at least fourfold in the U.S. Many psychiatrists, however, argued that their peers were mislabeling a condition that was not bipolar disorder at all and treating children with strong drugs before knowing what really ailed them.

Very few people younger than 20 develop true bipolar disorder, in which moods swing between depression and mania. The vast majority of the kids who received the label did not, in fact, oscillate in this way. Instead they were in a bad mood all the time and frequently exploded in anger and physical violence, even in response to a minor offense. Because of these differences, disruptive mood dysregulation disorder describes a child (younger than 10) who is constantly irritable and has extreme temper tantrums about three times a week.

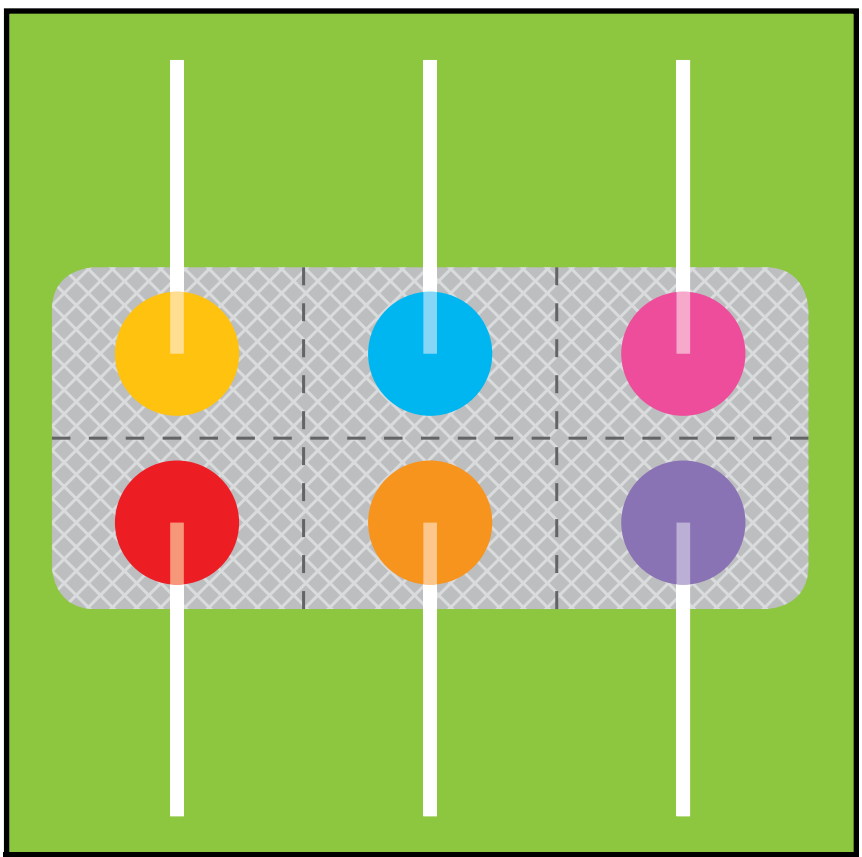
The APA says this pediatric entry will "provide a 'home' for these severely impaired youth," but some critics worry doctors will dole out the diagnosis like lollipops to droves of tantrum-prone toddlers. The treatment is the same, despite the new name: a mixture of mood stabilizers, antipsychotics, antidepressants and stimulants. —*F.J.*

interpret more loosely. This fundamental revision survives today.

The APA is now working on the fifth version of the hefty tome, slated for publication in May 2013. Because the *DSM-IV* was largely similar to its predecessor, the *DSM-5* embodies the first substantial change to psychiatric diagnosis in more than 30 years. It introduces guidelines for rating the severity of symptoms that are expected to make diagnoses more precise and to provide a new way to track improvement. The *DSM* framers are also scrapping certain disorders entirely, such as Asperger's syndrome, and adding brand-new ones, including binge eating and addiction to gambling.

In the past the APA has received harsh criticism for not making its revision process transparent. In 2010 the association debuted a draft of the new manual on its Web site for public comment. "That's never been done before," says psychiatrist Darrel Regier, vice chair of the DSM-5 Task Force and formerly at the National Institute of Mental Health. The volume of the response surprised even the framers: 50 million hits from about 500,000 individuals and more than 10,000 comments so far.

Critics swarmed the drafts. Some psychiatrists contend that the volume still



Psychiatrists have long come under fire for overdiagnosing certain ailments, especially in children, and doling out medications as freely as lollipops. Giving childhood bipolar disorder a new name and defining a syndrome of early psychosis may only intensify the problem.


To make its new diagnostic manual easier to use, the American Psychiatric Association organized the book's contents chronologically, starting with diseases that most often appear in childhood and covering adult disorders toward the back.

contains more disorders than actually exist, encouraging superfluous diagnoses—particularly in children. Others worry that the stricter, more precise diagnostic criteria may inadvertently give insurance companies new ways to deny medication to patients who need it.

The debates surrounding the manual's revisions are not merely back-office chatter. Although many psychiatrists do not sit down with the *DSM* and take its scripture literally—relying instead on personal expertise to make a diagnosis—the *DSM* largely determines the type of diagnoses clinicians make. Insurance companies often demand an official *DSM* diagnosis before they pay for medication and therapy. Many state educational and social services—such as after-school programs for kids with autism—also require a *DSM* diagnosis. Consequently, psychiatrists cannot dole out diagnoses of their own invention. They are bound to the disorders defined by the *DSM*.

Therefore, psychiatrists cannot ignore the new manual and go about business as usual. They must adapt, especially if they want to be sure that their patients keep receiving affordable treatment. Yet this diagnostic bible is a work in progress. In fact, although the revisions are 90 percent complete, the APA may still make significant changes and even delay the book's official release. Even after its publication, the *DSM* will remain a snapshot of a field in flux—an ambitious attempt to capture an evolving, often ambiguous science.

## Diagnosing the *DSM*

Psychiatrists have been kicking around the *DSM-5* in a scientific scrimmage that dates back to 1999, when the APA and the NIMH sponsored a meeting to jump-start planning. More than 13 joint conferences later, committees of psychiatrists and psychologists have

## Personality Problems

To a psychologist, a personality consists of persistent patterns of thought, emotion and behavior. Someone with a personality disorder has rigid and dysfunctional patterns that disrupt his or her ability to maintain healthy relationships. The current encyclopedia of mental illness, the *DSM-IV,* describes 10 such conditions. These include paranoid personality disorder—the inability to trust others and an irrational belief that people are out to get you—and narcissistic personality disorder, an exaggerated sense of self-importance, a need for constant admiration and excessive envy of others.

Suspiciously, between 40 and 60 percent of all psychiatric patients are diagnosed with a personality disorder, hinting that symptoms of at least some of these "disorders" resemble typical behavior too closely. In addition, psychiatrists often diagnose the same patient with more than one ailment, suggesting significant overlap. For example, people with both histrionic and narcissistic personality disorders insist on being the center of attention, take advantage of their families and friends, and have trouble reading others' emotions.

The upshot: *DSM-5*'s editors nixed histrionic personality disorder. Paranoid, schizoid and dependent personality disorders are also gone. Your personality can still, however, be narcissistic, antisocial, avoidant, borderline, obsessive-compulsive or "schizotypal." —*F.J.*

Curators of the new book eliminated over a dozen less distinct disorders, sometimes merging them into larger categories.

churned out dozens of white papers outlining how best to overhaul psychiatry's bible. In April 2006 the APA appointed clinical psychologist David Kupfer and Regier as chair and vice chair, respectively, of a team of 27 scientists assigned to digest the research literature and propose revisions to this historic volume.

Right away researchers fingered several major failings of the *DSM-IV*. First, many of the symptom checklists were so similar that many patients left a psychiatrist's office with several official diagnoses rather than just one. It is unlikely that large numbers of patients each have a variety of different disorders, says Steven Hyman, a task force member. Rather, he suggests, a single cognitive or biological process—maladaptive thought patterns, for instance, or atypical brain development—may manifest itself in symptoms of more than one ailment. To address this problem, curators of the new book eliminated over a dozen less distinct disorders, in some cases merging them into larger categories of illness, such as the autism spectrum [see "Psychosis Revisited," on page 30, and "Personality Problems," on opposite page].

Patients and their psychiatrists often struggle with the opposite problem, too: a person's symptoms might be fewer or milder than those listed in the *DSM* or simply do not match any disorder in the manual. As a result, psychiatrists slap large factions of their clientele with a "disorder not otherwise specified" label. The most frequently diagnosed eating disorder is "eating disorders not otherwise specified." The predominant autism spectrum disorder? By most estimates it is "pervasive developmental disorder not otherwise specified." The third most common personality disorder is, you guessed it, "personality disorder not otherwise specified." Health professionals rely so heavily on catchall diagnoses because the current *DSM* has some serious

## Good-bye to Asperger's?

Certain behavioral quirks have long been thought to distinguish Asperger's syndrome from other autistic disorders. "Aspies," as people with this affliction sometimes call themselves, tend to develop intense fascination with very specific objects or facts—the wheels of toy cars or the names of constellations—in the absence of a general interest in, say, automotive mechanics or astronomy. Now the diagnosis will disappear, and Aspies may find an important part of their identity stripped away.

Currently Asperger's is one of five so-called pervasive developmental disorders, along with autistic disorder, pervasive developmental disorder not otherwise specified (PDD-NOS), and the lesser-known Rett syndrome and childhood disintegrative disorder (CDD). All these problems are characterized by deficits in communication and social skills as well as by repetitive behaviors. Indeed, the APA has decided that four of the five disorders—autistic disorder, Asperger's, CDD and PDD-NOS—are so similar that they should all be placed into a new category called autism spectrum disorder (ASD). Psychiatrists using the new *DSM* will give anyone on the spectrum a diagnosis of ASD, along with a rating of illness severity.

Children whom psychiatrists would previously have diagnosed with CDD fall at the more severe end of the spectrum. They typically experience an almost complete deterioration of social and communication skills starting sometime between the ages of two and 10. Asperger's patients will land on the milder end. They generally do not show language delays and, in fact, often display excellent verbal skills. Rett syndrome, in which known genetic mutations stunt physical growth, along with language and social skills, is gone from the manual entirely. Ironically, the APA is eliminating it because a genetic test for the condition makes diagnosis so precise and straightforward. For now the *DSM* prefers to limit itself to a blunter diagnostic measure: behavior.

Statistical studies published in 2011 and 2012 confirm that the *DSM-5* criteria for autism are more accurate than those penned in the *DSM-IV*. The revised guidelines practically guarantee that anyone told they have the disorder really has it. To qualify as autistic by the new manual, a patient must meet five of seven symptoms—a higher bar than the six-of-12-symptom cutoff in the *DSM-IV*.

Some psychiatrists say the new rules are too strict: they worry some high-functioning autistic people, such those now diagnosed with Asperger's, may not meet the criteria and may miss out on educational and medical services as a result. On the other hand, if people with milder autismlike symptoms do make it onto the spectrum, the lack of an Asperger's label could benefit them. States such as California and Texas now provide educational and social services to people with autism that they deny to those with Asperger's. Some parents argue, though, that limited resources should go to kids with more severe symptoms before anyone else. —*F.J.*

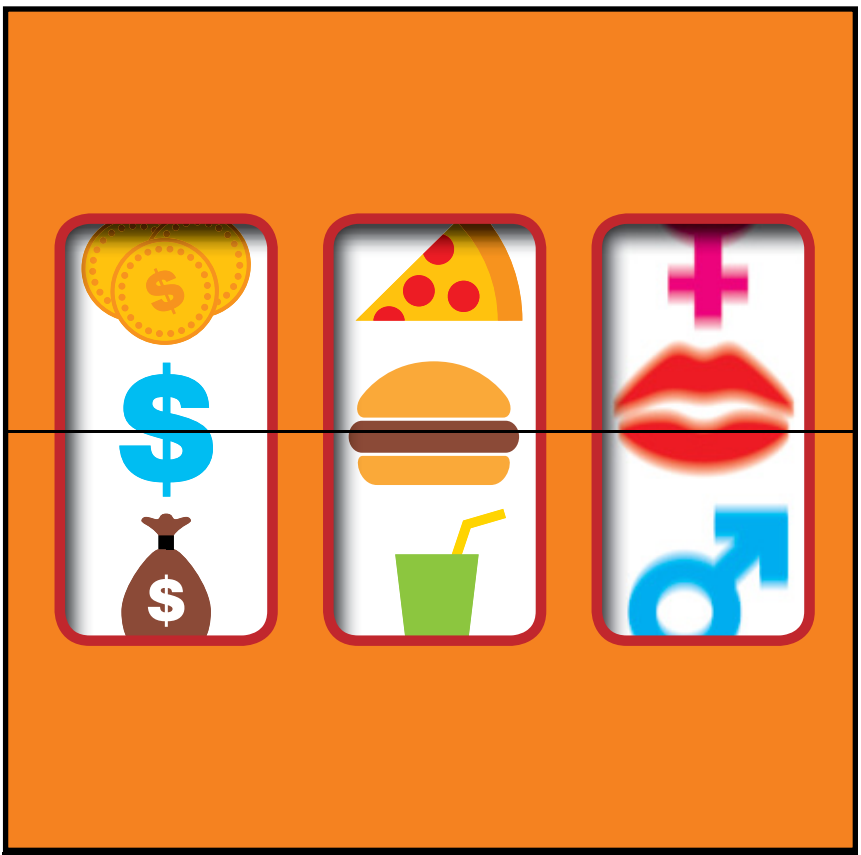
(The Author)

**FERRIS JABR is an associate editor at *Scientific American*.**

## Craving Cash, Food and Sex

Several new types of addiction may appear in the upcoming version of psychiatry's bible, the *DSM-5*. Gambling disorder is one. In the past decade studies have shown that people get hooked on gambling the same way they become addicted to drugs and alcohol and that they benefit from the same kind of treatment—group therapy and gradual withdrawal. Neuroimaging research has revealed that the brains of drug addicts and those of problematic gamblers respond to reminders of drugs and monetary rewards in similar ways: their reward circuits light up, much more than casual gamblers or one-time drug users. The *DSM-5* may also include obsessions with food and sex:

- **Binge Eating Disorder**
  Consuming "an amount of food that is definitely larger than most people would eat in a similar period of time under similar circumstances" and lacking control over what, how much or how fast one eats.
- **Hypersexual Disorder**
  Having unusually intense sexual urges for at least six months or spending excessive amounts of time having sex in response to stress or boredom, without regard for physical or emotional harm to oneself or others, despite the fact that it interferes with social life and work.
- **Absexual Disorder**
  Feeling aroused by moving away from sexuality or behaving as though moralistically opposed to sex. As sex educator Betty Dodson told Canadian newspaper *Xtra! West,* these are "folks who get off complaining about sex and trying to censor porn." —*F.J.*



Experts traditionally reserved the term "addiction" for drug problems. Now they are recognizing other types of addictive behaviors. Food, sex and gambling addictions are likely to make their debut in the latest edition of psychiatry's diagnostic bible.

gaps in its diagnostic offerings and has some superfluous entries.

In addition to eliminating ailments, the *DSM-5* will encourage psychiatrists to collect more detailed information about patients' symptoms. With more data to consider and more complete descriptions in the manual, the theory goes, psychiatrists are more likely to find a proper match between a patient and an illness.

### Degrees of Dysfunction

To improve diagnoses, the *DSM-5* asks doctors to grade the severity of their clients' symptoms. A verdict of major depression, for example, will include a rating for each symptom—insomnia, say, or thoughts of suicide. Similarly, a child who is diagnosed with attention-deficit hyperactivity disorder would also receive an assessment of her ability to focus, ranging from poor to excellent.

This ideological shift signals a step away from the simplistic notion that mental illnesses are discrete conditions wholly distinct from a healthy state of mind. Instead the new volume reflects the idea that everyone falls on a spectrum that stretches from typical behavior to various shades of dysfunction. Where you land on that scale determines whether your symptoms merit treatment. This approach might assist, for example, psychiatrists evaluating a patient's attention problems, which can seem almost ubiquitous in younger children. Considering an individual in the context of others can make it easier to flag the neediest cases. Psychiatrists, of course, already use many scales and questionnaires in their practice. The *DSM-5* will standardize such ratings so

that doctors use the same scales to measure a given disorder and increase the chances they will reach similar conclusions about comparable patients.

These detailed assessments should allow treatments to become more tailored. For example, a patient with mild signs of depression is more likely to benefit from therapy and lifestyle changes than from antidepressant medication, which recent findings suggest is more effective for severe depression. Psychiatrists and patients will also gain a new way to track improvement. A shift in the depression gauge from "severe" to "moderate" may in itself lift a patient's spirits, motivating him to stick to the regimen propelling his progress.

Although most psychiatrists support the idea of measuring severity, practitioners have also voiced various concerns. Placing several previously distinct disorders under the umbrella of autism, for example, has ignited fears that autistic people with less severe symptoms will no longer qualify for a diagnosis or treatment [see "Good-bye to Asperger's?" on page 33]. Questions have also been raised about how insurance companies will respond: Could these scales create barriers to treatment? A simple diagnosis of depression may no longer be enough to qualify a patient for antidepressants—insurance companies may demand that a patient's depression meet a certain severity level.

The new procedures will require patients to complete more evaluations and surveys than ever before, culminating in larger amounts of paperwork and more time spent on every diagnosis. Some psychiatrists worry the extra effort will deter their peers from using the *DSM* properly—and a few have even proposed doing away with the severity ratings altogether. More broadly, psychiatrists have also objected to the addition of certain disorders that they consider dubious [for examples, see "Craving Cash, Food and Sex," on opposite page].

## A Primitive Guide?

A second sweeping change to the *DSM* is the way it clusters disorders. The *DSM-IV* was organized around three categories of illness. One group captured all major clinical disorders, such as depression, bipolar disorder and schizophrenia. Another section encompassed all personality and developmental disorders. The third category contained "medical" problems that might play a role in mental illness: diabetes or hypothyroidism, for instance, can exacerbate depression. The *DSM-5* throws these relatively arbitrary divisions out the window. Instead it arranges diseases chronologically, starting with illnesses that psychiatrists typically diagnose in infancy or childhood—such as neurodevelopmental disorders—and moving toward those frequently found in adults, such as sexual dysfunctions. When evaluating a toddler, for instance, a psychiatrist can focus on the front of the *DSM-5* or the beginning of a chapter, say, on depressive disorders, where he or she will find the types of depression most likely to afflict children.

