A NATION ON DRUGS? THE ANTIDEPRESSANT BOOM (*page 44*)

SCIENTIFIC AMERICAN
MIND
BEHAVIOR • BRAIN SCIENCE • INSIGHTS

February/March 2008 www.SciAmMind.com

Moral Mind
Reason vs. Emotion
page 30

Why We Kiss
Secrets that lips reveal

PLUS:
Easing a Fear of Flying
And: Surviving the Baby Blues

The Time Machine
Inside Your Head

The Corporate Psychology of
Good and Evil

Bounce with Life's Bumps:
Roots of Resilience

Page Intentionally Blank

SCIENTIFIC AMERICAN
MIND
BEHAVIOR · BRAIN SCIENCE · INSIGHTS

HOW TO CONTACT US

FOR GENERAL INQUIRIES OR TO SEND A LETTER TO THE EDITOR:
Scientific American Mind
415 Madison Avenue
New York, NY 10017-1111
212-451-8200
editors@SciAmMind.com

COVER IMAGE BY AARON GOODMAN

Kiss and Tell

They had known each other since eighth grade, sharing the silly private jokes that only longtime pals know. Later, they lost touch for a couple of years, when they went to different colleges. But in their senior year the friends—now a young man and woman—became inseparable whenever they were home visiting their families. One evening just after graduation, when he dropped her off at her house in his old green pickup truck, he leaned over and kissed her. He found himself speechless for long moments afterward. She felt a shivery thrill as everything about their comfortable old relationship suddenly seemed to change. A month later he would propose.

My old friend and I have now been married for 18 years, but I remember that moment with crystal clarity. As Chip Walter's feature article, "Affairs of the Lips," explains, a smooch can communicate in powerful ways that spoken language does not easily match. "Kisses," Walter writes, "can convey important information about the status and future of a relationship." A bad first kiss, too, can bring an otherwise promising beginning to a quick close. Turn to page 24.

Too much emotion can cloud judgment, particularly when matters turn from deciding about personal attachments to coping with challenging moral questions. Imagine that a runaway trolley will strike five unsuspecting workers around a bend in the tracks ahead. Could you push a stranger in front of the trolley to save the workers? Cold logic might dictate trading one life for five—but would that be "right"? In "When Morality Is Hard to Like," starting on page 30, Jorge Moll and Ricardo de Oliveira-Souza discuss the cognition of morality.

Having a solid relationship or knowing you made the best decision in a bad spot cannot completely shield you from life's stresses. As Turhan Canli writes in "The Character Code," beginning on page 52, understanding an "anxiety gene" could ease suffering for those with mood disorders—and give us yet another important clue about the whys behind our shared human experience.

Mariette DiChristina
Executive Editor
editors@SciAmMind.com

SCIENTIFIC AMERICAN MIND
Volume 19, Number 1, February/March 2008

FEATURES

DEPARTMENTS

Scientific American Mind (ISSN 1555-2284), Volume 19, Number 1, February/March 2008, published bimonthly by Scientific American, Inc., 415 Madison Avenue, New York, NY 10017-1111.

Periodicals postage paid at New York, NY, and additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; QST No. Q1015332537. Publication Mail Agreement #40012504. Canada Post: Return undeliverables to 2835 Kew Dr., Windsor, ON N8T 3B7. Subscription rates: one year (six issues), $19.95; elsewhere, $30 USD. Postmaster: Send address changes to Scientific American Mind, 415 Madison Avenue, New York, NY 10017-1111. To purchase additional quantities: U.S., $10.95 each; elsewhere, $13.95 each. Send payment to SA Mind, PO Box 4002812, Des Moines, IA 50340. **For subscription inquiries, call (888) 262-5144. To purchase back issues, call (800) 925-0788.** Printed in U.S.A.

SCIENTIFIC AMERICAN
MIND
BEHAVIOR • BRAIN SCIENCE • INSIGHTS

VICE PRESIDENT AND PUBLISHER: Bruce Brandfon
SALES DEVELOPMENT MANAGER: David Tirpack
SALES REPRESENTATIVES: Jeffrey Crennan, Stephen Dudley, Stan Schmidt

ASSOCIATE PUBLISHER, STRATEGIC PLANNING: Laura Salant
PROMOTION MANAGER: Diane Schube
RESEARCH MANAGER: Aida Dadurian
PROMOTION DESIGN MANAGER: Nancy Mongelli

GENERAL MANAGER: Michael Florek
BUSINESS MANAGER: Marie Maher
MANAGER, ADVERTISING ACCOUNTING AND COORDINATION: Constance Holmes

ASSOCIATE PUBLISHER, CIRCULATION: Simon Aronin
CIRCULATION DIRECTOR: Christian Dorbandt
RENEWALS MANAGER: Karen Singer
FULFILLMENT AND DISTRIBUTION MANAGER: Rosa Davis

MANAGING DIRECTOR AND VICE PRESIDENT, ONLINE: Mina C. Lux
ASSOCIATE PUBLISHER, ONLINE: Paul Rothkopf
DIRECTOR, WEB TECHNOLOGIES, ONLINE: Vincent Ma
SALES REPRESENTATIVE, ONLINE: Gary Bronson