> "The *DSM* has always been a primitive guide to the world of psychological stress, but the categories have become more reliable and meaningful."

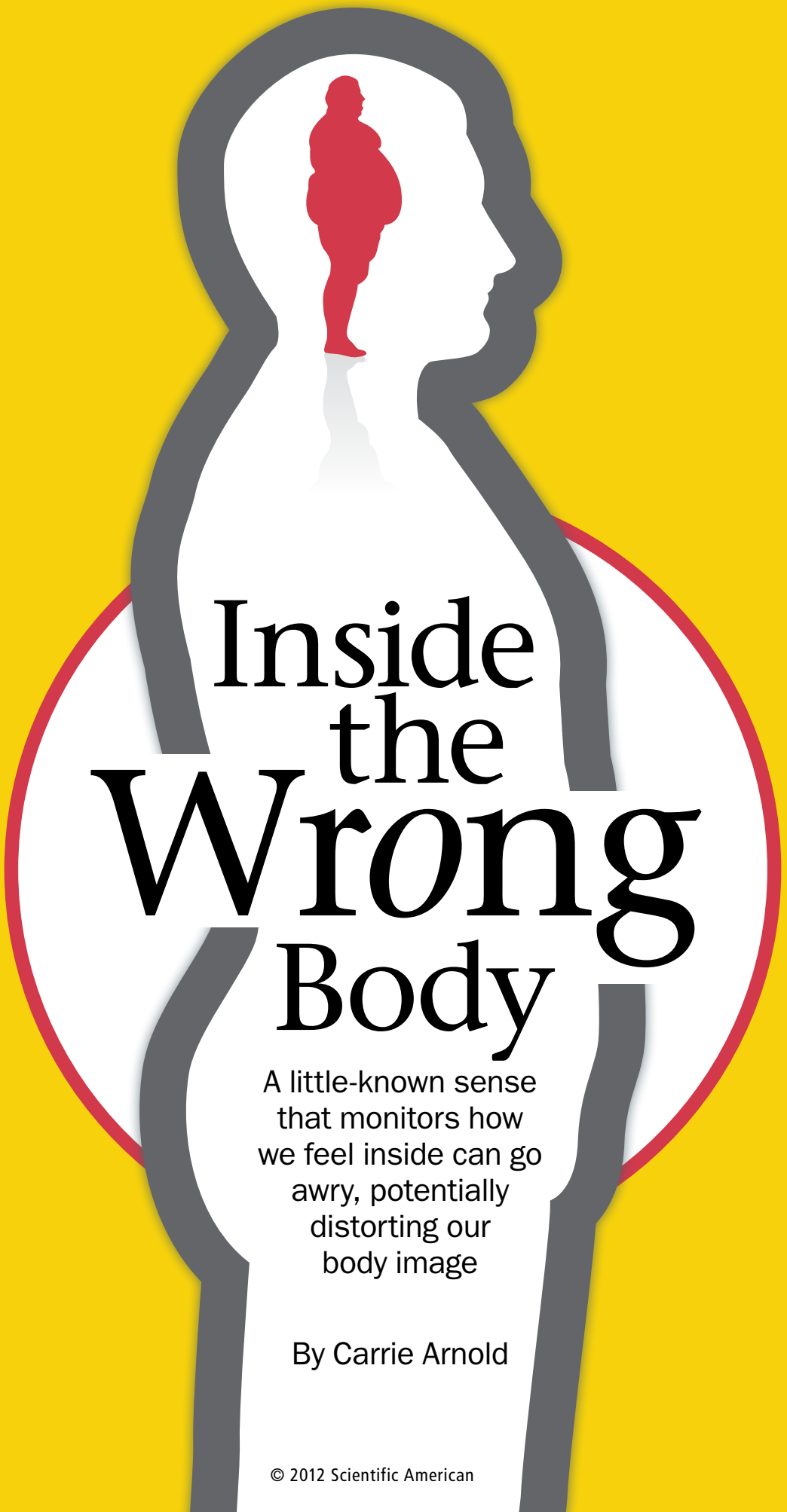
As genetic and neuroimaging studies improve our understanding of the relations among ailments, the *DSM* will be able to swiftly adapt. The APA plans to publish the new manual in print and as a "living" electronic document that can be updated frequently as version 5.1, 5.2, and so on. (The APA dispensed with Roman numerals to make this labeling practical.)

Eventually researchers aim to root the *DSM* in the biology of the brain. Someday scientists hope to find useful "biomarkers" of mental illness—genes, proteins or patterns of electrical activity in the brain that can serve as unique signatures of psychiatric problems. Lab tests based on such markers would make diagnosing mental illness easier, faster and more precise.

"The *DSM* has always been a primitive field guide to the world of psychological stress because we know very little about the underlying neural chemistry of psychological symptoms," says psychiatrist Daniel Carlat of the Tufts University School of Medicine. "But over the past 60 or 70 years the categories have become more reliable and meaningful." No one argues that the *DSM* flawlessly mirrors mental illness as people experience it, but every revision sharpens the reflection—and with it, people's understanding of themselves. M

## (Further Reading)


- **On Being Sane in Insane Places.** D. L. Rosenhan in *Science,* Vol. 179, pages 250–258; January 19, 1973.
- **Sexual Disorders: New and Expanded Proposals for the DSM-5—Do We Need Them?** Howard Zonana in *Journal of the American Academy of Psychiatry and the Law,* Vol. 39, No. 2, pages 245–249; April 2011.
- **The First Flight of DSM-5.** Niall Boyce in *Lancet,* Vol. 377, pages 1816–1817; May 28, 2011.
- **Autism Spectrum Disorders according to *DSM-IV-TR* and Comparison with *DSM-5* Draft Criteria: An Epidemiological Study.** M. L. Mattila et al. in *Journal of the American Academy of Child and Adolescent Psychiatry,* Vol. 50, No. 6, pages 583–592.e11; June 2011.
- **The Illusions of Psychiatry.** Marcia Angell in *New York Review of Books;* July 14, 2011. **www.nybooks.com/articles/archives/2011/jul/14/illusions-of-psychiatry**



# Inside the Wrong Body

A little-known sense that monitors how we feel inside can go awry, potentially distorting our body image

By Carrie Arnold

Nell (not her real name) was shivering, but she did not realize she was cold. Only when a colleague pointed out her goose bumps and blue lips did she think to put on a sweater. Nor does she register feelings such as exhaustion. "Sometimes I don't realize I'm tired until three in the morning," she says. "I just don't get those clues correctly."

These traits seemed like little more than quirks until September 2010, when the 36-year-old woman took a full battery of psychological tests as she reentered treatment for a relapse of anorexia nervosa, a disorder she had struggled with on and off for more than 20 years. One of the tests included a section measuring a little-known sense called interoception, awareness of the internal state of one's body. Interoception informs us of emotions, pain, thirst, hunger and body temperature. People vary on how well they receive such cues. As with other individuals who have eating disorders and body image issues, Nell showed profound difficulties with interoception.

Traditionally psychologists have attributed negative body image to pictures in the media of unusually thin or beautiful people with whom the rest of us compare our own physique. In June 2011 the American Medical Association released a statement that urged advertisers to stop the use of digitally altered photographs after researchers found links among exposure to mass media, negative body image and disordered eating.

The impact of distorted body image is widespread. Almost half of adolescent girls report being dissatisfied with their appearance, and the number of males reporting serious body image dissatisfaction is also on the rise (although the exact number of males with this problem is difficult to pin down). An additional one out of 20 Americans suffers from a clinical body image disturbance such as an eating disorder or body dysmorphic disorder, in which people cannot stop thinking about minor or imaginary "flaws" in their appearance.

Yet the question remains: Given that everyone is exposed to images of presumably perfect bodies,

PHOTOILLUSTRATION BY SCIENTIFIC AMERICAN MIND; SAUL HERRERA /*Stockphoto (bodies)*

Nearly half of all adolescent girls say they are unhappy with how they look. Many have a warped view of their physiques—a distortion thought to stem from minimal awareness of the internal state of their body.

why don't we all have serious trouble with body image? Research indicates that various biological and environmental factors must come together to create a problem. One of the more recently studied, and perhaps biggest biological contributors, is difficulty with interoception. A deficit in this internal sense plays a leading role in the development of anorexia, bulimia and body dysmorphic disorder. Identifying this sensory defect as a major contributor to these ailments suggests new treatments that could speed recovery.

## Internal Difficulties

We know whether we are full or hungry, hot or cold, itchy or in pain when receptors in the skin, muscles and internal organs send signals to a region of the brain called the insula. This small pocket of neural tissue is nestled in a deep fold of the brain's external layer near the ears. It cultivates an awareness of the body's internal state and, in doing so, plays an important role in self-awareness and emotional experience. Interoceptive data combine in the insula with external information about the body. This region will, for example, connect the sharp pain we experience when touching a hot stove with the red welt that appears on our palm. This integration forms our body image—that is, what we think we look like, says neuroscientist Manos Tsakiris of Royal Holloway, University of London.

The greater the contribution from interoception as opposed to external, visual cues, the better a person's body image, Tsakiris observes. A runner with good interoception, say, might focus on the steady thud of her heart and the jolt of her feet against pavement, cues she might use to guide the speed and length of her run. By paying attention to how her body is functioning, the runner feels good about it no matter its exact proportions. A runner with poor interoception, on the other hand, might be thinking about whether onlookers notice the jiggling of her thighs. Because she has little internal input to anchor her sense of self, she can become overly concerned with small visual details, potentially resulting in a diminished body image. Someone with body dysmorphic disorder also lacks this sense of self, inadvertently causing him to focus more on what his nose looks like than how his nose feels on his face.

Distorted body image—known formally as body dysmorphia—can range from mild worries about whether these jeans make one's butt look fat to an almost delusional misinterpretation of body size and shape as seen in anorexia nervosa and body dysmorphic disorder. People can also have misconceptions in the reverse direction. In a study in 2010 internist Sandeep Das of the University of Texas Southwestern Medical Center and his colleagues found that al-

FAST FACTS

### Turning Inward

1» **Difficulty with interoception—sensing your body's internal state—plays a leading role in the development of anorexia, bulimia and body dysmorphic disorder.**

2» **Those who lack a keen awareness of their own hunger, pain and body temperature seem to be easily swayed by the opinions of others.**

3» **One way to shore up interoceptive awareness is to practice mindfulness, a mental mode characterized by attending fully to the present moment without elaboration or judgment.**

STEVE NIEDORF PHOTOGRAPHY *Getty Images*

most one in 10 obese adults thought their weight was normal. One explanation for the positive distortion in body shape in these individuals is poor interoception.

In 2004 neuroscientist Hugo Critchley, now at the University of Sussex in England, and his coworkers developed a way to easily and reliably measure this internal experience. Critchley's team asked healthy subjects to try to count their heartbeats without taking their pulse while the researchers electronically monitored their heart rate. The investigators found that the people whose guesses were closest to their real heart rates also scored highest on other measures of interoceptive awareness, such as questionnaires and brain scans of insula activity.

"These heartbeat tests correlate well with how people judge other physiological changes, like feelings from their stomachs," Critchley says. Even those who are good at sensing their internal state do not know they have this talent because they have no way to compare themselves with others. As a result, most people who take the heartbeat test are at least somewhat surprised by their score, according to Critchley. (To take the heartbeat test yourself, see the box at the right.)

## Image Issues

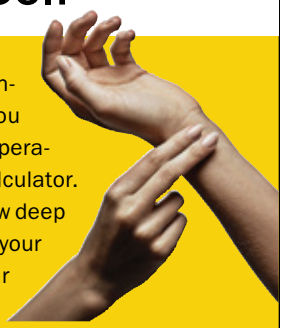
The score does matter. Differences between women in interoceptive skill predict their level of body satisfaction. In a study from last year, psychologist Christine Peat, now at the University of North Carolina School of Medicine, and her colleagues gave 214 college-age females tests for psychological problems ranging from social anxiety to disordered eating. They found that those who scored lower on measures of interoceptive ability had not only higher levels of body dissatisfaction but also more symptoms of eating disorders than those who were more in tune with their body.

People with anorexia have problems interpreting hunger and fullness cues. Someone with damaged interoception may not be able to physically sense her weight loss and so persists in thinking her body weight is normal or high even as she becomes emaciated. In anorexia patients, these difficulties extend to all areas of interoception: when they perform the heartbeat task, they typically do worse than people without the disorder.

In a study published in 2008, for example, psychologist Olga Pollatos, now at the University of Potsdam in Germany, and her colleagues found that 28 anorexic women were about 68 percent accurate in sensing their heart rate compared with a 77 percent accuracy rate for women who did not have an eating disorder. This result represents a significant difference in interoceptive ability, Tsakiris says. Besides being worse at interoception, the anorexic women also had more psychological problems, such as depression and anxiety, lower body weights and significantly higher body dissatisfaction. (Virtually all the imaging studies done in anorexia patients have involved women because of the low number of males diagnosed with the illness.)

Underlying the interoceptive issues of anorexic individuals may be an unresponsive insula. In a study published in 2005 psychologist Tetsuro Naruo of Kagoshima University in Japan and his associates used functional MRI to scan the brains, at rest, of 12 women who had recovered from anorexia nervosa. They found diminished blood flow—suggesting lower activation—in the insula of these

## Test Your Sense of Self



Here's a simple way to measure your interoceptive skills—that is, how well you sense your own hunger, pain, body temperature, and the like. Find a stopwatch and a calculator. Sit quietly in a comfortable chair and take a few deep breaths. Now start your stopwatch and count your heartbeats for a minute just by feeling your heart's rhythm. Don't touch your wrist or your neck. Write this number down.

Next, take your pulse in the normal way. Put your finger on your wrist or your neck and count beats for a minute. Wait for two minutes, then take your pulse again. Average your two measurements.

Calculate the difference between your heartbeat estimate and the average of your two pulse counts. Take the absolute value of the difference—you don't need to know whether you overshot or undercounted, just the amount by which you missed the mark. Then divide by your average pulse and subtract that result from 1. The formula for this calculation appears below:

$$1 - \frac{\text{estimated heartbeat} - \text{average pulse}}{\text{average pulse}}$$

### Interpreting Your Score

If your result was 0.80 or higher, your interoceptive ability is very good. A score of 0.60 to 0.79 means you have a moderately good sense of self. A result below 0.59 indicates poor interoception.

## (The Author)

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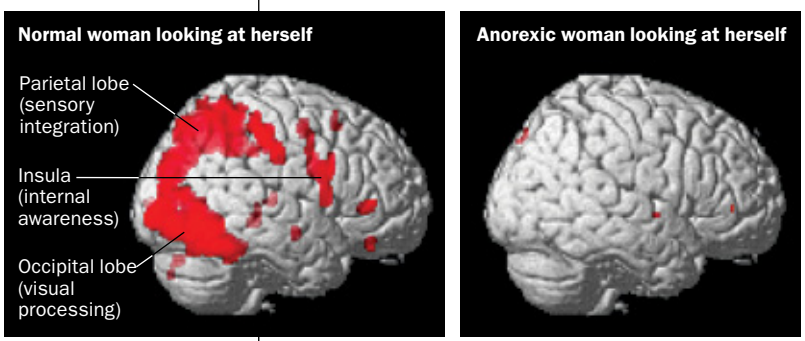
JAMES DAY PHOTOGRAPHY LTD *Getty Images*

Females with lower body awareness could be more easily fooled into thinking **a rubber hand** was part of their body.

women relative to 11 control subjects who had never had anorexia. An fMRI study published in 2003 by psychiatrist Maria Råstam, now at Lund University in Sweden, and her colleagues garnered similar results. Both studies suggest that recovered anorexics are relatively slow to process interoceptive information, a bottleneck that likely leads to less input to their brain about their body and may complicate the recovery process, says child psychiatrist Bryan Lask, a specialist in eating disorders at the Great Ormond Street Hospital in London.




**When a healthy woman looks at a picture of herself, blood rushes to the insula, a brain area in charge of internal awareness, among other areas (*left*). In contrast, no such rush occurs in an anorexic woman (*right*), indicating that she fails to link external cues to internal knowledge of her body.**

## Outside Influences

In addition to interpreting internal cues at rest, the insula typically responds with a burst of activity when a person is looking at a picture of herself. When normal, healthy women see photographs of themselves, blood rushes to the insula, suggesting that the picture enhances a person's experience of what it is like to be inside her own body.

In anorexic women, however, the insula remains mute, even when prodded by such images. In a study published in 2008 neuropsychiatrist Perminder Sachdev of the University of New South Wales in Australia and his colleagues asked 10 anorexic women and 10 other females to view photographs of themselves and of others while in an MRI machine. Although seeing images of themselves caused a boost in insula activity in the healthy women, no such increase in activity appeared in the anorexic women [*see illustration above*]. This finding hints that anorexics lack the ability to link external cues about their appearance to internal knowledge of their body, which was likely minimal in the first place. (The differences disappeared when the women looked at pictures of other people: in both groups, the insula was quiet.)

Compounding the problem, deficiencies in interoception may make your body image more vulnerable to other visual influences. In a 2011 study Tsakiris's team tested 46 female college students using an unusual type of visual cue: a rubber hand. In what is known as the rubber hand illusion, a person can be made to feel as if a rubber hand is part of his body by having him place both hands on a table and blocking his view of the left hand with a cardboard divider. Immediately to the right of the divider, an experimenter places a lifelike rubber hand. Then he or she gently strokes both the person's left hand and the rubber one with a small paintbrush. After a minute or two, many people begin to believe that the rubber hand is their real hand. Amazingly, the temperature of the left hand also drops significantly, suggesting that the brain loses ownership of the real left hand and gains ownership of the rubber hand.

Based on the results of the heartbeat test, Tsakiris and his colleagues split the women into two groups: those with high scores—the group average was better than 80 percent—and those whose scores were below 50 percent. They found that the females with lower bodily awareness could more easily be fooled into thinking that a rubber hand was part of their body. Similarly, Tsakiris thinks media images of thin women will have an outsize effect on those who lack internal awareness. People with good interoception, with their solid sense of themselves, would be less affected by seeing someone skinnier or, by some standards, more attractive than they are.

People with body dysmorphic disorder may have an additional perceptual problem. Evidence suggests they have visual-processing abnormalities that distort what they see [see "Imagined Ugliness," by Susanne Rytina; Scientific American Mind, April/May 2008]. This distortion probably combines with low interoception to create a particularly poor body image.

Those who lack a keen awareness of their internal state also seem to be easily swayed by the opinions of others. They may evaluate their goals and attributes based on how they think others perceive them rather than by their own standards. In a study in 2004 psychologist Myra Cooper of the University of Oxford and her colleagues asked adult women with body dysmorphic disorder to recall specific memories from childhood. The researchers found that these women were significantly more likely to relate personal expe-

COURTESY OF NARESH MONDRATY AND PERMINDER SACHDEV *Wesley Eating Disorder Center and University of New South Wales*; SOURCE: "BRAINS OF ANOREXIA NERVOSA PATIENTS PROCESS SELF-IMAGES DIFFERENTLY FROM NON-SELF-IMAGES: AN FMRI STUDY," BY PERMINDER SACHDEV ET AL., IN *NEUROPSYCHOLOGIA*, VOL. 46, NO. 8; MARCH 2008

PATRICK ORTON *Getty Images*

Some forms of yoga encourage a focus on breathing and body sensations, practices that may bolster a person's internal sense of self. In this way, yoga may help ameliorate eating disorders.

riences as if they were happening to someone else. Instead of describing an event using a first-person perspective (for instance, "I saw …"), the patients with body dysmorphic disorder told the story as if they were a narrator in a novel ("this happened …"). Building better interoceptive awareness, then, could not only improve body image, it could also bolster a fragile sense of self.

## Minding the Body

One way to shore up your internal sense is to practice mindfulness, a mental mode characterized by attending fully to the present moment without elaboration or judgment. In numerous studies in the past decade researchers have found that incorporating mindfulness training into cognitive-behavior therapy and other treatments for eating disorders and body dysmorphic disorder has diminished symptoms and enhanced quality of life. Training people to closely heed their current, ongoing physical sensations may improve their interoception, scientists theorize.

Recent studies have tested yoga as a potential therapy for eating disorders. Certain forms of yoga, such as hatha or vinyasa yoga, encourage the participant to focus on both their breathing and the different bodily sensations produced by each pose—practices central to mindfulness.

In 2010 clinical psychologist Tiffany Rain Carei of Seattle Children's Hospital and her colleagues assigned 27 adolescents receiving outpatient eating disorder treatment to eight weekly hour-long yoga sessions. The researchers hoped that by focusing their attention on the yoga poses and their own body, the adolescents would decrease their obsessions with food and weight.

The strategy seemed to work. At the start of treatment, these adolescents were so disconnected from their body that they had trouble balancing on one foot. After eight weeks of yoga, the teens had gained enough interoceptive skills to easily find their balance. They also showed greater improvements in all areas of eating disorder psychopathology, including body dysmorphia, than did 27 similarly afflicted youth who did not take yoga. "Yoga gave the kids a way to be more in tune with their body," Carei says.

Nell has found yoga to be tremendously helpful with her own ongoing recovery from anorexia. It has also lessened her other interoceptive difficulties; she can now, for example, more easily identify when she is cold or tired. "I get on the yoga mat, and while I'm there I find I can experience all of these [interoceptive] things," she says. "I'm not only aware that I'm hungry, I'm aware that I want to eat." M

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# Sleep's Secret Repairs

Slumber may loosen the links that undergird knowledge, restoring the brain daily to a vibrant, flexible state **By Jason Castro**

Compared with the hustle and bustle of waking life, sleep looks dull and unworkmanlike. Except for in its dreams, a sleeping brain doesn't misbehave or find a job. It also doesn't love, scheme, aspire or really do much we would be proud to take credit for. Yet during those quiet hours when our mind is on hold, our brain does the essential labor at the heart of all creative acts. It edits itself. And it may throw out a lot.

FAST FACTS

### The Brain's Undoing

1» **Most scientists agree that sleep has significant benefits for learning and memory.**

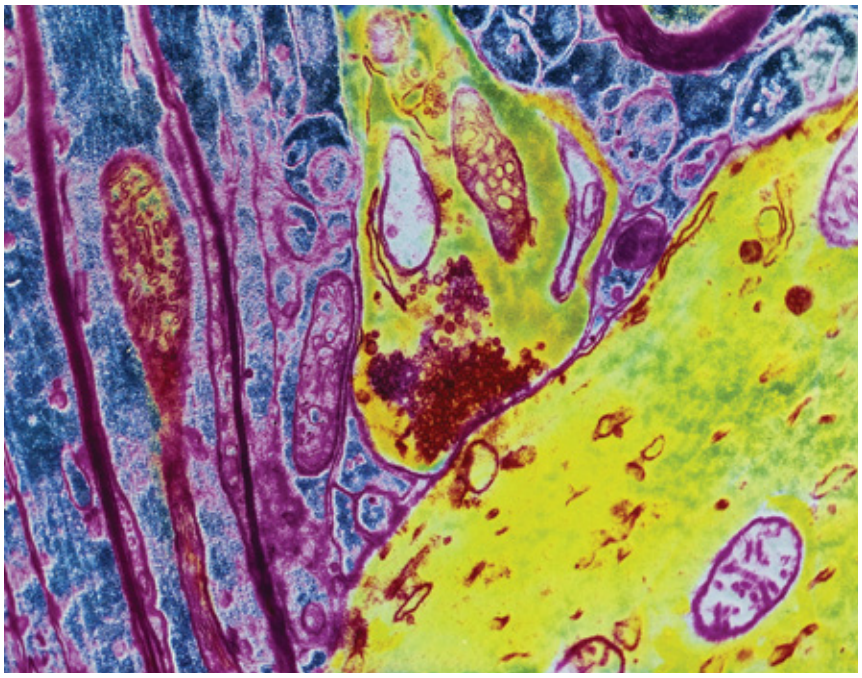
2» **Conventional wisdom holds that recently formed memories are replayed during sleep and in the process become more sharply etched in the brain.**

3» **Emerging evidence suggests that sleep also serves as a reset button, loosening neural connections throughout the brain to put this organ back in a state in which learning can take place.**

In a provocative new theory about the purpose of sleep, neuroscientist Giulio Tononi of the University of Wisconsin–Madison has proposed that slumber, to cement what we have learned, must also spur the brain's undoing. As the conscious mind settles into sleep, the neural connections that create a scaffold for our knowledge must partially unravel, his theory suggests. Although this nightly dismantling might seem like a curious act of cerebral self-sabotage, it may in fact be a mechanism for enhancing the brain's capacity to encode and store new information.

The benefits of sleep for learning and memory are widely accepted in the scientific community. The prevailing view holds that recently formed memories are replayed during sleep and in the process become more sharply etched in the brain [see "Quiet! Sleeping Brain at Work," by Robert Stickgold and Jeffrey M. Ellenbogen; Scientific American Mind, August/September 2008]. As Tononi surmised, however, the neural circuits buttressing those memories can be fortified only so many times before

JOHN HERSEY



MICROSCOPIC GOSSIP: In this magnified image of a synapse (the junction between two neurons), an extension from one neuron sends a chemical and electrical signal across the tiny gap between the cells to reach the membrane of the recipient cell.

reaching their maximum strength. He and his colleagues have gathered evidence that sleep also serves as a reset button, uniformly loosening neural connections throughout the brain to put this organ back in a flexible state in which learning can take place.

The theory is still controversial. Some sleep researchers consider the evidence for it too preliminary, favoring the conventional wisdom of sleep as a time of memory consolidation and reinforcement. Still, if Tononi is right, sleep may not be just for curating memories of the recent past. It may also set aside space for memories of experiences we have not yet had.

## Saturated Pixels?

Learning occurs when an experience—listening to new music, say, or navigating an unfamiliar city—imposes a pattern of activity on groups of neurons. The pattern alters the cells' interconnections: ties among co-active neurons grow stronger, and those among out-of-step neurons weaken. In this way, the cells become functionally lassoed together. This coalition becomes dedicated to preserving a specific fragment of experience—a memory. During later offline periods—sleep in particular—the pattern stamped in by experience gets replayed, leading to cellular changes that stabilize the pattern.

A decade or so ago most psychologists conceived of sleep as this recap of daytime learning. Yet Tononi sensed a potential problem: if the junctions among neurons—synapses—were being ratcheted tighter and stronger over consecutive nights and days, they would eventually plateau. As with the saturated pixels of a too-bright image, a set of maxed-out, uniform synapses would provide little information. Equally problematic, such a brain would have no way of storing new experiences.

Tononi also noted some interesting properties of the brain waves he and many other researchers had recorded in sleeping people. Scientists had long known that "slow-wave" sleep—that stage of rest when people are hardest to rouse—was necessary and restorative. Even so, he took note of two more specific phenomena. First, he recognized that when people are deprived of slow-wave sleep, they tend to make up for it with longer and more intense bouts of this type of sleep later on.

In addition, Tononi noticed that the intensity of this deep slumber—measured as amplitude in recordings of brain waves—dies down as the night progresses. Both observations struck him as examples of homeostasis, the push and pull of opposing forces to maintain equilibrium in a biological system. Slow-wave sleep seemed to be pulling the brain back to some kind of equilibrium that being awake had disturbed.

Tononi considered which biological process might underlie the changes in slow-wave sleep. He knew that its intensity is correlated with overall synapse strength. When neurons fire in unison, they drive groups of these neural junctions to activate in synchrony. Electric current flowing through them creates the slow-wave signal that is recorded with electrode pads on the scalp. Tononi surmised that being awake may lead to a proliferation or strengthening of synapses and that the initial high intensity of slow-wave sleep reflects these very strong cell networks. If synapses somehow weaken or break down during this period of sleep, their loss could explain why the sleep signals shrank during the night.

To support his conjecture, which he dubbed "synaptic homeostasis," Tononi wanted to look directly at how synapses differed between sleep and wakefulness. In a study published in 2008 he and his collaborators harvested brain tissue from rats, some of which had been sleeping and others that had been awake. For each tissue sample, the researchers used radioactive antibodies to selectively tag several proteins that exist only at synapses. They found that many of these proteins were significantly scarcer in snoozing rats than in awake ones. Their conclusion: fewer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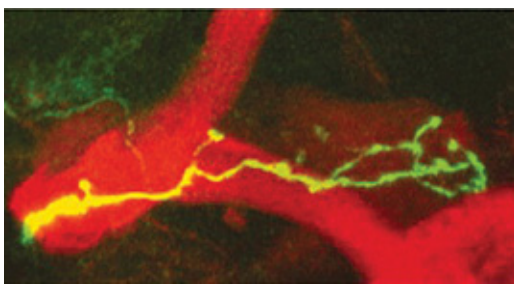
S. CINTI *Photo Researchers, Inc.*

**Neurons from awake rats received more current than those from sleeping rats did, hinting that cells in the sleeping brain are more weakly connected.**

synapses exist in the sleeping brain, or else these synapses have, on average, less of the machinery they need for effective communication—that is, they are weaker.

Further support for this view came from a study published in 2010 by Xiao-Bing Gao of Yale University and his colleagues. In collaboration with Tononi, Gao's team recorded electrical activity from individual neurons in slices of brain tissue that they took from both dozing and alert rodents. Neurons constantly chatter with one another by way of small electric currents that shuttle through their synapses. The more current flowing through a synapse, the stronger the synapse. Neurons from previously awake rodents received more vigorous barrages of current than did those from sleeping animals, indicating that neurons in the sleeping brain are connected by fewer or weaker synapses. The results hint that the brain flips between strongly and weakly connected states on a day-night cycle.



**SPECIAL EFFECTS: Scientists counted neuronal junctions (synapses) in the brains of sleeping and alert fruit flies by making their neurons fluorescent. In this fluorescent neuron (*green*), the long tendril is the axon, the neuron's main conduit for incoming information. The small, knoblike endings are the places where synapses form.**

## Sleepless Flies

If sleep remodels synapses, researchers should be able to see structural signs of these changes. The synapses through which neurons communicate can vary in number and size. In general, the more synapses and the bigger those synapses are, the more electrical "information" can travel between two connected neurons.

Scientists can visualize synapses by sticking fluorescent tags onto the proteins that work at either side of the synaptic gap. In 2011 Tononi, together with Wisconsin neuroscientists Daniel Bushey and Chiara Cirelli, reported using these techniques to track the size and number of synapses in fruit flies [*see illustration below*]. They forced some of the flies to stay awake by putting them in a revolving box—at the top of the rotation, snoozing flies would fall and wake up—to see if staving off sleep would prevent the shrinking and retraction of synapses. In striking agreement with Tononi's hypothesis, they saw a significantly higher density of synapses and considerably larger synapses—in some cases, twice as large—in brains of flies that had been forced to stay awake compared with brains of sleeping flies.

In an even more recent study from 2011 Tononi and his team have extended these results to mice. By labeling neurons in the cortex, or outer rind, of the mouse brain with fluorescent indicators, the researchers could watch the growth and retraction of spines—the tiny, knoblike protrusions on neurons where synapses are made. They saw that the overall density of synapses increased with wakefulness, remained high when the mice were sleep-deprived and decreased only after sleep was allowed.

## Bedtime Tonic

Before synaptic homeostasis can be hailed as the main reason we sleep, however, investigators must provide better proof that some measurable aspect of neural function—learning, memory or perception, for example—is improved by the shrinking and dismantling of synapses and impaired when these activities are somehow curtailed. Such evidence will be difficult to dig up. If and when it surfaces, Tononi's ideas could add considerable nuance to the established notion that sleep serves to cement memories by strengthening synapses forged during the day.

Intuitively, we know that sleep is restorative, and many colorful metaphors have tried to capture this idea. Sleep is a tonic. Sleep is a balm. As Shakespeare put it, sleep "knits up the ravell'd sleave of care." He couldn't possibly have known that sleep may renew us by undoing in the brain some of what the day knits, so that we can live to learn another day. M

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# The Subtle Power of

## Can subliminal advertisements influence our behavior? New research says yes—but only under certain circumstances

**By Wolfgang Stroebe**

The birth of subliminal advertising reads almost like a script from a television show. In this real-life story, the spotlight falls on James M. Vicary, an independent marketing researcher.

On September 12, 1957, Vicary called a press conference to announce the results of an unusual experiment. Over the course of six weeks during the preceding summer, he had arranged to have slogans—specifically, "Eat popcorn" and "Drink Coca-Cola"—flashed for three milliseconds, every five seconds, onto a movie screen in Fort Lee, N.J., while patrons watched *Picnic*. Vicary argued that these messages were too fast for filmgoers to read but salient enough for the audience to register their meaning subconsciously. As proof, he presented data indicating that the messages had increased soda sales at the theater by 18 percent and popcorn sales by 58 percent.

The public reacted with fury. Vicary's findings played directly into a popular fear at the time that Madison Avenue could manipulate consumers like mindless puppets. The idea that ads might be broadcast subliminally, below the threshold of conscious awareness, seemed akin to brainwashing. On October 5, 1957, some three weeks after Vicary's event, Norman Cousins, editor in chief of the *Saturday Review,* wrote an article called "Smudging the Subconscious," in which he lambasted ad campaigns designed to "break into the deepest and most private parts of the human mind and leave all sorts of scratch marks." The Central Intelligence Agency soon issued a report on the operation-

# Hidden Messages

al potential of subliminal perception. Vance Packard's book *The Hidden Persuaders*—which described Vicary's claims in detail—became an overnight best seller. As public pressure mounted in response, the U.K., Australia and the National Association of Broadcasters in America all banned subliminal advertising sight unseen.

There was a glitch, however. Researchers tried to replicate Vicary's findings during this time, but none succeeded. After five years Vicary confessed that his so-called experiment was "a gimmick." His admission garnered far less attention than his initial publicity stunt. Many in the U.S. and Europe continued to believe that subliminal advertising could shape consumer choice despite all the evidence to the contrary.

Recently, though, psychologists have begun to discover that subliminal messages can sometimes redirect our decisions, but not at all in the way Vicary had proposed. Subliminal messaging cannot override our intentions or commandeer our will. On the contrary, it seems that we are susceptible to these extremely brief suggestions only under special, somewhat limited circumstances. Because these subconscious hints streak through our memory almost as fleetingly as they flash on a screen, they hold no power unless they happen to relate to our immediate goals or natural proclivities.

## Backlash and gniksamkcaB

In the decades after Vicary's experiment, marketers, politicians, film directors and even law-enforcement agencies tried to harness the powers of subliminal persuasion without measurable success. Their intimation tactics typically followed Vicary's lead, embedding millisecond flashes of words or images in other

**Advertisers—as well as politicians, musicians, the self- to sway public opinion using images or slogans aired be-**

film clips. For example, in 1978 a Wichita, Kan., TV station received permission from the police to show a glimpse of the sentence "Now call the chief" during a report on the "BTK" serial killer, hoping he might then feel compelled to turn himself in. Unfortunately, the man they were after, Dennis Rader, eluded capture until 2005.

In 2000 subliminal messaging entered the U.S. presidential race. One Republican campaign spot spliced the word "rats" into a segment about Democratic candidate Al Gore. Although "rats" was part of a clearly visible line, "bureaucrats decide," the less than flattering four letters appeared on screen 30 milliseconds before the rest. Republican candidate George W. Bush claimed it was an accident, but television affiliates quickly pulled the commercial from the airwaves.

Other controversial campaigns have involved "backmasking," or backward masking—a technique in which audio engineers record spoken words backward onto a track. Proponents claimed that the reversed messages acted subliminally on listeners. In the 1980s religious groups in the U.S. feared that some rock bands used backmasking to convey satanic teachings. Two sets of parents sued British musician Ozzy Osbourne, claiming that backmasked phrases in his songs had prompted their children to commit suicide. The courts dismissed these cases—as they did similar suits brought against rock band Judas Priest—because they found insufficient evidence that backmasking worked. Researchers repeatedly demonstrated that backmasking left no measurable traces in memory. Even so, the uproar led to public record burnings, and in 1983 California restricted the practice.