DIRECTOR, ANCILLARY PRODUCTS: Diane McGarvey
PERMISSIONS MANAGER: Linda Hertz

CHAIRMAN: Brian Napack
PRESIDENT: Steven Yee
VICE PRESIDENT AND MANAGING DIRECTOR, INTERNATIONAL: Dean Sanderson
VICE PRESIDENT: Frances Newburg
CHAIRMAN EMERITUS: John J. Hanley

HOW TO CONTACT US

FOR ADVERTISING INQUIRIES:

Scientific American Mind
415 Madison Avenue
New York, NY 10017-1111
212-451-8893
FAX: 212-754-1138

FOR SUBSCRIPTION INQUIRIES:

U.S. and Canada: 888-262-5144
Outside North America:
Scientific American Mind
PO Box 5715, Harlan, IA 51593
515-248-7684
www.SciAmMind.com

TO ORDER REPRINTS:

Reprint Department
Scientific American Mind
415 Madison Avenue
New York, NY 10017-1111
212-451-8877
FAX: 212-451-8252
reprints@SciAm.com

FOR PERMISSION TO COPY OR REUSE MATERIAL FROM SCIAMMIND:

Permissions Department
Scientific American Mind
415 Madison Avenue
New York, NY 10017-1111
212-451-8546
www.SciAm.com/permissions
Please allow three to six weeks for processing.

GOD MOLECULES

David Biello's "Searching for God in the Brain" discusses the neural circuitry involved in religious experience. Based on my team's research, I believe that the body's naturally occurring hallucinogenic molecules are a more fundamental cause of spiritual experience—whether that experience is self-willed or brought about by external means. The powerful hallucinogen DMT has been found in human blood, lung and brain. Clinical research we performed in the 1990s with DMT, which also occurs naturally in many plants, led us to propose a role for the brain-based compound in mystical states. The human body's hallucinogens may also contribute to other cognitive effects, such as psychosis.

Rick Strassman
University of New Mexico

FAIRLY UNBALANCED

As a person who has lived with recovered memories for 17 years, I was initially interested in but ultimately disappointed by "Brain Stains," by Kelly Lambert and Scott O. Lilienfeld.

The article lacks the perspective of an individual who has seriously considered the possibility of false memories but come to the conclusion that his or her own are not fabrications. Instead the authors quote research that is highly questionable—particularly the findings that showed that 100 percent of patients reported torture or mutilation and estrangement from extended families. From my own experience and from what I have heard from others, it is evident that the sampling was biased and does not accurately reflect all recovered memories.

Irresponsible therapists may create false memories, causing serious harm. This issue clearly needs to be addressed. But let us not determine, therefore, that there are no true recovered memories.

Eve Richardson
Toronto

I am writing to express my dismay at what I consider to be very biased writing in "Brain Stains." The 1990s saw a huge push by some to debunk the diagnosis of dissociative identity disorder (DID) and the clinicians who treated DID patients. In response to that effort, many professionals endeavored to address the issues from a more balanced middle ground. Among other results from that decade was the book *Memory, Trauma Treatment, and the Law,* by Daniel Brown, Alan W. Scheflin and D. Corydon Hammond (W. W. Norton, 1998). Lambert and Lilienfeld would have benefited by taking advantage of the authors' well-balanced presentation of the issue.

Instead your magazine has promulgated an inflammatory, biased presentation of traumatic memory therapy. I ask that you invite the response of other authors whose stance is seen as more balanced by mental health professionals such as myself.

Paul W. Schenk
Tucker, Ga.

LAMBERT AND LILIENFELD REPLY: *Richardson and Schenk raise several intriguing issues but confuse the question of whether some recovered memories may be genuine (which was not the focus of our article and remains scientifically unresolved) with the question of whether suggestive therapeutic procedures can induce false memories and false identities in certain clients (which*

was the focus of our article and should, in our view, no longer be in scientific dispute). Moreover, in scientific terms, "balance" does not imply that the truth invariably lies between two extremes—the fact that some people believe the earth is round and others believe it is flat does not imply that the earth is oblong. Indeed, Harvard University psychologist Richard J. McNally and others who have carefully investigated widespread claims for the existence of recovered memories have found most of these claims wanting. Knowing that recovered memory therapies are potentially devastating, as in Sheri J. Storm's case, it is incumbent on mental professionals to exercise extreme caution.

CONTRADICTING ADVICE

I was confused by your October/November issue. In Nikolas Westerhoff's article "Fantasy Therapy" I read that psychologists "treated male disaster workers traumatized by the World Trade Center attacks of September 11 by exposing them to realistic renditions of planes flying over virtual twin towers...." But then in "Brain Stains" I read, "For example, research ... has shown that reliving traumatic memories shortly after a terrifying event—performed in a popular therapeutic technique called crisis debriefing—may cause unnecessary stress and impede recovery."

Are some traumas so damaging that once they have occurred there is not much therapy can do?

Chuck Kollars
Ipswich, Mass.

LAMBERT AND LILIENFELD REPLY: *Regarding the question of when, if ever, therapeutic exposure to traumatic experiences is helpful, both learning theory and scientific evidence offer guidance. Exposure can be helpful, but only when it is sufficiently prolonged to permit clients' anxiety to dissipate. One of the key shortcomings of crisis debriefing is that it is typically conducted in an uncontrolled fashion—some clients may leave sessions less anxious than when they entered, whereas others may leave sessions more anxious. For the latter individuals, crisis debriefing may be harmful.*

MOOD MEDS VS. PLACEBOS

"The Best Medicine?" [Facts and Fictions in Mental Health], by Hal Arkowitz and Scott O. Lilienfeld, is a valuable article on the advantages of cognitive-behavior therapy over antidepressants. But the authors err in repeating the highly inflated claim of 67 percent effectiveness for antidepressants in the study by psychiatrist A. John Rush and his colleagues, which offered patients a four-step sequence of different antidepressant medications. If patients did not attain remission at one stage, they could then try a different antidepressant.