Also during the 1980s a flourishing trade arose around self-help cassette tapes that claimed to employ subliminally perceptible messages recorded in the correct direction. In 1991, though, Anthony G. Greenwald of the University of Washington and his colleagues proved that these recordings were also ineffective. Greenwald and his team gave 237 test subjects classical music cassettes that held subliminal tips to boost either self-confidence or memory. Unbeknownst to the study participants, who listened to the tapes daily for five weeks, half of the cassettes were deliberately mislabeled. The researchers found that the cassettes had no effect on self-confidence or memory. The participants, however, had a different experience: those who believed that their cassette would increase self-confidence perceived an improvement, as did listeners who expected supercharged memories.

For many scientists this experiment closed the books on subliminal messaging. In 1992 Anthony R. Pratkanis, a psychologist at the University of California, Santa Cruz, and one of the co-authors of the cassette study, wrote that belief in the efficacy of subliminal persuasion offered an example of what physicist Richard Feynman called a cargo-cult science, in reference to the phenomenon in which a tribal society encounters "cargo" from a technologically advanced culture and designs rituals around it. By Feynman's definition, given as part of a commencement speech at the California Institute of Technology in 1974, cargo-cult science appears to have all the trappings of real science—seeming objectivity and apparently careful


GEORGE W. BUSH AND OZZY OSBOURNE: These men have both been accused of using hidden messages. Bush's 2000 presidential campaign ran ads against Al Gore that subliminally flashed the word "rats" (*left*). Parents unsuccessfully sued Osborne (*right*), claiming his music contained secret backmasked tracks that had driven their children to commit suicide.

CORBIS (*left*); ROGER RESSMEYER *Corbis* (*right*)

FAST FACTS

## Conscious Consumers

1» For decades the public has feared subliminal advertising, viewing it as akin to brainwashing. Scientists, however, view it as largely a myth.

2» Recent experiments demonstrate that subliminal messages flashed onto a screen or computer monitor can influence our decisions only if we are open to persuasion because of a particular need, such as thirst.

3» Despite our fear of being manipulated, our surroundings exert an unconscious influence on our decisions every day. For example, the smell of grilling meats can make us feel hungry, and the music in a supermarket can steer us toward certain purchases.

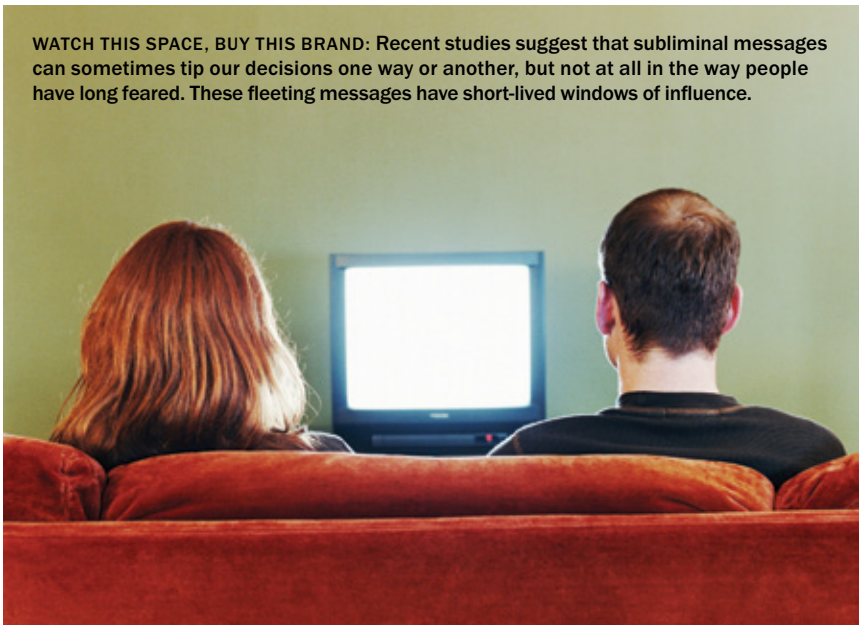
**help industry and law-enforcement agencies—have tried low the threshold of conscious perception.**

experimentation—but is missing something fundamental: its practitioners lack skepticism. Throughout the 1990s subliminal messaging as a research field fell silent, relegated to the realm of reflexology, ESP and other dubious disciplines.

During the past decade, though, psychologists have taken a renewed interest in the topic, and their work has produced some intriguing results. In 2001 Ap Dijksterhuis of Radboud University Nijmegen in the Netherlands, then working with colleagues at the University of Amsterdam, gave students a computerized attention test. Throughout the test he flashed either nonsense syllables or "cola" and "drink" on the screen. Afterward he asked the participants if they would like a cola or a mineral water. The subjects who watched the subliminal messages were more likely to ask for a drink. They did not, however, ask for cola more often. A year later Joel and Grant Cooper of Princeton University replicated the finding, planting subliminal suggestions—the word "thirsty" and images of cola cans—in an episode of *The Simpsons*. Again the people they subjected to the subliminal messages felt parched by comparison to those who watched unaltered shows.

## Drinking the Kool-Aid

To understand why the subliminally cued participants in these studies felt thirstier but not necessarily more inclined to drink cola, consider what happens when you enter a convenience store in search of a drink. First you have to be able to retrieve from memory the name of a beverage. Chances are you will select whatever brand comes to mind fastest. If you drink Coca-Cola all the time, you are probably impervious to any subliminal suggestion to buy another brand. If, however, you sometimes drink Lipton iced tea, messaging that you experience below the threshold of consciousness might sway your choice, making that brand name at least temporarily more accessible in your memory.



NOAH WEBB *Getty Images*

**WATCH THIS SPACE, BUY THIS BRAND:** Recent studies suggest that subliminal messages can sometimes tip our decisions one way or another, but not at all in the way people have long feared. These fleeting messages have short-lived windows of influence.

We decided to test the theory that Coca-Cola as a brand name may be too deeply imprinted in most people's memories for subliminal stimuli to have any effect. Working with Jasper Claus at Utrecht University, John Karremans of Radboud and I conducted an initial study in 2006 in which we asked volunteers to perform a computerized attention task. We repeatedly bombarded half of our participants with 23-millisecond flashes of the words "Lipton Ice," a brand of iced tea. Based on a questionnaire, we determined that Lipton Ice was well suited to our purposes: it is a good thirst quencher but not most people's first choice. The other half of our subjects saw 23-millisecond flashes of nonsense syllables. After the test, participants had to choose a beverage, either Lipton Ice or mineral water. As expected, the Lipton Ice group chose that brand far more often than the control group did. Again, as in the studies described above, only thirsty subjects reacted this way. Unless you are thirsty, it doesn't matter which drink brand is foremost in your mind.

In a second study, we used some pretense to give salt drops to half of our volunteers in the hopes of making them thirsty before we showed them the subliminal advertisement. In this scenario, more than 80 percent of the thirsty subjects—and about half of those who said they were not thirsty—chose Lipton Ice. Without subliminal messages, only 30 percent of the thirsty crew and 20 percent of our well-hydrated subjects took the iced tea. In 2011, working with our colleagues Thijs Verwijmeren and Daniël Wigboldus, Karremans and I refined these results and demonstrated that the subliminal priming worked only in thirsty test subjects who liked Lipton iced tea but did not drink it regularly. We could not influence people who said that Lipton iced tea was their favorite beverage. This finding might explain at least in part why earlier investigations, which typically involved


(The Author)

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**In practice, subliminal messaging is far less potent or ter- reason to believe it could be used successfully in limited**

Coca-Cola, failed to demonstrate a subliminal effect on brand choice. For decades Coke has been the favorite drink among university students, from whom researchers typically recruit their test subjects. Also, these studies did not take into account different levels of thirst.

Other researchers have observed a similar weakness to subliminal persuasion among tired, as opposed to thirsty, individuals. In 2009 Christina Bermeitinger of the University of Hildesheim in Germany, then working at Saarland University, with colleagues at the University of Western Australia, told the subjects that she and others planned to examine the effects of dextrose pills on concentration. They devised two fictitious brands of these pills and designed logos, each of which they presented subliminally to half of the participants while they played a computer game. During breaks the test subjects were offered dextrose pills labeled with the phony brand names. In the end, the more fatigued the participants said they were, the more they gravitated toward the brand they had seen flashed subliminally on the screen.

From these investigations it is clear that an individual's vulnerability to subliminal suggestion depends on a number of variables, including his or her physical needs and habits. A related effect, subliminal revulsion, also can be triggered under particular conditions. We showed this effect in a more recent study in which we subliminally projected the words "Lipton Ice" during two film clips: a funny sequence from the animated film *Madagascar* and a disturbing scene from a film about heroin addicts, *Trainspotting*. After the screening we offered participants Lipton Ice or mineral water. Compared with a control group, who were not subliminally primed, those who saw the brand embedded in *Madagascar* wanted more Lipton Ice. Those who watched *Trainspotting*, however, chose it less often. Once again, the subliminal messaging influenced only thirsty test subjects.

## Brainwashing at the Supermarket

The idea of subliminal advertising still terrifies many people. Research in the area remains somewhat taboo, and funding is scarce. *Programming the Nation*, a documentary film released in October 2011, sensationally asks, "Are we all brainwashed? Or have we lost our minds?" Such levels of fear simply are not justified. Certainly no one likes to feel manipulated, but the fact is that our surroundings color our choices all the time, without us consciously realizing it. The aroma of coffee escaping from a bakery can make us crave an espresso; the scent of grilled meat from a restaurant can set our stomach growling. Our research to date indicates that subliminal messages


**THIRSTY SUBCONSCIOUS:** When test subjects viewed subliminal advertising for Lipton Ice, many more of them opted to drink this brand of tea instead of water. The effect was most pronounced among thirsty participants—their subconscious took notice of the subliminal hint.

PHOTOILLUSTRATION BY SCIENTIFIC AMERICAN MIND; GETTY IMAGES (*billboard in landscape*)

**rifying than it was first thought to be. But we have every but immediate day-to-day situations.**

hold sway over our behavior in the same way as these environmental cues do. The thirsty test subject is more receptive to a subliminal hint about a drink just as the hungry shopper is more likely to overfill his or her cart at the supermarket.

To test the potency of everyday hidden persuaders, in 2005 Rob Holland and his colleagues at Radboud devised a clever experiment. The team asked 56 students to list five activities they hoped to undertake during the next few days. Half of the participants encountered the citrus smell of an all-purpose cleaner in the lab, whereas the other half worked in a scent-free room. The first group did not report noticing any odor. Even so, 36 percent of them wrote that they planned to clean their apartments. By comparison only 11 percent of the subjects who worked in the odor-free setting considered cleaning. Holland and his colleagues concluded that the citrus scent had increased the cognitive accessibility of the goal of cleaning. They did not find out how many of the would-be cleaners completed the task, however. Those good intentions may well have disappeared down the memory hole as soon as other, more urgent matters—such as studying for exams—came to the fore.

BRAINWASHING BACKGROUNDS: **Subliminal messages influence us in the same way environmental cues do: the smells from a cafe can make us feel hungry; a citrus scent can trigger thoughts about cleaning; even music can affect what we buy in a shop.**

GETTY IMAGES

Indeed, such hints do not last long in our memory. Environmental triggers appear to be most potent in scenarios where we can act on them immediately, a fact that makes them useful in certain commercial settings. When department stores play Christmas music, it is meant to put us in a gift-giving mood and increase sales. In 1993 economists Charles Areni and David Kim of Texas Technical University revealed another way in which music can alter behavior. During several weeks at a wine store they played a variety of music, alternating between classical tracks, such as Antonio Vivaldi's "The Four Seasons," and popular tunes, including songs by Fleetwood Mac. They found that the musical selection had no bearing on the total number of bottles sold. Customers listening to classical selections, however, bought more expensive wine than did those listening to pop.

The spending habits of restaurant patrons appear to vary in response to musical cues as well. Adrian North, then at the University of Leicester in England, and his colleagues spent three weeks varying the music in a restaurant dining room from classical to pop to no music at all. When the background track was classical, guests spent an average of $45. By comparison they spent $40 when listening to pop songs and only $39 when there was no music at all.

In some cases, background music can even influence what types of products customers choose. In another experiment, North and his colleagues put a selection of four German or four French wines, equally priced, on display in a British supermarket. On some days the market played German brass band tracks, on others, French accordion music. When interviewed later, very few shoppers could say if they had heard any music. Those customers who heard French tunes, though, more frequently chose the French wines and vice versa.

We have every reason to believe that, just like the music in these examples, subliminal advertising could be used successfully in immediate, day-to-day situations. To have any genuine effect, however, subliminal slogans would have to be short, delivered near the time of a decision, and relate to a person's immediate intentions or habits. Given such constraints, it is unlikely that subliminal television ads could ever compel consumers days later to buy one brand or another on a weekly shopping trip.

Our work reveals that, in practice, subliminal messaging is far less potent or terrifying than it was first believed to be. It might even be put to good use. A handful of studies have shown that millisecond exposures to the words "angry" or "relax" can have definite, if short-lived, effects on a person's heart rate and blood pressure. Our subconscious registers many different kinds of suggestions, not just the ones advertisers may be aiming for. M

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BARA K. KRISTINSDOTTIR *Aurora Photos*

# Are We Born to Be Religious?

## Genes and personality influence our attitudes toward religion

*By Vassilis Saroglou*

A deep question pervades the debates surrounding religion—whether God exists, sure, but that one is mighty difficult to answer. Instead we can ask a related, more approachable query: Why does God exist for some of us but not for others? Theologians and ministers preach that faith is preeminently a matter of personal choice. Is it, really?

Not everyone is a believer, of course, nor do we all maintain allegiance to a single belief system throughout the course of our life. Almost half of American adults, for example, have changed religious affiliation at least once during their lifetime, and most do so before age 24, according to the Pew Forum on Religion and Public Life. Although religious affiliation may be fluid, once people enter adulthood they tend to stick with one category, retaining either faith in God or the absence thereof.

For the most part, people are either religious or atheists because they were raised that way. Parents, classmates and other trusted figures impress their views on children and introduce them to a set of rituals and practices. Later in life those influences hold less power. Several forces can diminish a person's religiosity—frequently cited reasons include the absence of social pressures to be religious or a desire to distance oneself from one's family. Personal crises can also spur a change, prompting some people to convert and others to abandon religion.

Recent research suggests, however, that this is not the whole story. By studying the correlations among thousands of individuals' religious beliefs and measures of their thoughts and behaviors, scientists have discovered that certain personality types are predisposed to land on different spots of the religiosity spectrum. Genetic factors account for more than half of the variability among people on the core dimensions of their character, which implies that a person's feelings regarding religion also contain a genetic component. By analyzing twins, some of whom share the same DNA, psychologists have begun to collect evidence for the genetic roots of religiosity. These studies are starting to explain what makes some of us believers, whereas others end up rejecting supernatural notions.

### Bringing Up Believers

The search for a biological basis for religion has gained wide appeal as the tools to probe our internal makeup have improved. Numerous brain-scanning experiments have sought to pinpoint

If you were the man in the suit, would you stop to help the woman who fell? Your response may reveal not only facets of your personality but also your religious inclinations.

one or another brain region as being important to the religious experience, prompting occasional claims that humans are equipped with a "God module," a part of the brain that causes us to have religious beliefs. In 2004 a much hyped book called *The God Gene* proposed that a particular gene, *VMAT2*, was linked with religiosity. The data supporting that claim, however, were never published in a peer-reviewed journal, and other scientists never replicated the purported results.

Discerning how genes lead to behavior is one of biology's toughest tasks. Genes make proteins, and figuring out how those proteins give rise to behaviors, let alone beliefs, pushes at the edges of our scientific knowledge. What is clear is that genes are not a blueprint; instead they interact with environmental influences in many complex ways, twisting fate at every turn. One way to examine the question is to look at personality characteristics: genes predispose a person to particular traits, which can manifest as certain behaviors.

The study of personality began almost a century ago, when pioneering psychologists working in the 1920s and 1930s became inspired by biology's orderly classification systems and set out to codify personality. They started by scanning the dictionary for all the terms that captured some aspect of a person's character, producing a list several thousand items long. Factions of psychologists debated over which descriptors, and how many of them, were needed to capture the essential dimensions of personality.

More recently, psychologists have rallied around "the big five," as psychologist Lewis Goldberg of the University of Oregon called them in 1981. These five traits—extroversion, neuroticism, agreeableness, conscientiousness and openness—have been shown to be independent of one another and to remain stable throughout most of life. In work published in 1987 Robert R. McCrae and Paul T. Costa of the National Institutes of Health verified the five factors by administering questionnaires and collecting self-reports and peer ratings from thousands of people. Subsequent surveys in many languages and countries have contributed to the dominance of the five-factor model in personality psychology today.

According to this model, the ways in which individuals' personalities differ from one another can be organized along five main dimensions. People differ in extroversion: extroverts are dynamic, gregarious and socially warm, whereas introverts are timid and reserved. Neuroticism refers to a person's tendency to be anxious, depressed and generally emotionally vulnerable, as opposed to emotionally stable and positive. A third facet is agreeableness, which captures whether a person is empathetic, helpful and trusting of others, as opposed to mean, individualistic and arrogant. Conscientious individuals are methodical, self-controlled, and willing to establish goals and work toward achieving them, whereas those low in conscientiousness tend to be impulsive and disorganized. Finally, we can differ in openness: whether we like novel, challenging and complex ideas, experiences and feelings. Less open individuals prefer to stay within their comfort zone.

## Linking Personality and Religion

To find links between a person's religious beliefs and any other facet of life, scientists must sift through enormous quantities of data. In 2010 I published an in-depth analysis of 70 previous studies seeking to link religion and personality with a total of more than

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### Roots of Religiosity

1» **Many people change their religious affiliation during the course of a lifetime. Overall attitudes toward belief, however, are generally stable in adulthood.**

2» **Specific clusters of personality traits correlate highly with particular kinds of religious belief.**

3» **Although environmental influences play a large role in determining a person's religious beliefs during adolescence, genetic factors emerge as more important in adulthood.**

MICHAEL BLANN *Getty Images*

## You Look Religious

The choices you make, both big and small, can broadcast hints about your religious beliefs. In a 2009 study Laura Naumann, then at the University of California, Berkeley, and her collaborators asked study participants and their acquaintances to describe the participants' personality and religiosity. They also took full-body photographs of the subjects. A second group of students then looked at the pictures and guessed at the individual's personality and religiosity. They got it right more than 60 percent of the time. Further analyses showed that the observers made their judgments of religiosity partially based on how neat or messy participants looked.