It is important to note that this study included no placebo control groups. Published studies that do include such controls typically find a 25 to 30 percent success rate with placebo. Only one drug in Rush's study achieved even that rate of remission—all other drugs and drug combinations did worse. Rush's 67 percent figure came from cumulating across trials without taking into account the placebo effects operating within each trial.

Moreover, supporting the explanation that antidepressants provide primarily a placebo effect, patients showed very high relapse rates consistent with the time-limited value of placebos.

The widely quoted 67 percent figure is bogus. I am the second author of an article soon to be submitted for publication that provides a critique of this study, citing the placebo problem as well as other issues.

Allan M. Leventhal
Silver Spring, Md.

Could some recovered memories be genuine?

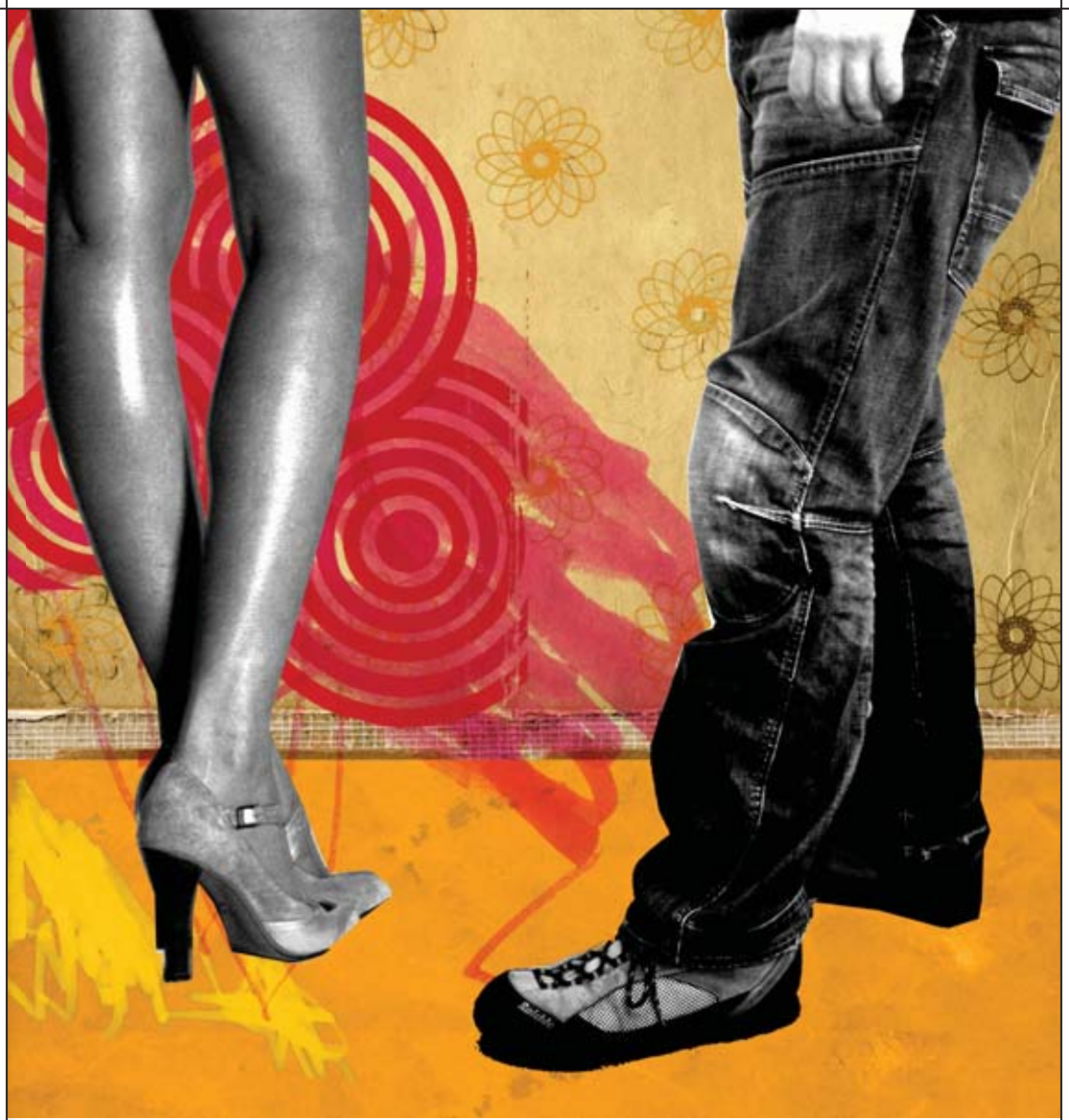
ARKOWITZ AND LILIENFELD REPLY: *Leventhal raises two different but related questions about Rush's study. The first is, How effective was the treatment sequence used in this study (regardless of what was responsible for its effectiveness)? We disagree that the 67 percent finding is "bogus." Irrespective of what caused this outcome (active medication or placebo effect), it is true that 67 percent of the patients were in remission by the end of the study.*

The second question relates to the degree to which the outcomes could be attributed purely to the active effects of the medications. Leventhal correctly points out that the absence of placebo control groups in the study makes it unclear whether the outcomes were the result of the drugs or placebo factors such as expectations of change and supportive contact with the research staff. This issue becomes even more significant in light of the fact that most studies comparing antidepressants with placebos usually show only a small advantage for the medications.

We thank Leventhal for clarifying an important issue. As he correctly notes, it is likely that the contribution of medications to the outcomes was considerably less than the widely reported 67 percent remission statistic would indicate.

SHERI J. STORM

Head Lines



MICHELLE THOMPSON

>> SEXUALITY

C'mere, Big Boy

Studies suggest that ovulating women experience a human version of "heat"

Most female mammals go into some form of estrus, or heat, when fertile, displaying hormone-induced behavioral changes that mark ovulation. Scientists used to think that humans were the exception, but evidence is mounting that women may undergo their own, albeit subtler, period of heat.

A number of recent studies have shown that ovulating women appear—and even smell—more attractive to men. And a recent University of New Mexico study found that female strippers earn up to twice as much tip money during their most fertile period as compared with other times.

But Meghan P. Provost, a psychologist at Mount Saint Vincent University in Halifax, says that women in heat are not interested in just any man. Research suggests that ovulating women favor men who have more masculine qualities, such as a strong jawline. And Provost recently published work showing that women's walks appeared sexier to men when they were not in the fertile phase of their cycle. Provost says that one explanation for this surprising result is that the attractive cues women give off when fertile are intended for people they choose to interact with, whereas walking is more public.

Psychologist Geoffrey Miller, who led the New Mexico study, notes that this pickiness does not make us so different from our caterwauling primate relatives. "It's a common misconception that females are always promiscuous during heat," Miller says. "In most species females are being very choosy."

—Katherine Leitzell

>> BEHAVIOR

'Til Death Do Us Part

Monogamous monkeys reveal the brain circuits of pair bonding

When it comes to studying love, prairie voles, with their strong pair bonds, are the laboratory stars. Now researchers at the University of California, Davis, have established a primate model of monogamy they believe will be more relevant for uncovering the basis of human affection.

The researchers used PET scans to examine brain activity in male titis, small South American monkeys that form strong relationships with their mates. They discovered that lone, unpaired male titis had strikingly different patterns of brain activity than males in long-term, monogamous

partnerships did. These differences were primarily found in two brain circuits: one that is involved in reward processing and another that plays a part in social recognition. These circuits appear to be necessary for pair bonding, lead researcher Karen L. Bales says. And although the regions are also implicated in rodent models of monogamy, she believes titi monkeys will ultimately be more useful for studying human bonding and social disorders, such as autism.

The scientists also studied the brains of lone males who had recently been introduced to new mates. Although the average of the monkeys' brain activity was somewhere in between that of unpaired males and that of those in long-term partnerships, testing showed tremendous individual variation in both behavior and brain activity. "I think we can all identify with that as humans," Bales says. "It's not always love at first sight."

—Emily Anthes

The most smitten women reported having orgasms more easily and of higher quality.

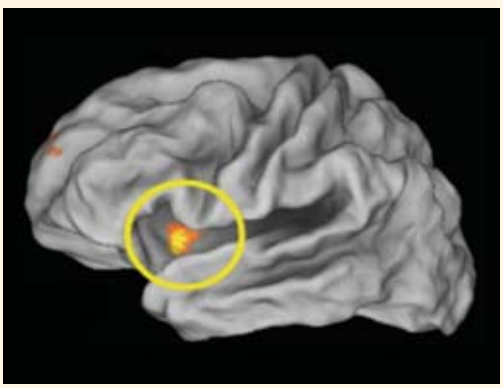
>> IMAGING

Sex Is Better for Women in Love

Reward areas in the brain are tied to orgasm quality

Women certainly know when they experience one, but science, on the other hand, knows surprisingly little about the female orgasm. Most studies have looked at animals rather than humans, focusing on how sensory information flows to and from the sex organs. Now a new study suggests that a woman's orgasms have more to do with her brain than with her body. Not only do neural networks play a large role, but the feelings a woman has for her sexual partner are tied to just how good her orgasms are.

Researchers at Geneva University in Switzerland and the University of California, Santa Barbara, asked 29 head-over-heels heterosexual women to rate the intensity of their love as well as the quality, ease and frequency of the orgasms they achieved with their partner. Then the researchers used functional magnetic resonance imaging to map the subjects' brain activity while they focused on an unrelated cognitive task. As the subjects worked, their lovers' name flashed on screens in front of them too quickly to be noticed consciously but slowly enough to evoke a subliminal response from the brain—a technique that has been shown to reveal the neural networks involved in partner recognition and related emotions.



The more "in love" the subjects reported being, the greater activity the name flash triggered in the left angular gyrus, a brain region involved in memories of events and emotions. The most smitten subjects also reported having orgasms more easily—and far better ones, too—with ease and quality linked to activity spikes in the left insula (*circled above*), a region involved in reward and addiction. "The more they were satisfied by their sexual relationship in terms of orgasm, the more this brain area was activated," explains U.C.S.B. psychologist and study coauthor Stephanie Ortigue. And this finding has implications: "Do we have to consider orgasm as another addiction?" she asks.