Other unexpected connections between religiosity and behavior have also been discovered. In our lab at the Université Catholique of Louvain in Belgium, we looked into how religious people use humor. We found, first, that they reported a lack of appreciation for hostile, sexual and dirty humor—no surprise there. We also presented our subjects with frustrating situations and asked them how they would respond. To hide the key objective, we told them we were investigating the ways in which we cope with life's everyday difficulties. Amazingly enough, the more religious the students were, the less likely they were to spontaneously use humor in their answers.

A similar trend exists in professional interests. I analyzed data from the European Social Survey, which included 25 countries and more than 40,000 participants, and discovered that religious people have a greater chance of ending up in education, health, medical services and humanities than in other fields. Nonbelievers are more likely to go into engineering, sciences and mathematics. —*V.S.*

21,000 participants. These papers covered several decades, ages and religions, although Christianity was most heavily represented. Several of these reports corroborated self-assessments, with ratings provided by family members, friends and colleagues.

What those studies revealed is that religious people consistently differ from low-religious or nonreligious individuals on two personality dimensions: agreeableness and conscientiousness. The effects were modest in size: 60 percent of religious versus 40 percent of nonreligious people are agreeable or conscientious. Yet this correlation showed up in study after study. It was present in both men and women, from teenagers to adulthood, and among several cohorts ranging from the 1970s to the present, as well as in a study from the 1940s. We saw this trend in people of all major religions, not only in Protestant and Catholic but also in Jewish and Muslim faiths. Several behavioral experiments bolster the idea that religious individuals tend to display agreeable and conscientious behaviors. For example, religious people are inclined to show cooperation in laboratory experiments and to volunteer in real life. They also endorse healthy lifestyles that reflect self-control such as low alcohol, drug and tobacco use. Again, these effects are modest, but the fact that they are pretty consistent across studies makes them notable.

> Rather than religion making people agreeable and conscientious, it is personality that determines religiousness.

One could argue that rather than certain types of people being more likely to become religious, religion might instead instill agreeableness and conscientiousness in believers. To answer this question, researchers examined data from the Terman Longitudinal Study, a project that followed people with high IQs throughout their life. In the early 1920s, when these participants were between the ages of 12 and 18, their parents and teachers evaluated various aspects of their personalities. In 2003 Michael McCullough of the University of Miami and his collaborators found that of the 492 subjects they analyzed, the children and adolescents rated as more agreeable and conscientious turned out to be more


### (The Author)

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religious 19 years later than the individuals who were rated lower on these measures as children. Another analysis published two years later examined changes in religiosity of Terman study participants over the course of 50 years. The people who were high in agreeableness in their early adulthood were more likely to remain believers or even to become more religious later than those who were less agreeable as young adults.

These results are in line with personality theory. Personality traits are already present in early childhood. Later in life they heavily shape social attitudes, values and identities. It thus becomes clear that rather than religion making people agreeable and conscientious, it is personality that determines religiousness.

> The more distance we get from our early influences, the more idiosyncratic factors hold sway over our beliefs.

If further research, especially in Eastern cultures and religions, confirms this pattern, we may have psychological evidence in favor of some of the universal functions of religion. Scholars have long suggested that because religion fosters social cohesion, it may have played an important evolutionary role by enabling larger groups of people to band together. These findings on personality traits support that idea. Agreeableness and conscientiousness together denote a preference for social harmony and personal order—in other words, stability.

## A Profile of Belief

We can add even more nuance to our personality profiles of believers. In my 2010 meta-analysis I also reviewed studies that had focused on either spirituality, which encompasses more modern forms of faith not necessarily connected to religious institutions, or fundamentalist types of religion. About 62 percent of those who are high in openness to experience—and are agreeable and conscientious—are interested in and involved with spirituality. About the same percentage of people who are agreeable and conscientious but low on openness tend to become involved with fundamentalist religious groups. Openness appears to tune believers to the kind of faith they end up holding.

An important question is how these clustered traits might relate to choices in real life or at least to real life as it is modeled in the lab. In a study I conducted in 2005 at the Université Catholique of Louvain in Belgium with Isabelle Pichon, we asked Belgian participants how they would react in several situations in which they could choose to either offer help or not. Here is one scenario: you are trying to catch a train when you see a person whose suitcase flies open and from which the contents scatter. Do you stop to help? We assigned our subjects randomly to one of two conditions. In one, the person needing help was a friend, family member or colleague. In the other, the person requiring assistance was unknown. Our findings were intriguing: the more religious the participants, the more they expressed willingness to help the familiar individual but not the stranger. Spiritual subjects, however, did not distinguish between known and unknown people. They were equally willing to help in both cases.

We can make further distinctions among types of religiosity. In collaboration with my graduate student Joanna Blogowska, we replicated the suitcase scenario with Polish participants in a study published in 2011. We added a second study, in which we examined the willingness to help either a student in need or a feminist student in the same situation. It turned out that participants who were high on religious fundamentalism were not very will-

By studying twins, researchers are beginning to find evidence of a genetic contribution to our religious beliefs.

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## Boiling Down Beliefs

**Agreeable and conscientious people also tend to be religious. Whether they incline toward fundamentalist or spiritual belief systems often depends on how they rate in openness. The top three and bottom three rows reveal the similarities—and differences—between authoritarian and fundamentalist dispositions, as well as between spiritual persons and those who experience paranormal phenomena. A creative-rebellious type is much less likely to be religious.**

| | Extroversion | Agreeableness | Conscientious-ness | Neuroticism | Openness to Experience |
|---|---|---|---|---|---|
| Religiosity | | High | High | | |
| Fundamentalism | | High | High | | Low |
| Spirituality | High | High | High | | High |
| Creativity-rebelliousness | | Low | Low | | High |
| Authoritarianism | | | High | | Low |
| Paranormal beliefs | High | | | | High |

ing to help unknown people or a feminist, an individual whom they perceived as threatening to their values. They did, however, frequently offer to help either a close acquaintance or a student in need. The participants who were high in fundamentalism assisted individuals in those latter two categories 66 percent of the time versus exactly half of the time for feminists and strangers. In other words, those viewed as outsiders were least likely to receive a helping hand from more conservative believers.

### Genes and Environment

These clustered personality traits—and their corresponding behavior—suggest an underlying genetic component. To investigate this idea, researchers have contacted hundreds of pairs of twins to assess their religious beliefs at different points in time. These twin studies aimed to identify how each of the following variables helped to determine religiosity—the unique experiences of each twin, the shared environmental factors of family and environment, and finally, heritability.

What these studies conclude is that shared environment—namely a family's approach to religion—plays a great role, especially during childhood and adolescence. After that, the picture shifts, the early environment becomes less potent, and a genetic influence emerges between the ages of 18 and 25 years.

Let us look a little more deeply at one of these twin surveys. In a 2005 study by Laura Koenig, then at the University of Minnesota, and her colleagues, for example, the researchers analyzed reports on the religiosity of twins in adolescence compared with adulthood. The intent was to calculate the relative importance of genetic factors versus environmental influence at those two stages of life. The scientists used a statistical model to determine which factor is most important in adolescence versus adulthood. For adolescents, they learned that genetics—in other words, dispositions for certain personality traits—accounted for only 12 percent of their religious identity, and a shared upbringing contributed 56 percent to the outcome. (If you include a third category, which captures all the unique events that shape a twin's life, these three numbers add up to 100.) Conversely, 44 percent of adults' religiosity could be attributed to genetics, and 18 percent had to do with their environment.

All these data suggest that genetic influences help to explain why adults sometimes stray from the beliefs of their childhood. The more distance they get from the influences of their early years, the more idiosyncratic factors can hold sway over a person's attitudes. In a way, we are born to be inclined toward religion or atheism. Does God call us? For some of us, the answer is yes: through our genes, parents, acquaintances and life events. M

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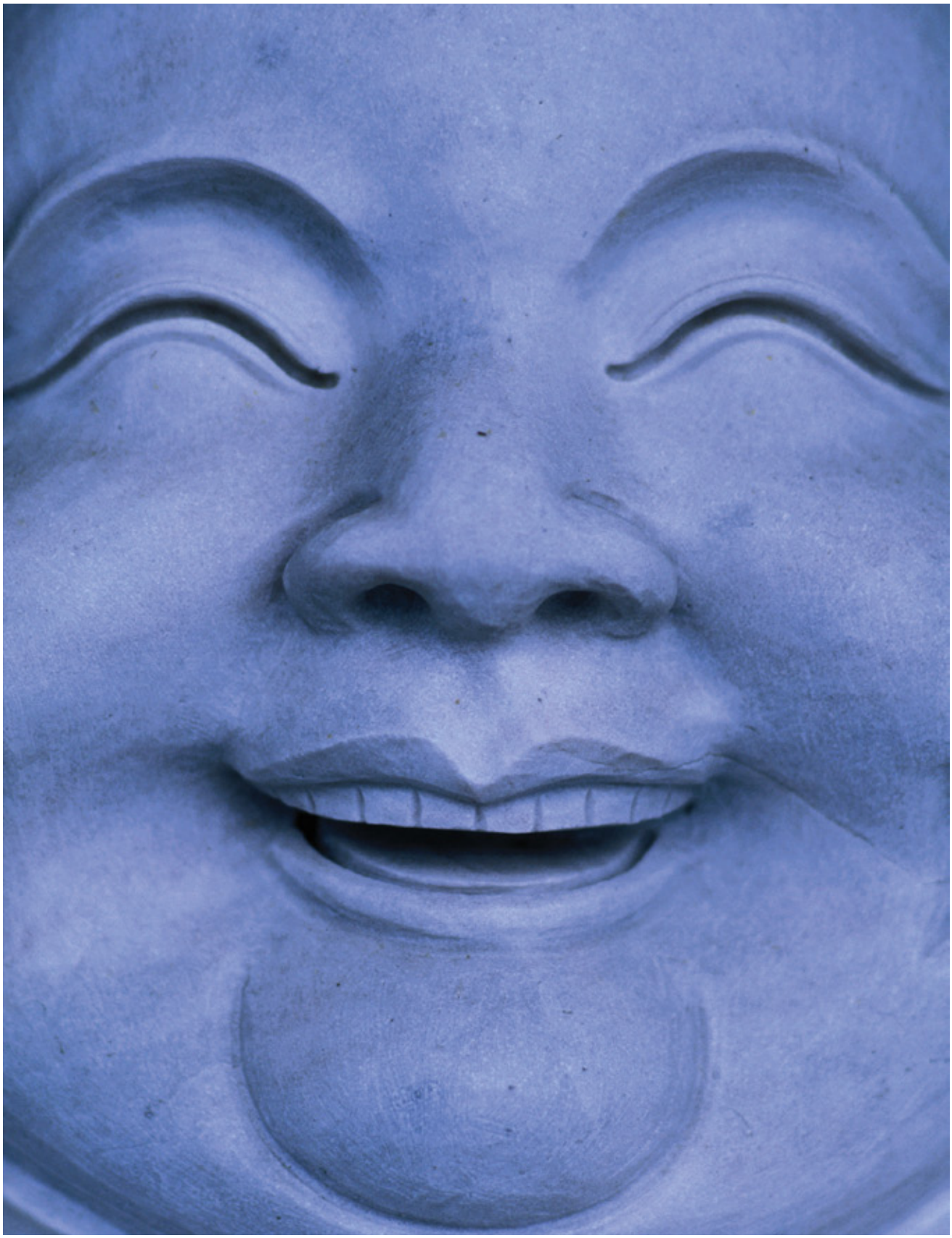

Alain de Botton, a prominent writer and outspoken atheist, has a grand vision to nurture a truly secular society. He foresees awe-inspiring monuments dedicated to nature. Museum and hotel designs would encourage contemplative thought and self-improvement. Psychotherapists would occupy offices in accessible yet glamorous boutiques, providing easy opportunities for supportive interactions with others.

Although such a radical transformation of civic life—religion for atheists, as he calls it—is unlikely to make it beyond the blueprints, de Botton is on to something. Atheists miss out on a lot of great perks that come automatically with belonging to a faith. As a religious person, you gain a community of like-minded individuals, many of whom are eager to welcome you into their social circle. During tough times, this network softens your fall. When it comes to happiness, "there appears to be something special about having friends at church," says sociologist Chaeyoon Lim of the University of Wisconsin.

# HEALTHY SKEPTICISM

## Who is better off: the religious or atheists? Cultural values determine the answer

*By* Sandra Upson

You also don't get saddled with the many negative attributes associated with atheists. Nonbelievers are considered immoral, untrustworthy and, in the U.S., among the least likely to be elected president. A handful of states' constitutions even ban atheists from holding public office. Worst of all, a large body of research suggests that, as compared with religious individuals, people who lack a creed are less likely to be healthy and happy—surely the two most important earthly concerns—and tend to lose out on at least seven years of life, some estimates suggest. Several large-scale population studies have reinforced a single premise: the more you engage with religious activities, the better off you are.

Yet many people are less certain about their beliefs than ever before. Nonbelievers number between 500 million and 750 million worldwide, according to one analysis. In the past two decades the percentage of the U.S. population that proclaims its religious affiliation as "none" has more than doubled, to about 15 percent. Most of these individuals do not identify as atheists; even so, many of them conduct their life outside the religious establishment. Although research on this population is only now emerging, a 2011 study by Daniel Mochon, Michael I. Norton and Dan Ariely found that people who were less committed to their religious creed were actually less happy than avowed atheists.

If the shifting beliefs of a growing number of people portend lower health and a less contented outlook, knowing exactly how religion benefits its followers becomes a matter of public concern. Once we know what atheists are

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lacking, the de Bottons of the world can start dreaming up ways of providing it. "Religion is not going to affect happiness supernaturally. It has to happen through psychological, sociological and biological mechanisms," says psychiatrist Harold Koenig of Duke University. Gallup, the polling organization, even held a symposium in February, attended by government officials, to discuss what policy implications the religion-and-health connection might have.

FAST FACTS

### Secular and Satisfied

1» **Being religious is often linked with greater well-being. New research suggests that the effect is culture-specific.**

2» **A strong predictor of a person's religiosity is the condition of the society in which he or she lives.**

3» **Finding communities and social groups that align with your beliefs can improve life satisfaction.**

Several recent studies have sought to answer facets of this question by examining it with greater resolution. For the first time, researchers affiliated with Gallup have collected a representative sample of the world that measures religiosity and happiness. They found that the positive effects of religion depend enormously on where you live. Religious people may be happier than their godless counterparts, but only if the society they belong to values religion highly, which not all societies do. For atheists and the growing ranks of unaffiliated individuals, these findings bode well. Although many questions remain about how nonbelievers can acquire the health benefits of religion, scientists are now finding that secular communities of like-minded people can offer similar social support.

## Religion's Earthly Rewards

The idea that religion imbues people with contentment has a long history, especially in the popular imagination. For just a taste of it, consider a public service announcement from the late 1950s or early 1960s, in which an American teen idol known as Fabian counseled: "Teenagers would feel a lot

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happier inside if they visited the inside of a church more often." In the following decades sociologists and psychologists confirmed what the pompadour-sporting pop star and many others had intuited—that identifying as religious correlates with improved health and higher ratings on various measures of contentment. A National Opinion Research Center survey of Americans conducted between 1972 and 2008, for example, found that the percentage of people reporting that they were "very happy" ranged from 26 percent among those never attending religious services to 48 percent for those who go more than weekly.

To figure out how religion affects people, social scientists rely mainly on population surveys, which are an imperfect way to study a phenomenon with subtle influences. No one experiment can properly assess whether religious behavior causes certain life outcomes over decades, and no group of people is untouched by religion, making it impossible to fully separate out the variables. As a result, researchers end up hunting for faint signals hidden in the cacophonous data on many thousands of people's lives.

Nevertheless, such surveys have their uses. In one paper published in 2010, for example, Lim and Robert D. Putnam of Harvard University analyzed a poll on the beliefs of about 3,000 Americans to gain insight into why religion makes people happy. The respondents were asked many questions about religious behavior, such as how often they "feel God's love," pray or read scripture.

The data showed that happiness is not a matter of how often people say they think about God, talk about God or feel God's presence. Instead people reported being more satisfied with their life simply when they attend religious services more frequently. Controlling for all other variables, Lim and Putnam found that 28.2 percent of people who checked in with their congregation weekly reported being "extremely satisfied" as compared with 19.6 percent for those who never attend services. The researchers equated that nine-point gap with the difference in happiness for a person who reports being in "good" rather than "very good" health or the difference between a lower-class and upper-middle-class family income.

The advantages of a religion cannot simply be boiled down to the social network it provides, however. Comparing participants with a similar number of close friends but different degrees of religiosity, they found that the happiest people are those who belong to religious groups, have more close friends in their congregations, *and* believe that religion is very important to their sense of self. Without a strong religious identity, congregational friendship mattered less. Even more telling, people who attended regularly but had no friends in their place of worship were worse off than those who did not go to services at all. "Maybe there's something we can learn about this secret ingredient in church friendship," Lim says. "We can begin to look for a similar ingredient in a secular setting."

> People who attend services regularly but lack friends in the congregation are worse off than those who do not go at all.

Though statistically strong, this study and many others on the topic were conducted in the U.S., where being religious is the cultural norm. It could be that attending services offers a unique opportunity for psychological one-stop shopping. "The churches in the U.S. may be singular in that they … handle social relations, charity opportunities, coherent worldviews and like-minded social support," notes psychologist Luke Galen of Grand Valley State University. Many of religion's elements can, after all, be derived from other sources. Data from around the world can sharpen the focus.

## Borders of Belief

To examine how the U.S. compares with the rest of the world, psychologist Ed Diener of the University of Illinois and his colleagues conducted a global survey, including a state-by-state sample in the U.S. They reached more than 350,000 people living in the U.S. during 2009. They gathered data on how well their respondents' basic needs were met, such as whether they had sufficient money for food and shelter. They probed their sense of personal safety with questions about how they feel walking alone at night. Income, education levels and other variables determined which respondents were living in "difficult circumstances." Participants were also asked whether religion was important to them. To assess

(The Author)

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the respondents' subjective well-being—an umbrella term for life evaluations and feelings—they were asked whether they had experienced a variety of emotions the preceding day.