Ortigue points out that her study found no link between intensity of love and how often the women climaxed. After all, and quite fortunately, she says, a woman doesn't have to be in love to have an orgasm.

—Melinda Wenner

KEREN SU *Corbis (top)*; FROM "CORRELATION BETWEEN INSULA ACTIVATION AND SELF-REPORTED QUALITY OF ORGASM IN WOMEN," BY S. ORTIGUE, S. T. GRAFTON AND F. BIANCHI-DEMICHELI, IN *NEUROIMAGE*, VOL. 37, NO. 2; 2007 (*bottom*)

>> COGNITION

A Blood-Brain Balance

A new theory proposes that blood may do more than nourish neurons

When a brain region becomes active, a flood of blood arrives within a few hundred milliseconds to service local neurons with the oxygen and glucose they need for energy. Scientists exploit this flow when they use functional magnetic resonance imaging to determine what parts of the brain respond to different stimuli. Recent estimates, however, peg the rush of blood to be nearly 10 times the amount neurons need for metabolism.

Now neuroscientist Christopher I. Moore of the Massachusetts Institute of Technology has proposed a new theory behind the excess flow—the blood, he says, may actually be involved in information processing in the brain. Moore's "hemo-neural hypothesis" posits several mechanisms for how blood might modulate neuron activity. Molecules in the blood might diffuse into the brain and affect neurotransmitter release, or changes in the volume, pressure or temperature of blood vessels may stress neuronal membranes to regulate transmission. Or there may be a middleman—astrocytes, the nonneuronal supporting cells that surround capillaries in the brain, could secrete chemical signals to neurons in response to a change in blood flow.

Previous research supports Moore's idea, such as the recent work on Alzheimer's disease suggesting that vascular decline may precede, and facilitate, neurodegeneration. Further, if blood were to play a tempering role, disruptions in its flow could explain the mechanism behind epilepsy, which can result from overexcited neurons.

Although some in the neuroscience community are dismissive, many believe that a true model of brain processing must include some role for blood. If his hypothesis proved true, Moore says, cerebral blood flow would no longer be thought of simply as a means to investigate brain function. "It would be a Heisenberg sort of thing," he suggests, referring to the way observing a quantum state changes it, "where what you're looking at is actually a part of the computation going on."

—Nikhil Swaminathan

>> SLEEP

Irritable? Take a Nap

Sleep deprivation leads to heightened emotions

Parents of toddlers have known for years that tired kids have trouble controlling their emotions. But recent findings from neuroscientists at Harvard University and the University of California, Berkeley, extend far beyond temperamental tykes. After the researchers kept adult volunteers awake for about 35 hours, they found with MRI scans that sleep deprivation impairs the "rational" prefrontal cortex's control over the amygdala, the brain's emotion center. The result is the moodiness that often accompanies exhaustion, described by the team as an amplified response from the brain's emotion hub. The study also suggested that sleep deprivation interferes with the ability of the prefrontal cortex to make logical decisions.

—Katherine Leitzell

Staying awake for too long leads to an impaired ability to make rational decisions.

3D4MEDICAL.COM *Getty Images (top)*; GETTY IMAGES *(bottom)*

>> HEALTH

A False Alarm

Panic attacks may mistakenly warn against suffocation

One minute you are feeling fine. Then suddenly you are trembling, nauseated and short of breath; your heart is racing, and your chest hurts. You fear you are about to die. A panic attack is a terrifying experience—and one that can strike anyone at any moment. Although the cause of panic attacks remains uncertain, new research suggests too much carbon dioxide might be to blame.

Experimental psychiatrist Eric Griez and his colleagues at the University of Maastricht in the Netherlands asked healthy volunteers to inhale air with varying levels of carbon dioxide. The higher the dose of carbon dioxide, the more the participants reported feeling fear and discomfort, as well as a fear of losing control and dying. "Metabolic distress is unconditionally translated into a dramatic emotional distress," Griez says.

The research builds on Columbia University psychiatrist Donald Klein's "false suffocation alarm" theory, which suggests that people have an evolved suffocation monitor sensitive to carbon dioxide and sodium lactate levels, both of which rise in the brain during suffocation. More than a decade ago Klein found that air enriched with carbon dioxide induced attacks in patients with panic disorders. These individuals have an overly sensitive monitor, he proposed, which fires false biological alarms in the form of panic attacks. Griez's work adds to the theory by showing that even healthy people exhibit signs of panic in the midst of high levels of carbon dioxide.

This new work may yield clues about what causes panic attacks, which until now has largely been a mystery. Genes may play a role, according to family and twin studies. "It's clear that there is a genetic component to vulnerability," says biological psychiatrist Jordan Smoller of Harvard University. "It's also clear that genes don't explain all of it." For people with certain phobias or post-traumatic stress disorder, objects that elicit fear or reminders of traumatic events can trigger attacks. In those with other anxiety disorders, episodes can happen without obvious cues, which makes them difficult to prevent. To add to the puzzle, panic attacks in healthy people occur out of the blue.

Griez's research on carbon dioxide could be a step toward relief. Experts agree that the work may lead to the development of new ways to test anxiety medications and treatments.

—Corey Binns

Heart Attack Panic

At their peak, panic attack symptoms are so severe and frightening that people often mistake them for signs of a heart attack and rush to the hospital. Although it is unclear whether the attacks themselves endanger the heart, those who experience them may be at higher risk of cardiovascular disease, says Jordan Smoller of Harvard University. In a recent study led by Smoller, researchers found that postmenopausal women who reported having a panic attack within six months of the study were four times as likely as other older women to have a heart attack or cardiac-related death during the next five years. ***—C.B.***

MIKE BLUESTONE *Photo Researchers, Inc. (top)*; GETTY IMAGES *(bottom)*

BRIEFS

■ **When we think** of death, our brain does not wallow in morbidity—rather it becomes subconsciously biased toward happy ideas, according to new research. Psychologists at the University of Kentucky and Florida State University asked subjects to ponder their mortality and then perform a word completion task. They tended toward positive words, choosing "joy," for example, over "job." This bias, the researchers concluded, is a brain mechanism that helps us cope with an unfathomable threat.

■ **Anthropologists** have long wondered whether Neandertals possessed language. Now the discovery in Neandertal DNA of a gene related to speech may be a clue. Geneticists at the Max Planck Institute for Evolutionary Anthropology in Leipzig say the *FOXP2* gene they extracted from Spanish Neandertal fossils means that our most recent hominid relatives may have shared our gift of gab, but skeptics point out that *FOXP2* is only one of several genes related to language.

■ **Hand gestures** not only enhance our ability to articulate thoughts, they also may boost thinking itself. Psychologists at the University of Chicago found that children who were encouraged to gesture while explaining how they approached a math problem became more receptive afterward to instructions on how to solve other numeric brainteasers. Conveying an unspoken idea with gestures, the scientists said, prompted new problem-solving strategies that readied kids to learn.

>> DEVELOPMENT

The Sound of Silence

Before we can hear, specialized ear cells ready our brain for noise

Understanding how the brain learns to hear could help explain inherited deafness.

From the moment we begin to hear, our auditory system is precisely tuned, able to distinguish subtle differences between sounds. But how does it get that way? New research reveals how developing ears generate their own noise, a process that may help calibrate our auditory system.

Johns Hopkins University researchers studied the auditory systems of rats, which are deaf until about 12 days of age. During this prehearing period, the scientists discovered, the rodents have bursts of activity in certain cells—called support cells—in their cochleas. These nonnerve cells spontaneously release a chemical messenger called ATP, sending signals to other cells in the inner ear and eventually to the brain.

"It appears that this activity plays an important role in the development of the auditory system," lead researcher Dwight E. Bergles says. For instance, it seems to be necessary for refining the brain maps that differentiate among auditory frequencies. The spontaneous activity—which, in humans, would take place in utero—may also shed light on tinnitus, or the perception of phantom sound, and explain how certain genetic mutations can cause deafness.

—Emily Anthes

>> MEDICINE

Predicting Alzheimer's

A new technique may give years of advanced warning

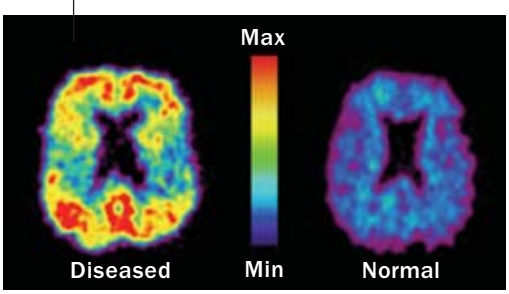
Diagnosing Alzheimer's disease is difficult—confirmation can be obtained only postmortem, by verifying at autopsy that the brain has an abundant amount of plaque made up of the sticky beta-amyloid protein. To gauge Alzheimer's in living patients, neurologists must depend on time-consuming assessments of the brain's degeneration—such as monitoring progressive memory loss—that often delay a conclusive judgment.

Now a new technique is poised to greatly speed diagnosis. Ongoing studies at Uppsala University in Sweden have shown that the chemical agent dubbed Pittsburgh Compound-B, or PIB, is a highly accurate marker of plaque buildup and that its abundance in the brain can predict whether patients with mild cognitive impairment will develop Alzheimer's—and when that decline will likely start. "It has always been a puzzle," says Chester A. Mathis, a radiologist at the University of Pittsburgh who pioneered the amyloid-imaging technique with Pittsburgh psychiatrist William E. Klunk. Even specialty clinics, Mathis says, have trouble distinguishing those patients whose memory loss is a prelude to Alzheimer's from those who have another underlying cause, such as depression.

PIB works by binding to amyloid in sufficient amounts to appear in a positron-emission tomography (PET) scan image. Because PIB selectively binds to brain amyloid deposits but quickly clears from normal tissue, the chemical dye accurately indicates the amount of protein that is deposited in the living brain. Although other tracers can detect the presence of plaque, PIB is the first to show a strong ability to predict the onset of Alzheimer's.

The technique could provide potential Alzheimer's sufferers and their families with several years of advance warning, allowing them to prepare for the debilitating disease while delaying its arrival with diet and exercise. Even more promising, experts say, is the window of opportunity for drug intervention. Many potential Alzheimer's drugs such as Alzhemed, now in its final clinical trial, target amyloid plaque. PIB is not only a powerful tool for studying the efficacy of these drugs; it is also a way to ensure that patients on the road to Alzheimer's start getting treated early enough to minimize irreparable neuronal loss.

—Peter Sergo



Red, orange and yellow indicate high levels of plaque deposits in the brain.