In line with earlier findings, two thirds of those surveyed regarded religion as important to their life. The states, however, varied by a factor of two: in Vermont, 44 percent rated religion as important, compared with 88 percent in Mississippi. In the states where religion was very important, people were much more likely to be living in difficult circumstances. They also had lower subjective well-being than people living in less religious parts of the country. Did religion make them happier, as previous studies had shown? Absolutely, according to the data—but they still were worse off than the contented residents of more affluent states, where religion mattered less.

Gallup's operatives also surveyed people in 154 countries, with an average of almost 3,000 people per country. Respondents were asked the same types of questions as in the U.S. Overall, three out of four reported that religion was important in their life.

Again, the devil was in the details. The countries in the sample varied in religiosity by a factor of six, ranging from 16 percent of respondents in Sweden agreeing with the statement that religion was an important part of their life to 99 percent affirmation in Bangladesh, Egypt, Sri Lanka and Somaliland. In this global poll, a tough environment also tended to coincide with greater national religiosity. If you live in a nation where daily existence is difficult, your life satisfaction is generally lower. In those countries, being more religious appears to grant you a premium on happiness that your less religious neighbors do not enjoy. If the living is easy, however, both nonreligious and religious people have similar, relatively high subjective well-being. This effect held true for all religions represented in the sample—Buddhism, Christianity, Hinduism and Islam.

More important, whether a person was struggling or thriving was nowhere near as predictive of religiosity as a society's conditions and norms. "Do you have individual choice about what you believe? Yes, but there are strong influences in society—whether everyone around you is religious," Diener says. "That's the eye-opener for me, that societal forces led to religiosity rather than individual forces."

For nonbelievers, these are heartening data. They bolster the idea that believers will accrue more psychological benefits only in places that value religiosity more, and vice versa. It means atheists are not permanently shut off from some fountain of happiness—although they may want to find a like-minded community to live in. As Roy Baumeister, now at Florida State University, and Mark Leary, now at Duke, wrote in 1995, "belongingness can be almost as compelling as food."

Further support for the conjecture that religiosity gains its power by being culturally valued came earlier this year from psychologist Jochen E. Gebauer of Humboldt University in Berlin and his colleagues. They mined a data set consisting of almost 190,000 records of individuals from 11 European countries who had set up profiles on an online dating site. These people had all rated how important religion was to them and how well a variety of positive adjectives—such as calm, healthy and resilient—described them. The researchers combined their answers into a single term, "psychological adjustment."

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**The benefits of being religious are greatest when the surrounding society values religiosity and circumstances are challenging.**

The researchers found that the link between high religiosity and psychological adjustment was stronger in more religious countries and disappeared almost entirely in countries that did not tend to value religiosity. As the authors put it, "religiosity, albeit a potent force, confers benefits by riding on cultural values."[For more on happiness and cultural fit, see "The Many Faces of Happiness," by Suzann Pileggi Pawelski; Scientific American Mind, September/October 2011.]

> Atheists are not shut off from some fountain of happiness, although they may want to find a like-minded community.

### The Happiest Atheists

In the least religious nations—which include Estonia, the Scandinavian countries, Hong Kong and Japan—the role of faith in public life can still be surprisingly complex, however. Phil Zuckerman, a sociologist at Pitzer College, spent 14 months interviewing people in Denmark, one of these hallowed lands where religious belief is low, yet people's spirits are high. Just 19 percent of the population considered religion important, according to Diener's survey.

To illustrate the difference between Denmark and the U.S., Zuckerman shares an anecdote from an American playground. His daughter, then six years old, was playing on a swing set with a friend when her companion asked her if she believed in God. The little girl replied, "No." Her friend immediately got off the swing, damned Zuckerman's daughter to hell and walked away.

In Scandinavia, the situation between the two girls would be reversed, he argues in his book, *Society without God*. As Sarah, a 20-year-old grocery clerk from a village in Jutland, told him: "Young people think that religion is kind of taboo. As a young person, you don't say, 'I'm a Christian, and I'm proud of it.' If you do that, you often get picked on."

Denmark and Sweden buck conventions in more ways than one. They have the lowest church attendance in the world. Ask them if they believe the basic tenets of Christian doctrine, and by and large they say they do not. "Even the vast majority of the clergy don't believe in God," Zuckerman says. Yet most Danes and Swedes baptize their babies, get married in churches and pay a tax that supports the church.

How the presence of the church contributes to Scandinavians' well-being is an open question. The institution likely represents a sense of community, a shared moral foundation and a national heritage. Yet as one Danish bishop told Zuckerman, "Danes don't need to go to church to feel community. They live in Denmark." The country has been described as a modern tribe; with a language spoken by only about six million people and few immigrants, Denmark's homogeneity serves as social glue. The country also has egalitarian workplaces, with minimal social distance separating bosses and employees.

That is all well and good for the Danes, but for the rest of us some lessons can emerge. Belief in God or gods is not a prerequisite for a pleasurable existence, although it can make life easier. Socializing with like-minded people on a regular basis, and living and working in a supportive community, can offer many of the same benefits. As Diener puts it, "Religion can certainly help people to be happier, but other things can help you do the same thing. A peaceful, cooperative society, even in the absence of religion, seems to have the same effect."

Studying religion, it seems, is not so different from placing anything else under the microscope. View your arm from a comfortable distance, and it appears to be smooth. With greater resolution, you see that your skin is teeming with microorganisms. Look further still, and the surface is not even a solid expanse but molecules in constant motion, bumping up against one another and jostling around.

Life on the macroscale also possesses some of these shape-shifting features. Beating a path to happiness requires knowing what peculiar cocktail of social forces affects our lives and how we can manipulate them. M

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# When Coping Fails

Revisiting the role of trauma in post-traumatic stress disorder

BY SCOTT O. LILIENFELD AND HAL ARKOWITZ

STRESS is an inevitable part of our life. Yet whether our daily hassles include the incessant gripes of a nasty boss or another hectoring letter from the Internal Revenue Service, we usually find some way of contending with them. In rare instances, though, terrifying events can overwhelm our coping capacities, leaving us psychologically paralyzed. In such cases, we may be at risk for post-traumatic stress disorder (PTSD).

PTSD is an anxiety disorder marked by flashbacks, nightmares and other symptoms that impair everyday functioning. The disorder is widespread. At least in the U.S., it is thought to affect about 8 percent of individuals at some point during their lifetime.

Although PTSD is one of the best known of all psychological disorders, it is also one of the most controversial. The intense psychological pain, even agony, experienced by sufferers is undeniably real. Yet the conditions under which PTSD occurs—in particular, the centrality of trauma as a trigger—have come increasingly into question. Mental health professionals have traditionally considered PTSD a typical, at times even ubiquitous, response to trauma. They have also regarded the disorder as distinct from other forms of anxiety spawned by life's slings and arrows. Still, recent data fuel doubts about both assumptions.


## Shell Shock

PTSD did not formally enter psychiatry's diagnostic bible, the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM*), until 1980. Yet accounts of syndromes that mirror PTSD date back to Sumeria and ancient Greece, including a mention in Homer's *Iliad*. In the American Civil War, veterans suffered from "soldier's heart"; in World War I, it was called "shell shock," and in World War II, the term used was "combat fatigue." In the 1970s some soldiers returning from the war in Southeast Asia received informal diagnoses of "post-Vietnam syndrome," which also bore a striking resemblance to the *DSM*'s description of PTSD.

According to the *DSM*, PTSD occurs in the wake of "trauma"—defined by the manual as an extremely frightening event in which a person experiences or witnesses "actual or threatened death or serious injury, or a threat to the physical integrity of self or others." (Less violent experiences such as serious relationship or financial problems do not count.) The most frequent triggers of PTSD thus include wartime combat, rape, murder, car accidents, fires, and natural disasters such as tornadoes, floods and earthquakes.

PTSD is now officially characterized by three sets of symptoms. These include reliving the event through intrusive memories and dreams; emotional avoidance such as steering clear of reminders of the trauma and detaching emotionally from others; and hyperarousal that causes sufferers to startle easily, sleep poorly and be on alert for potential threats. These problems must last for a month or more for someone to qualify for the PTSD label.

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

## Immune to Trauma?

After the terrorist attacks of September 11, 2001, many mental health experts confidently predicted an epidemic of PTSD, especially in the most severely affected locations: New York City and Washington, D.C. The true state of affairs was much more nuanced, however. It is certainly true that many Americans experienced at least a few post-traumatic symptoms following the attacks, but most of the afflicted recovered rapidly. In a 2002 study psychologist Roxane Cohen Silver of the University of California, Irvine, and her colleagues showed that about 12 percent of Americans suffered significant post-traumatic stress between nine and 23 days after the attacks. Six months later this number had declined to about 6 percent, suggesting that time often heals the psychic wounds.

Work by epidemiologist Sandro Galea of the New York Academy of Medicine and his colleagues, also published in 2002, revealed that five to eight weeks after 9/11, 7.5 percent of New Yorkers met the diagnostic criteria for PTSD; among those who lived south of Canal Street—that is, close to the World Trade Center—the rates were 20 percent. Consistent with other data, these findings suggest that physical proximity is often a potent predictor of stress responses. Yet they also indicate that only a minority develops significant post-traumatic pathology in the aftermath of devastating stressors. Indeed, the overall picture following the 9/11 attacks was one of psychological resilience, not breakdown.

More broadly, research that psychologist George A. Bonanno of Columbia University and his colleagues reviewed in 2011 suggests that only about 5 to 10 percent of people typically develop PTSD after experiencing traumatic life events. And although the rates rise when stressors are severe or prolonged, they hardly ever exceed 30 percent. The rare exceptions may occur with repeated trauma. In another 2011 study psychologist Stevan Hobfoll of Rush Medical College and his colleagues reported that of 763 Palestinians living in areas rife with political violence, more than 70 percent exhibited moderate PTSD symptoms and about 26 percent had severe symptoms.

The finding that PTSD is not an inevitable sequela to trauma has spurred investigators to pursue factors that forecast relative immunity to the condition. Across studies, higher income and education, strong social ties and male gender tend to confer heightened resilience, although these predictors are far from perfect. People who usually experience very little anxiety, guilt, anger, alienation and other unpleasant emotions—that is, who have low "negative emotionality"—are also less likely to suffer from PTSD following trauma. Thus, in ways that researchers do not yet understand, individual characteristics must combine with trauma to produce this illness.

## Emotional Triggers

Not only is trauma insufficient to trigger PTSD symptoms, it is also not necessary. Although by definition clinicians cannot diagnose PTSD in the absence of trauma, recent work suggests that the disorder's telltale symptom pattern can emerge from stressors that do not involve bodily peril. In 2008 psychologist Gerald M. Rosen of the University of Washington and one of us (Lilienfeld) reviewed data demonstrating that significant PTSD symptoms *can* follow emotional upheavals resulting from divorce, significant employment difficulties or loss of a close friendship. In a 2005 study of 454 undergraduates, psychologist Sari Gold of Temple University and her colleagues revealed that students who had experienced nontraumatic stressors, such as serious illness in a loved one, divorce of their parents, relationship problems or imprisonment of someone close to them, reported even higher rates of PTSD symptoms than did students who had lived through bona fide trauma. Taken together, these findings call into question the long-standing belief that these symptoms are tied only to physical threat.

In light of these and other data, some authors have suggested that the PTSD diagnosis be extended to include anxiety reactions to events that are stressful but not terrifying. Yet such a change could lead to what Harvard University psychologist Richard J. McNally calls "criterion creep"—expanding the boundaries of the diagnosis beyond recognition. This and other controversies aside, recent results raise the possibility that PTSD is a less distinctive affliction than originally thought and that its symptoms may arise in response to a plethora of intense stressors that are part and parcel of the human condition. M

> PTSD symptoms can follow upsetting life events such as employment difficulties, **divorce or loss of a friendship**.

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

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

## (Further Reading)

- **Posttraumatic Stress Disorder: An Empirical Evaluation of Core Assumptions.** Gerald M. Rosen and Scott O. Lilienfeld in *Clinical Psychology Review,* Vol. 28, No. 5, pages 837–868; 2008.
- **Resilience to Loss and Potential Trauma.** George A. Bonanno, Maren Westphal and Anthony D. Mancini in *Annual Review of Clinical Psychology,* Vol. 11, pages 511–535; April 2011.

# Memories of Tomorrow

Why we tend to predict rosy times ahead

BY WRAY HERBERT


I REMEMBER my retirement like it was yesterday. As I recall, I am still working, though not as hard as I did when I was younger. My wife and I still live in the city, where we bicycle a fair amount and stay fit. We have a favorite coffee shop where we read the morning papers and say hello to the other regulars. We don't play golf.

In reality, I'm not even close to retirement. This is just a scenario I must have spun out at some point in the past. There are other future scenarios, but the details aren't all that important. Notably, all of my futures have a peaceful and contented feel to them. They don't include any financial or health problems, nor do they include boredom—not for me or anyone else I know.

A new study from the January issue of *Psychological Science* may explain why we are all so optimistic about what's to come. The authors report that people tend to remember imagined future scenarios that are happy better than they recall the unhappy ones.

Cognitive scientists are very interested in people's "remembered futures." The whole idea seems contradictory in a way, as we tend to think of memory in connection with the past—recollections of people and things gone by. The fact is that we all imagine the future, and from time to time we recall those imaginary scenarios. Recent research has shown that the same brain areas are active when we remember past events and when we think about the future. Indeed, some scientists believe that these "mem-

**The same brain areas** are active when we remember past events and when we think about the future.

MATT MENDELSON (*Herbert*); RON CHAPPLE *Getty Images* (*eyeglasses*)

ories" are highly adaptive, allowing us to plan and better prepare ourselves for whatever lies in store. If we can remember the actions and reactions we thought about in the past, our future behavior will be more efficient.

Still, very little was known until recently about how these simulations work. Are all future memories equally beneficial? Which scenarios do we recall best? Are most people's forecasts as rosy as mine? Or do we also spin out less optimistic simulations of the years to come, ones that we tend to forget over time?

These are very difficult questions to study in a laboratory—or at least they were until now. A team of psychological scientists, headed by Karl K. Szpunar of Harvard University, devised a novel method for generating authentic future simulations, which he then used to study their characteristics and staying power.

## Recalling Tomorrow

Szpunar and his colleagues began by collecting a lot of biographical detail from volunteers' actual memories. This information included people they had known, places they had been and the ordinary things surrounding them. I might, for example, tell the researchers about having a beer with my cousin Karen at a bar in Baltimore; buying a television at Best Buy with my wife; and borrowing $10 from my college roommate Roger at the bookstore. Szpunar's team asked for more than 100 of these specific event memories from each of the 48 volunteers in their study.

A week later the researchers took each person's raw material—all those people, places and things from near and distant pasts—and jumbled it all together. They presented the students with random combinations and instructed them to generate imaginary future scenarios for each one. For me the random set might have been my roommate Roger, the Baltimore bar and the TV. Sometimes the volunteers were instructed to imagine a positive future, sometimes a negative one and others times neutral. So I might envisage Roger and me having a terrific time cheering on the Orioles at that Baltimore bar, or I could imagine the two of us falling into a bitter argument at the same bar, while the news played on the TV in the background.

Later, the researchers tested the volunteers' memories of these future scenarios by giving them two of the three details—the bar and Roger, say—and asking them to fill in the missing detail (the TV, in this case) to re-create the simulated future scene. The scientists tested some of the volunteers 10 minutes after they had generated the imaginary future scenarios, and they tested others a day later. The idea was to see if the emotional content of the imagined futures—positive, negative or neutral—made them more or less memorable.

The results were intriguing. The researchers found that after only a 10-minute delay, the volunteers could remember all types of scenarios equally well. One day later, however, the details of negative simulations were much more difficult to recall than the details of positive or neutral simulations.

To ensure that the original memories were not influencing the participants' recall of the future scenarios, the experimenters had a different set of volunteers generate lists of familiar people, places and objects without calling up memories—for instance, using Facebook to find the names of 110 familiar people. Then they did the same imagery and memory tasks as the first group. The results of this second experiment were the same as those of the first.

## Happy Endings

These findings are consistent with what is known about negative memories for actual past events, which also tend to fade more rapidly than positive ones. Szpunar and his colleagues hypothesize that the emotion associated with a future simulation is the glue that binds together the details of the scenario in memory. As the negative emotion dissipates, so, too, does the integrity of the remembered future.

So the negative versions of the future fade away with time, and the positive versions endure—leaving, on balance, an overly rosy vision of what's to come. But that may not be a bad thing. People who suffer from depression and other mood disorders tend to not only ruminate on negative events from the past but also spin out gloomy scenarios for the future. Psychologically healthy adults tend to be unduly optimistic about what lies ahead. It's probably adaptive to occasionally imagine the worst so we can do our best to avoid the things we can avoid—but then let those invited troubles fade away. M

One day later the details of **negative future simulations** were much more difficult to recall.

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

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

## (Further Reading)

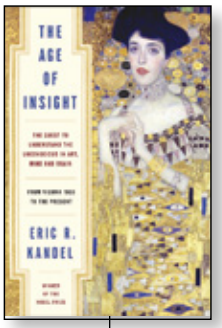
◆ **Memory for Emotional Simulations: Remembering a Rosy Future.** Karl K. Szpunar, Donna Rose Addis and Daniel L. Schacter in *Psychological Science,* Vol. 23, No. 1, pages 24–29; January 2012.

# books

**ARTFUL THINKING**

## The Age of Insight: The Quest to Understand the Unconscious in Art, Mind, and Brain, from Vienna 1900 to the Present

by Eric R. Kandel. Random House, 2012 ($40)




What happens when an obscure interest in early 20th-century Austrian art meets up with an encyclopedic knowledge of brain science? In three words, action potentials fly. Enough neurons were firing to ignite most people's heads when Kandel wrote this ambitious 672-page book about possible ways in which art and modern brain science can enrich and inform each other.

In *The Age of Insight,* Kandel, a neuroscientist and Nobel laureate in medicine, gives us two extraordinary books in one. The first is about five influential geniuses who overlapped to some extent in the early 1900s in Vienna, Austria: visual artists Egon Schiele, Oskar Kokoschka and Gustav Klimt; writer Arthur Schnitzler; and the father of psychoanalysis, Sigmund Freud. Kandel's fascination with this space and time is more than professional; he was born in Vienna in 1929 and forced at age nine to depart from his country with his family because of increasing violence against Jews.

Schiele, Kokoschka and Klimt—together the Austrian expressionists—abandoned realism in art in favor of abstract and often sensual ways of using a canvas to reveal the inner mind of a portrait subject. Schnitzler experimented with stream-of-consciousness writing for the same end, and Freud virtually defined the modern concept of the unconscious and developed techniques for probing it for therapeutic purposes.

What is in effect a separate book—the second half—reviews the recent explosion of research in brain science, bringing us up-to-date on what is currently understood about the neural correlates of vision, memory and creativity and arguing convincingly that a great deal of important brain activity is in fact beyond conscious awareness.

Though astonishing in both depth and breadth, *The Age of Insight* is lacking in one respect: Kandel's unwillingness to criticize the ideas he is presenting or at least to wonder about their validity. He asserts, for example, that artists "intuit" properties of the brain when they use lines or colors in certain ways to evoke particular reactions from viewers, but that contention goes well beyond the facts. It is far more likely that artists simply experiment with the medium, adopting the techniques that produce desired effects and discarding the rest.

Kandel's reluctance to self-criticize is especially unsatisfying when he asks "what and where" consciousness is. He declares that the experience of consciousness is correlated with neural activity in "a vast number of regions distributed throughout the brain." Such activity, he says, "ignites consciousness"—which is what, exactly, and where? Kandel never says.

*The Age of Insight* does not unravel all the mysteries of art or solve all the problems of neuroscience, but it is an amazing ride, at the very least showing you the workings of one of the world's most extraordinary intellects in a frenzy of creative motion. —*Robert Epstein*

**WHEN SPARKS FLY**

## Imagine: How Creativity Works

by Jonah Lehrer. Houghton Mifflin Harcourt, 2012 ($26)


What do *Toy Story II,* Post-It Notes and *West Side Story* have in common? According to Lehrer, they all emerged from a unique combination of context, circumstance and attitude—the stuff of creativity.

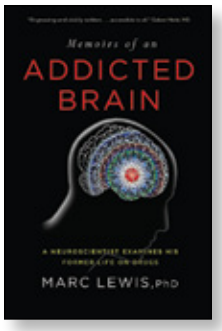
In Lehrer's new book, *Imagine,* the prolific science writer delves into one of the most familiar—and mysterious—capacities of the human mind: the "ability to imagine what has never existed." Through a whirlwind tour of innovative personalities, Lehrer covers various facets of creative thinking: the importance of casual conversations that can lead to unexpected ideas, the value of debate and criticism in challenging our assumptions, and the necessity of focusing our attention on a single task. He introduces us to a Pixar computer animator in Silicon Valley who finds his greatest insights when his ideas are ripped to shreds at daily group meetings and to an autistic surfer whose obsession and comfort with the ocean lets him improvise moves never seen before.

Creativity, as Lehrer describes, is not an individual "gift," a lucky trait that some people are just born with; it comes from a combination of processes. He highlights what spurs creativity on a small scale, noting, for instance, that a small fold of tissue in the brain called the anterior superior temporal gyrus (what he calls the "neural correlate of insight") becomes active seconds before an epiphany. He steadily works all the way up to a large scale, discussing how serendipitous meetings in a sprawling metropolis can spark innovation by exposing us to unfamiliar ideas.

Lehrer also sprinkles in useful tips to feed our own imagination. Feeling stuck? Go for a walk or take a warm bath. According to a British scientist, interruptions are crucial to forming new ideas because the mental break lets your brain turn inward to notice stray thoughts and insights. Or consider painting the walls blue: one study suggests the color can double your creative output by triggering associations with the sky and the ocean. The mental relaxation associated with these natural milieus helps to stimulate our imagination.

The research that Lehrer describes defies conventional wisdom. The traditional form of brainstorming—free association with only positive feedback—might seem productive, but it does not work. Creativity actually thrives on criticism and debate because it forces us to engage with new ideas.

For a book about creativity, Lehrer's approach can often feel formulaic: an anecdote here, some history there, a few scientific studies interspersed. Even so, the book is comprehensive, presenting a clear picture of our current scientific understanding of creativity. By exploring the moving parts of creative genius, Lehrer allows us to see what makes our own imagination tick. —*Lena Groeger*




**DESTRUCTIVE DESIRES**

## Memoirs of an Addicted Brain: A Neuroscientist Examines His Former Life on Drugs

by Marc Lewis. PublicAffairs, 2012 ($26.99)

Why do we crave things and seek them compulsively, despite the consequences? As a junkie who kicked the habit and became a neuroscientist, Lewis is uniquely positioned to answer these questions.

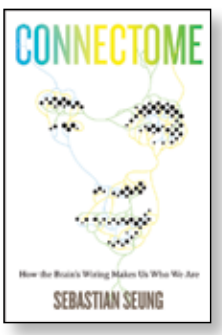
Each chapter of Lewis's memoirs recounts an episode of his life: as a homesick 15-year-old at a prep school in New Jersey, where he got drunk and smoked pot for the first time; then as a Berkeley undergraduate during the hippie heyday of the late 1960s, when he experimented with methamphetamines, LSD and heroin. In the jungles of Malaysia he sniffed nitrous oxide and bought heroin directly from the factory, and in Calcutta he frequented opium dens. Back in his hometown of Toronto, Lewis descended into a life of addiction, desperation and petty crime.

Lewis also weaves in how each drug acts on the brain. LSD, he explains, alters sensory information, so that "perception opens up into this massive cascade of colors, shapes and patterns," whereas heroin produces a dramatic shift in brain physiology to put one "into a state of safety, comfort, warmth [and] pleasure."

The book effortlessly explores the experience of being under their influence. Lewis explains how cycles of anticipation and reward are fundamental to the human condition, drawing parallels between drug addiction and our cravings, such as sex, money or material goods. Drug addiction, however, is far more powerful, as it mercilessly hijacks the brain's reward circuitry, priming us to single-mindedly seek out these chemical rewards at the expense of relationships and work. Lewis eventually climbed out of addiction and returned to school to focus on psychology and neuroscience. "Drawn by a need to understand my own dark years, I came around—full circle—to study the neuroscience of addiction," he writes.

Even after 30 years of being clean, addicts' brains are wired to desire narcotics, leaving them "vulnerable for the rest of their lives." For Lewis, filling his life with a meaningful career and a loving family has helped him resist those temptations. *—Moheb Costandi*

**MENTAL MAPS**




## Connectome: How the Brain's Wiring Makes Us Who We Are

by Sebastian Seung. Houghton Mifflin Harcourt, 2012 ($27)

To truly understand how the human brain works, Massachusetts Institute of Technology computational neuroscientist Seung argues that researchers should focus on what he dubs the connectome—the set of connections among all neurons in the brain.

In *Connectome,* Seung argues that these maps might explain what makes us unique: revealing, for example, why two people react to the same social situation differently or why some individuals are afflicted with, for instance, schizophrenia, but others are spared.

Puzzling out the connectome would allow the fabled frontier of personalized neuroscience to become a reality. Yet with more than 100 billion neurons in the human brain, some say this mapping project is practically impossible.

Seung postulates, however, that recent technological advances have made it doable. Equipped with new devices, scientists may be able to work synapse by synapse to understand how brain wiring can go awry to cause disease and find suitable targets for drug interventions.

First, Seung offers sound explanations of state-of-the-art tools and processes that may allow us to map our connectomes. He then takes liberties, discussing his thought experiments on what might become possible if researchers could tap into personal connectomes. He wonders, for example, whether scientists will be able to reconstruct our experiences in a computer simulation, displaying, for instance, a memory of a loved one's smile.

Although he entertains the "what if" scenarios, Seung remains pragmatic about which milestones are currently possible and which are decades or several hundred years away. Seung is clearly onto something, and he believes the payoff will be worth the wait. *—Brian Mossop*

ISTOCKPHOTO

## Roundup: Strategic Thinking

Three books help us to think more clearly.

Between paying the bills, hitting the gym and managing the family, anyone can succumb to periods of chaos and intense stress. In **Organize Your Mind, Organize Your Life** (Harlequin, 2011), psychiatrist Paul Hammerness and wellness coach Margaret Moore offer six ways in which we can maximize our attention, forge new mental connections and step back to view the big picture.

Paralyzed by choice? In **The Decision Book: Fifty Models for Strategic Thinking** (W. W. Norton, 2012), journalist Mikael Krogerus and management consultant Roman Tschäppeler walk us through the decision-making process, presenting 50 tactics to structure and understand the challenges we face every day, including the Personal Performance Model to test whether you should change jobs and the Black Swan Model to help people cope with surprising events.

Intelligence does not necessarily come naturally—mental acuity must be developed, too. **Smart Thinking: Three Essential Keys to Solve Problems, Innovate, and Get Things Done** (Perigee Trade, 2012) draws on a range of studies to demonstrate the difference between smart thinking and raw intelligence. Author Art Markman, professor of psychology and marketing at the University of Texas at Austin, explains how memory works, how to learn effectively and how to use this knowledge to get things done. *—Victoria Stern*

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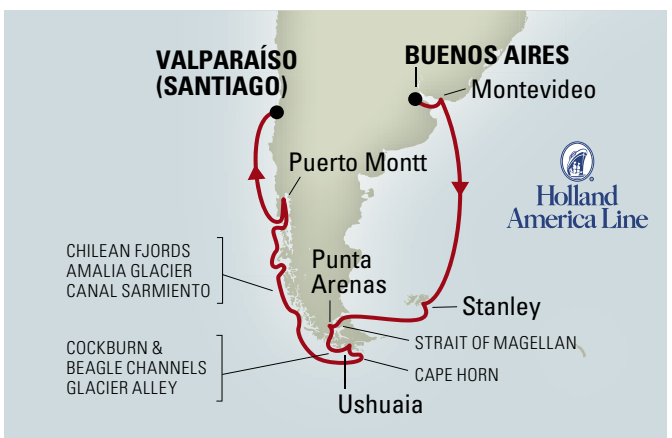





## THE EARTH FROM SPACE

**Gary Lagerloef, Ph.D.**

### Earth From Space: A Dynamic Planet

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

### The Oceans Defined

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

### Climate Science in the Space Age

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

### The Aquarius/SAC-D Satellite Mission

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

## GEOLOGY

**Speaker: Victor A. Ramos, Ph.D.**

### The Patagonia Terrain's Exotic Origins

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

### The Islands of the Scotia Arc

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

### The Andes: A History of Earthquakes and Volcanoes

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

### Darwin in Southern South America

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

## PHYSICS

**Speaker: Lawrence Krauss, Ph.D.**

### The Elusive Neutrino

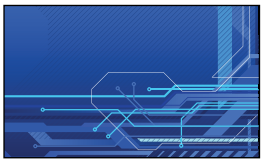
Neutrinos are the most remarkable elementary particles we know about. They are remarkable probes of the Universe, revealing information about everything from exploding stars to the fundamental structure of matter. Dr. Krauss will present a historical review of these elusive and exciting objects, and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

### The Physics of Star Trek

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

### Space Travel: Why Humans Aren't Meant for Space

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



## NANOSCIENCE

**Chris Sorensen, Ph.D.**

### Fire, Fractals and the Divine Proportion

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

### Light Scattering

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

### Nanoparticles: The Technology.

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

### Nanoparticles: The Science.

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

## ASTROBIOLOGY

**Speaker: Seth Shostak, Ph.D.**

### Hunting for Life Beyond Earth

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

### Finding E.T.

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

### What Happens If We Find the Aliens?

One-third of the public believes that aliens are visiting Earth, pirouetting across the skies in their saucers. Few scientists agree, but researchers may soon discover intelligent beings sharing our part of the galaxy. Could we handle the news? What facts could be gleaned

immediately, and what would be the long-term effects such a discovery would have on us and our institutions, such as religion?

### The Entire History of the Universe

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

## SKEPTICISM

**Speaker: Michael Shermer, Ph.D.**

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

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

### Skepticism 101: How to Think Like a Scientist

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

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

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

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

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

# SCIENTIFIC AMERICAN Travel HIGHLIGHTS

## IGUAZU FALLS

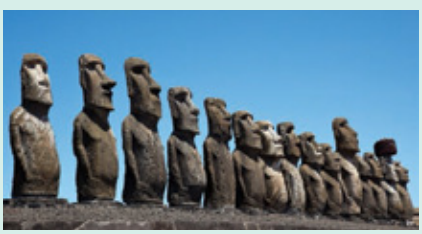
**March 5–7, 2013** — Surround yourself with 260 degrees of 240 foot-high walls of water at Iguazu Falls. Straddling the Argentinian-Brazilian border, Iguazu Falls is split into about 270 discrete falls and at peak flow has a surface area of 1.3 million square feet. (By comparison, Niagara Falls has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

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

## MACHU PICCHU

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

## EASTER ISLAND



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

## GALAPAGOS

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

SCIENTIFIC AMERICAN Travel

# BRIGHT HORIZONS 17

**APRIL 11TH – 25TH, 2013 ✷ ASIA ✷ www.InsightCruises.com/sciam17**

GET THE BIG PICTURE ON ASTRONOMY, GENOMICS, AND MIND-boggling East Asia with Scientific American on Bright Horizons 17. Go deep into cutting edge science while absorbing experiential knowledge of the dynamism and duality of a region on the move. Join us on the Celebrity Millennium April 11–25, 2013 from Hong Kong to Shanghai, visiting ports in China, Taiwan, Japan, and Korea.

Look into the big picture of geospatial imaging with Dr. Murray Felsher. Peer into the past and future of telescopic space exploration with Dr. Stephen Maran. Hear a forecast on genomic technologies, next generation science and medicine with Professor John Mattick. Map the potential research directions whole-genome sequences facilitate with Dr. Mohamed Noor. Update your knowledge of galaxy evolution with Dr. Elaine Sadler.

The peoples and cultures of Asia have drawn curious travelers and admirers for ages. Enjoy the beauty, ponder the issues, absorb the energy, trace the history, and observe the traditions while Bright Horizons takes care of the details. We've created pre-, mid-, and post-cruise optional excursions to enrich your adventure.

Gain new perspectives and expand your horizons on Bright Horizons 17. If you've dreamed of the Hong Kong skyline, the bustle of Japan's cities, and the ancient culture of China, this is the time to see it in comfort, with ease. If you've wondered what's next in astronomy and evolutionary biology, Bright Horizons' experts are ready with facts and concepts. Please join us!

Cruise prices start at $1,299, per person, based on double occupancy. For those attending our seminars, there is a $1,575 fee. Port charges are $345. Government taxes and fees total $195 per person. Gratuities are approximately $195 per person. Program subject to change. For more info please call 650-787-5665 or email us at **Concierge@InsightCruises.com**


## MOLECULAR BIOLOGY

**Speaker: John Mattick, Ph.D.**

### The History of Molecular Biology and the New Age of Medicine

The 20th century was dominated by nuclear physics, organic chemistry, electronics and computing. It also saw the birth of molecular biology, which came of age with the 2001 sequencing of the human genome, at a cost of $3 million. Today we can sequence a human genome for just $3,000, and the price is dropping quickly. Come hear about the events leading up to the founding of molecular biology and the human genome project and how genomics is set to revolutionize society, medicine, and your health future.

### The Programming of Human Development

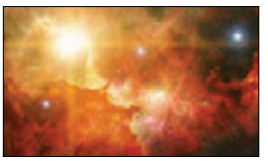
The human genome is a marvel. It is a zip file containing 3 billion letters (equivalent to 6 gigabytes) that programs the development of an organism with 100 trillion cells arranged into a myriad of muscles, bones, and organs. Less than 2% of the human genome encodes proteins, with most of the rest thought to be junk because it does not fit the conventional concept of a gene. Find out how molecular biology now understands the structure of human genetic programming.

### The Evolution and Molecular Basis of Human Cognition

Life has existed on Earth for around 4 billion years, mostly in microbial form. It was not until the last billion years that developmentally complex organisms began to evolve, culminating 500 million years ago in the so-called 'Cambrian explosion,' when ancestors of all animal phyla appeared. While plants and animals diversified, information processing capacity evolved which ultimately led to the rise of human intelligence and cognition. Come hear about the developments which led to the evolution of intelligence in the primates.

### Epigenetic Inheritance

For decades it has been an article of faith in evolutionary biology that mutation is random and that sperm and ova are immune from environmental influence. However, recent evidence suggests that the processes that control our development can be influenced by experience and that experience can be transmitted between generations. Learn how we may be the product of both our ancestors' genes and their experiences, and how the new field of 'epigenetics' is influencing ideas of health and health policy.



## COSMOLOGY

**Speaker: Elaine Sadler, Ph.D.**

### The Lives of Galaxies

How did galaxies like our own Milky Way begin? Why do galaxies look the way they do, and how do they change over cosmic time? Learn the latest ideas and findings on both nearby and distant galaxies as well as how our understanding of galaxies as 'cosmic ecosystems' has progressed rapidly in recent years.

### Secrets of the Invisible Universe

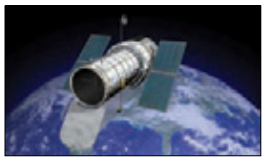
Modern telescopes allow us to study the universe at radio, X-ray and gamma-ray wavelengths which are invisible to the human eye. They reveal an energetic and sometimes violent universe populated by supermassive black holes, exploding stars and other exotic cosmic phenomena. Come discover some of the many secrets of the invisible universe.

### Astronomy in Australia

Astronomy is seen as a flagship of Australian science. Find out why in a short history of Australian astronomy from the Dreamtime to the present day. You'll learn about some of the main astronomical observatories and instruments in Australia, including those currently under construction as pathfinders for the international Square Kilometre Array (SKA) radio telescope.

### Serendipity and Discovery in Modern Astronomy

All scientists hope to make discoveries which change our view of the world, and the past 100 years have seen immense shifts in our understanding of the Universe we live in. So how is progress really made? We will discuss some Nobel-prizewinning discoveries, the search for exoplanets, the role of serendipity in astronomical discovery, the contributions of amateur astronomers and the rise of 'citizen science'.



## PLANETARY SCIENCE

**Speaker: Stephen P. Maran, Ph.D.**

### Galileo To Hubble and Beyond

How do Galileo's mind-blowing first telescopic discoveries contrast with current knowledge of the same celestial phenomena, examined with 21st century telescopes and space probes? Both Galileo and Hubble Space Telescope focus on centers of revolution, moons, planets, and rings, and galaxies. Find out how 17th and 21st century optical astronomy compare and relate.