CORBIS (*top*); UNIVERSITY OF PITTSBURGH PET AMYLOID IMAGING GROUP (*bottom*)

AGE FOTOSTOCK (*left*); HYBRID MEDICAL *Photo Researchers, Inc.* (*right*)

>> AGING

Double-Edged Sword

Education delays dementia, but memory declines faster once it hits

Research has found that the onset of dementia is delayed in people who have more years of formal education. But a new study shows that this protection may come at a price: once dementia does hit, the well-educated lose their memory faster.

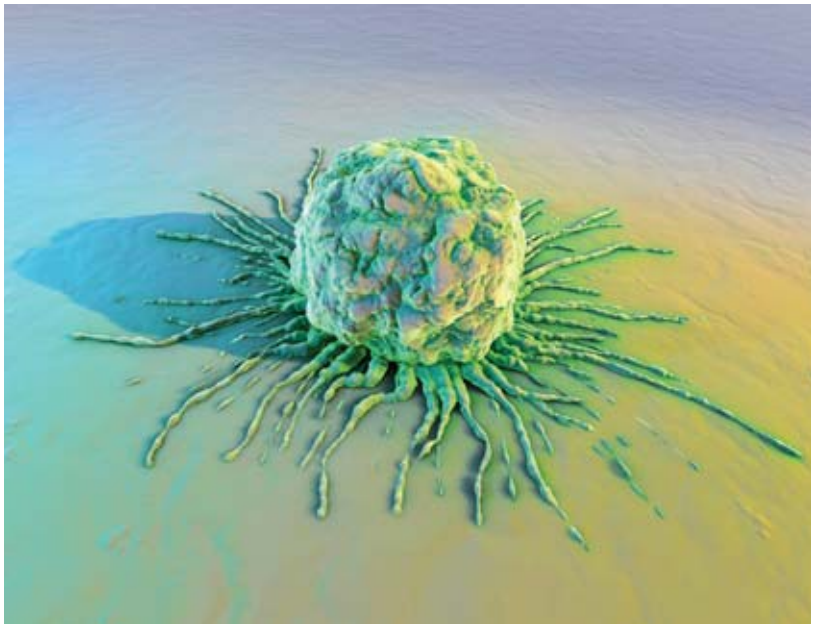
Researchers from Albert Einstein College of Medicine of Yeshiva University studied people with three years to more than 16 years of formal education and found that for every additional year of schooling people had, their memory declined 4 percent more quickly after the onset of dementia. The researchers speculate that individuals with more education can unconsciously compensate as their brain changes with age, preventing the early symptoms of dementia from showing. Consequently, when disease eventually overwhelms the brain and symptoms become severe enough to warrant a diagnosis of dementia, the memory decline that follows is more rapid because the degeneration is at a later stage.

Past studies have shown that challenging the brain with activities, such as solving puzzles or reading books, may also delay dementia. But researchers do not yet know if these mental challenges truly protect the brain or if the people who engage in these activities are simply better educated. *—Sara Goudarzi*

>> NEUROSCIENCE

Stem Cells for Memory

New synapses repair recall after a stem cell injection



Stem cells have long been heralded as a potential treatment for a range of brain ailments, but research has so far focused on movement disorders such as Parkinson's disease. Now a new animal study shows that the immature cells could also help with cognitive impairments. Frank M. LaFerla of the University of California, Irvine, and his colleagues showed that neural stem cells can reverse memory loss.

The team manipulated the genome of mice such that they could initiate neuron death in the hippocampus by turning on specific genes. Mice whose brains were injured with this method showed significant memory impairment on place-recognition tests. After receiving an injection of neural stem cells from young mice, however, they performed as well as healthy mice did.

When the researchers tracked the stem cells in the mice's brains, they saw that only about 5 percent of them actually developed into neurons, suggesting the cells did not rescue memory by replacing dead neurons, LaFerla says. Instead mice injected with stem cells developed a far greater number of synapses, or connections between neurons, at the damaged site than control mice did. LaFerla thinks that neurotrophins—biochemical compounds secreted by the injected stem cells—most likely were responsible for the effect. This finding could open the door for drug treatments based on these compounds. "Such a treatment would be much less risky than injecting actual cells," he says, adding that transplanted stem cells could potentially develop into tumors.

That risk is currently a hurdle in many stem cell therapies, says Curt Freed of the University of Colorado Health Sciences Center in Denver. For example, animal studies have shown that neurons derived in the lab from human embryonic stem cells improve Parkinson's symptoms; however, any residual stem cells associated with those neurons could form masses of unwanted cells. But scientists are making progress in refining these therapies, and the first ever trial of fetal stem cells injected directly into the brain is currently under way in children with Batten disease, a rare and fatal illness of the nervous system.