### Mystery Forces in the Solar System

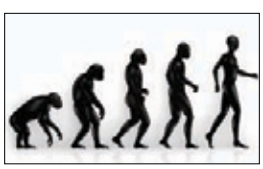
Astronomers have investigated puzzles and discrepancies noted in the paths of moving bodies, and discovered previously unknown celestial objects and astrophysical phenomena. While each mystery solved is just a footnote in space discovery, together they demonstrate the unforeseen benefits of scientific exploration. Get the details with Stephen Maran.

### Through Time and Space with the Hubble Space Telescope

What is the significance of the Hubble Space Telescope? Join Dr. Maran for a look at the whats and hows, highs and lows of the Hubble Space Telescope. The epic story spans vision, disaster, innovation, and outstanding discovery, much of which was unforeseen when the Hubble project began. Listen in on missions accomplished and new beginnings afoot.

### Exoplanets and Life in Space

My, how things have changed! For years astronomers largely denied the existence of exoplanets. Now astronomers find planets wherever they look. Explore the stunning contributions of NASA's planet-hunting Kepler mission to the search for exoplanets and Goldilocks zones where life could exist. Join the discussion about the possibilities and implications.



## 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? Evolution affects your everyday life, from your health to your livelihood, and this class will help you learn why!

### Sexual Selection — Trials and Tribulations of Picking a Mate

Darwin recognized the importance of "sexual selection" in causing elaborate displays and differences between species. Recent work, however, shows that adaptations to get more matings or offspring sometimes causes harm to the other sex, and results in "arms races" between males and females. Come hear and see some interesting case studies on the trials and tribulations of picking (or resisting) a mate.

### Molecular Adaptation

While we know some traits are "adaptive," like giraffe's necks or "bad" like genetic diseases, what is the genetic basis of these traits and what evolutionary forces affect them? With the growth of genetic mapping and the emergence of extensive genome sequencing, we have far more case studies of "molecular adaptation" than ever in the past. We will explore classic and recent advances in the study of molecular adaptation.

### The Wonder of Recombination

Geneticists often describe "mutations" as the ultimate source of all genetic variation. However, genetic recombination is fundamentally important in all realms of genetics and evolution— ranging from the evolution of sex to the formation of new species to generating variation on which natural selection can act. Come learn some of the evolutionary wonder associated with this basic genetic process.

## GEOSPATIAL IMAGING

**Speaker: Murray Felsher, Ph.D.**

### Observing a Changing World

Geospatial imaging uses an array of remote sensing technologies to image the Earth from Space. Gain a basic understanding of how sensor technology now aboard earth-orbiting spacecraft provides data and information about planet Earth. Join Dr. Felsher in a program which will test your assumptions, expand your horizons, and pique your curiosity.

Topics include:

- Natural disaster monitoring, assessment, and mitigation: flood plain inundation, tsunami, earthquakes, and volcanic eruptions
- Renewable and non-renewable resource mapping: crop identification and yield, precision agriculture, and petroleum and mineral exploration
- Environmental applications: desertification and deforestation and oil spills
- Science applications: meteorology, oceanography, and hydrology
- Policy and political considerations: land use planning, coastal zone management
- Homeland defense and security implications
- "The View From Space: Planet Earth as an Artist's Palette", a look at terrestrial images from an aesthetic perspective

# SCIENTIFIC AMERICAN Travel HIGHLIGHTS

## GUILIN, HONG KONG, AND MACAU

**Pre-Cruise: April 8–12** — While locals assert that Guilin's mountain and water scenery is "best under heaven" any visitor can agree that the region's otherworldly beauty is among the most picturesque anywhere. Soak in Guilin's vistas, then contrast it with the bustle and urban delights of Hong Kong, China's longtime interface with the Western world.

Trip Includes: • Visits to Guilin Village, Barrier Gate, A-Ma Temple, and St. Paul's Cathedral • 3 nights accommodation in outstanding hotels (Shangri-la Hotel in Guilin, Ritz Carlton Hotel in Hong Kong) • Services of a Western bilingual China Host and local tour guides • All land transportation (as listed on the itinerary) • Entrance fees to all tourist sites (as listed on the itinerary)

## BEIJING

**Mid-Cruise: April 20–22**—Simply put, Imperial Tours has made a connoisseur's visit to Beijing possible. Extraordinary access to behind the scenes, extraordinary experiences, and extraordinary memories await you.

Trip Includes: • Visits to the Great Wall, Tian'anmen Square, the Forbidden Palace, and the Summer Palace • 2 nights accommodation in an outstanding five star hotel (China World Summit Wing) • Services of a Western bilingual China Host and local tour guides • All land transportation (as listed on the itinerary) • Entrance fees to all tourist sites (as listed on the itinerary)

## SHANGHAI & XI'AN

**Post-Cruise: April 25–28** — Tap into 2,300 years of China's vitality, continuity, and beauty. From Shanghai's dynamism to Xi'an's Silk Road heritage and incomparable terra cotta warriors, you'll sense China's rich, complex history.

Trip Includes: • Visits to Yu Garden, Terracotta Warriors, and the Great Mosque in Xi'an • 3 nights accommodation in outstanding five star hotels (Peninsula Hotel Shanghai and Hilton Xi'an) • Services of a Western bilingual China Host and local tour guides • All land transportation (as listed on the itinerary) • Entrance fees to all tourist sites (as listed on the itinerary)

# askthe**Brains**

## Is it true that left-handed people are smarter than right-handed people?

—**Matthew Robison,** Concord, N.H.

**Chris McManus,** *professor of psychology and medical education at University College London, responds:*

IF BY INTELLIGENT you mean someone who performs better on IQ tests, the simple answer is no. Studies in the U.K., U.S. and Australia have revealed that left-handed people differ from right-handers by only one IQ point, which is not noteworthy.

Left-handedness is, however, much more common among individuals with severe learning difficulties, such as mental retardation. A slightly higher proportion of left-handers have dyslexia or a stutter. Other problems, such as a higher rate of accidents reported in left-handers, mostly result from a world designed for the convenience of right-handers, with many tools not made for left-handed use. Although some people claim that a higher percentage of left-handers are exceptionally bright, large research studies do not support this idea.

If by smarter you mean more talented in certain areas, left-handers may have an advantage. Left-handers' brains are structured differently from right-handers' in ways that can allow them to process language, spatial relations and emotions in more diverse and potentially creative ways. Also, a slightly larger number of left-handers than right-handers are especially gifted in music and math. A study of musicians in professional orchestras found a significantly greater proportion of talented left-handers, even among those who played instruments that seem designed for right-handers, such as violins. Similarly, studies of adolescents who took tests to assess mathematical giftedness found many more left-handers in the population. The fact that mathematicians are often musical may not be a coincidence.

Left-handed people differ from right-handers by only one IQ point, which is not noteworthy.

For other talents and skills, the benefits of being left-handed are less clear. In one-on-one competitive sports, being in the minority can be a tactical advantage. For instance, most right-handed tennis players have little experience playing left-handers, whereas left-handers have plenty of experience playing right-handers. Sports arenas can also be asymmetric, which may give left-handers an advantage. In baseball, for instance, a left-handed hitter is closer to first base after striking the ball than a right-handed batter is.

Whatever the advantages, handedness seems to be genetic. With 10 percent of people preferring their left hand, there must be some selective advantage, or else the genes would probably not survive.

## How do painkillers buffer against social rejection?

—**Lauren Sippel,** State College, Pa.

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

WE OFTEN feel rejected when faced with the popular clique at school or the office bully. Learning to protect yourself against such social assaults can prove quite difficult, but new research shows a common painkiller may reduce the impact of these upsetting interactions.

A recent study published in the journal *Psychological Science* suggests that acetaminophen, the active ingredient in Tylenol, may buffer against social pain. The lead investigator, psychologist C. Nathan DeWall of the University of Kentucky, hypothesized that the neural overlap between physical and emotional pain might enable a drug designed to alleviate physical pain to cushion emotional pain.

In one experiment, DeWall and his team examined 62 healthy volunteers who took 1,000 milligrams of either acetaminophen or a placebo daily for three weeks. In the evening the participants described to what extent they experienced social disappointment or felt upset during the day using a version of the Hurt Feelings Scale, a social pain measurement tool. Participants who took acetaminophen reported fewer hurt feelings and more resilience to social pain than the subjects receiving the placebo.

In a second experiment, the investigators looked at 25 healthy volunteers who ingested 2,000 milligrams of either acetaminophen or a placebo every day over the course of three weeks. During the investigation, subjects played a computer game geared to evoke feelings of social rejection while lying in a functional MRI machine. The resulting brain scans revealed that the participants who received the drug exhibited reduced neural responses to social rejection in brain regions associated with interpreting emotional and physical pain. In contrast, the regions associated with physical pain became more active in the placebo subjects when they were rebuffed in the video game. Overall, these results indicate that acetaminophen may decrease self-reported social pain over time.

Thus, the next time you are taking cold medication, monitor how you feel in social settings and at work. You might be pleasantly surprised by how easily things roll off your back. M

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

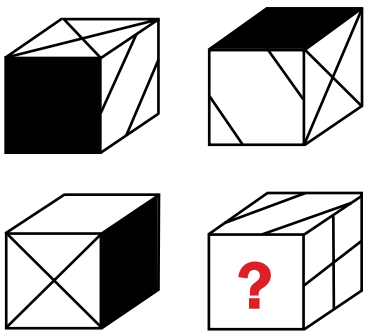
JAMIE CARROLL *iStockphoto*

# Head Games

Match wits with the Mensa puzzlers

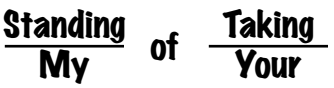
## 1 VISUALIZE IT

The following drawings show the same cube from different vantage points. What design is on the blank face in the image at the lower right?




## 2 WORD PICTURE

What phrase does the diagram below represent?




## 3 NICKELED AND DIMED

The Young Investors' Club membership dues get more expensive every year. The second year, membership costs $2 more than the first, the third year costs $3 more than the second, and so on. If four years of dues amount to $96 total, how much is the initial membership fee for the first year?

## 4 A BINDING BOND

A contractor made a deal with a very cranky employer. Per the arrangement, he got $60 for each day of work (including weekends), but he had to pay $20 for every day that he did not show up. At the end of 60 days he had earned $1,440. How many days had he worked?

## 5 MGRN

The following scrambled words were originally 12 letters long, but a certain letter has been removed from all of them. What are the words?

**CCNILHBN BMSSDRSSE YRMIILPRT CPPNREREE NNMMOOICL**

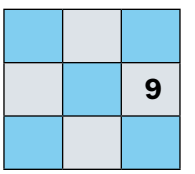
## 6 CRYPTOGRAM

Solve this cryptogram by breaking the code, in which each number stands for a letter. Hint: You may need HELP!

**1 2 3 4 5 1 12 20 12 20 18 21 12 5 2 1 6 19 9**

## 7 MAGIC SQUARE

Fill in the grid with the numbers 1 to 9, using each number only once, so that every line (across, down, and diagonal from corner to corner) adds up to 15. We got you started by placing the 9.

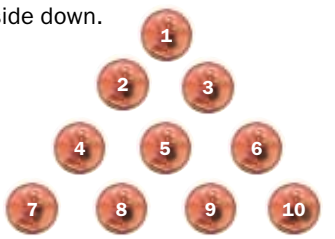



## 8 SPEND BIG TO WIN BIG

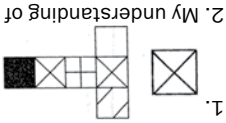
There is a bowl in the local grocery store that contains 15 losing tickets, 10 $1-prize tickets and five $10-prize tickets. If each pick costs $1, how much would you have to spend to guarantee that you would get one of the $10 prizes? And how much more would you have to spend to guarantee that you would come out ahead?

## 9 FLIP IT

Below is a pyramid of 10 coins. Move only three coins to turn the pyramid upside down.




## Answers

1. 

2. My understanding of your undertaking.

3. $20.

4. 33 days.

5. BACCHANALIAN, AMBASSADRESS, PARAMILITARY, REAPPEARANCE, MONOMANIACAL.

6. HELP THIS IS QUITE HARD
The code is set up as follows:

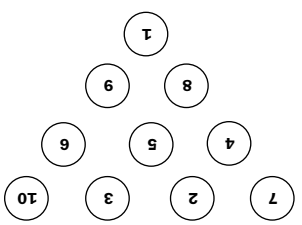
| H | E | L | P | | T | H | I | S |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | | | | | 5 |

The first letters of the sentence are numbered from 1 to 5, and the alphabet is numbered in order thereafter (A = 6, B = 7, and so on), omitting the letters that already have numbers (H, E, L, P and T).

7. Here is one possibility:

| | | |
|---|---|---|
| 8 | 3 | 4 |
| 1 | 5 | 9 |
| 6 | 7 | 2 |

8. $26 to guarantee you will get a $10 ticket (the first 25 could be the 15 losing tickets and the 10 $1 prizes), and only one more dollar ($27 total) to guarantee at least a $3 profit.

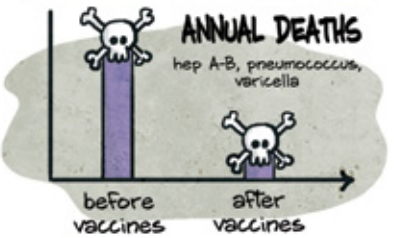
9. 

# HERD THINKING

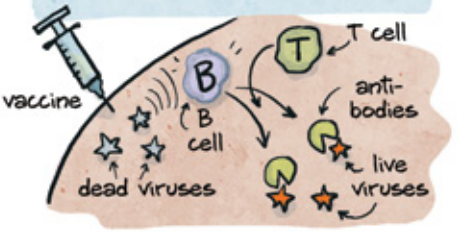
BY DWAYNE GODWIN AND JORGE CHAM

MILLIONS OF KIDS EACH YEAR GET IMMUNIZED TO PROTECT AGAINST DISEASE.


SMALLPOX, WHICH KILLED MILLIONS, IS NOW ERADICATED FROM NATURE.




VACCINES INTRODUCE INACTIVE VIRUSES OR BACTERIA THAT STIMULATE B AND T IMMUNE CELLS TO PRODUCE ANTIBODIES, WHICH FIGHT THE DISEASE.

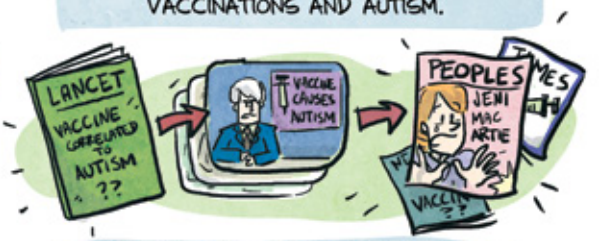



VACCINATIONS PRODUCE "HERD IMMUNITY" WHEN ENOUGH PEOPLE ARE VACCINATED:

IF ONLY A FEW ARE IMMUNIZED, THE DISEASE SPREADS EASILY.

BUT WITH ENOUGH VACCINATIONS, THE DISEASE IS CONTAINED.

IN 1998 A PAPER IN A MAJOR MEDICAL JOURNAL PROPOSED A LINK BETWEEN MMR (MEASLES, MUMPS AND RUBELLA) VACCINATIONS AND AUTISM.




THE POPULAR PRESS (AND CERTAIN CELEBRITIES) FUELED ANXIETY ABOUT VACCINATIONS BASED ON THIS REPORT.

AUTISM IS A COMPLEX NEUROBEHAVIORAL DISORDER THAT OCCURS WITH A SPECTRUM OF SYMPTOMS.


A RISE IN INCIDENCE MAY HAVE MORE TO DO WITH CHANGING DIAGNOSTIC STANDARDS THAN OTHER FACTORS.

IN FACT, FURTHER STUDIES HAVE FAILED TO FIND ANY CONNECTIONS BETWEEN AUTISM AND VACCINES.


AND THE ORIGINAL PAPER HAS BEEN RETRACTED AMID ALLEGATIONS OF FRAUD AND CONFLICTS OF INTEREST.

YET CELEBRITIES ARE SO INFLUENTIAL THAT MORE THAN HALF OF AMERICANS STILL SUSPECT THERE'S A LINK.


THE CONSEQUENCES ARE SERIOUS: IN IRELAND, VACCINATIONS DROPPED ABOUT 30%, RESULTING IN OUTBREAKS OF MEASLES AND MUMPS THAT INCLUDED 3 DEATHS.

BETTER A SORE BOTTOM THAN A DEADLY BOTTOM LINE?

*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.*

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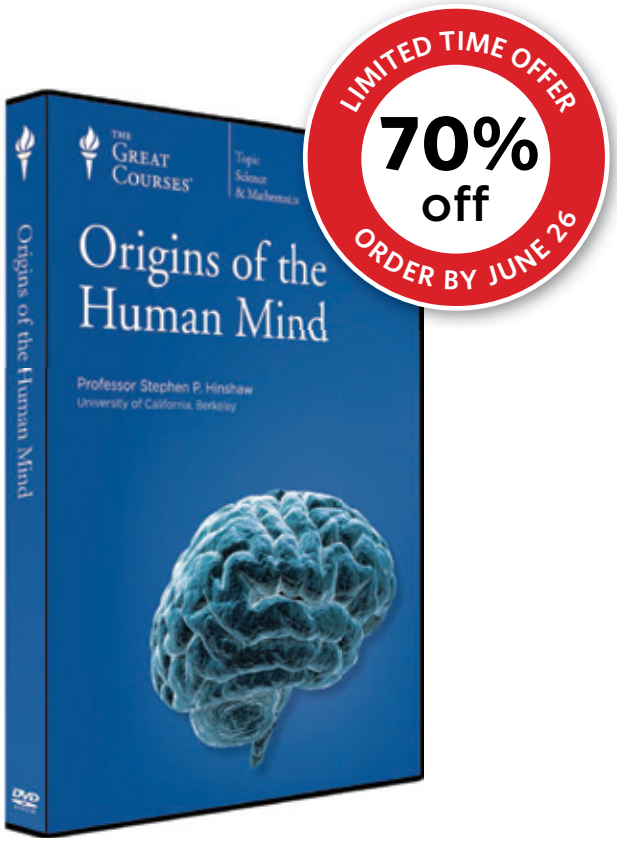


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