Freed expects transplants of neurons derived from embryonic stem cells to enter the clinical arena soon as well. "I think Parkinson's will be the first disease in which these cells are used, and I would say that that's likely to happen as early as two years from now." *—Nicole Branan*

>> MEDICINE

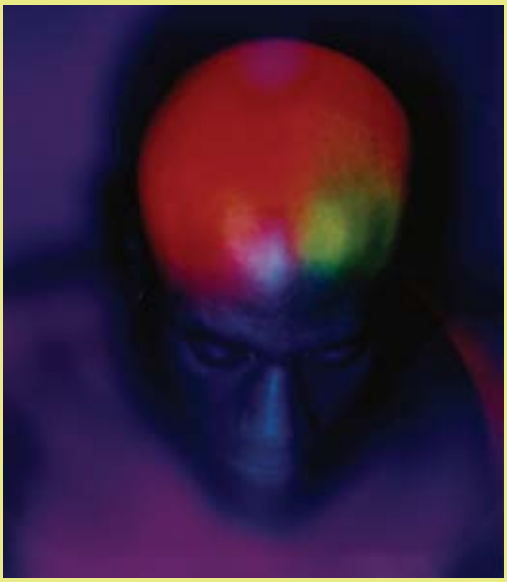
"Chemo Brain" Culprit

Lifesaving cancer treatment may cost patients their neurons

Those who have endured the rigors of cancer therapy talk about "chemo brain," the memory and concentration problems that accompany radiation and chemotherapy. Now researchers led by neurologist Michelle L. Monje of Harvard University have found the root of these cognitive difficulties: damaged stem cells.

In the hippocampus, a brain region vital for laying down new memories, "stem cells continue to add new circuit elements," says Stanford University neuroscientist Theo D. Palmer, who helped Monje find out why brain fogginess can persist for years after cancer treatment has ended. They discovered that the chemicals and radiation used to kill tumor cells damage the stem cell reservoir in the hippocampus and nearly halt the formation of new neurons in both children and adults.

Radiation treatment also triggers a response from microglial cells, the immune cells of the central nervous system. Because the inflammatory cells stifle neuronal growth, some experts think that the microglia may be the real culprit behind radiation-induced brain defects. The researchers' previous work in rats



showed that anti-inflammatory drugs helped to restore some neurogenesis.

Without such intervention, stem cells damaged by radiation do not seem to recover, according to Monje. But there is hope: exercise has been shown to stimulate neurogenesis in healthy animals and in people, so Monje thinks there is a good chance that being active would help improve cognition in cancer survivors, too.

—Roberta Friedman

Treatment with anti-inflammatory drugs may help restore cancer patients' neurons.

>> TECHNOLOGY

A Virtual Laboratory

Second Life emerges as a new setting for psychology research

Residents of Second Life—an online computer game in which players can do almost everything they can do in real life, such as buy and sell property, take classes and date—tout their world's realistic settings and social opportunities. Now a growing number of scientists are beginning to take notice and are bringing their human behavior research into the virtual world.

Second Life allows researchers to study scenarios that they cannot in real life, such as placing a person in someone else's body, changing the laws of physics or even performing experiments that are otherwise ethically taboo. Communications scientist Nick Yee of the Palo Alto Research Center, who uses Second Life as his primary laboratory, says that the setting could provide new ways to explore people's feelings about age, sex or race. Another group of researchers at University College London recently repeated Stanley Milgram's notorious 1963 experiment—in which participants were asked to administer apparently lethal electric shocks to another volunteer—in a virtual-reality setting. The results were similar to those of the original experiment; although the participants became uncomfortable, many continued administering shocks at the request of the researchers. Computer scientist Mel Slater, who led the experiment, says that virtual reality is more realistic than Second Life but agrees that, like virtual reality, the game has the potential to be a powerful research tool.

Dmitri Williams, a communications professor at the University of Southern California, says that online games such as Second Life also offer an unprecedented chance to gather large amounts of accurate behavioral data. "In these worlds," Williams explains, "you have the equivalent of cameras recording people's every move."

Some experts, however, caution that it is too early to say for sure whether experiments done in virtual worlds can be applied to real behavior. A recent study from Yee's group demonstrated that many people respond to social cues such as personal space and eye contact much as they would in real life. But in other cases, such as risk-taking behavior, people behave very differently in games, because the cost of death is relatively insignificant. "We need to find out which situations do match up [with reality] and which don't," Williams says. "We're not even close to that yet."

—Katherine Leitzell

MICHAEL NORTHRUP *Getty Images (top)*; COURTESY OF SECOND LIFE *(bottom)*

GETTY IMAGES

>> MORALITY

Some Are More Equal

The primate preference for fairness may depend on complex social rules

Life may not be fair, but humans have a strong bias for fairness. In experiments, humans will generally reject or punish a partner who offers noticeably less than half of a shared reward, even if they wind up empty-handed. Chimps, it turns out, are not so picky and will (rationally, an economist might add) take whatever they can get, according to an October 2007 *Science* paper. So what could explain this difference between our closest living relatives and us?

The answer may lie in the social relationships that influence so many of our actions. Recent studies of primate fairness seem to contradict one another—unless you consider who exactly is cheating whom.

In 2003 a provocative study led by Sarah F. Brosnan, now at Georgia State University, concluded that capuchin monkeys were exhibiting humanlike social indignation when they turned down unfair deals. The monkeys refused to perform tasks if they saw companions getting better rewards for the same work. They threw tantrums, and their food rewards, to protest the unequal treatment.

In 2006, however, a group at American University reported the opposite result—their capuchins' behavior was not affected by the food their partners got. In response, Brosnan's group released an updated study, again showing the capuchins' penchant for fairness. But some experts are still not convinced—Clive Wynne of the University of Florida warns that the different study designs make comparisons "messy."

Brosnan argues that social relationships are more important than the other groups are accounting for. Her group found that chimpanzees were more likely to accept unfair deals from members of their social group than from outsiders. In another study, humans accepted unfair deals from computers but not from people. These results imply that relationships matter when primates judge fairness, Brosnan says, and "may explain the failure to find a response in [the *Science*] study." The chimps, in other words, may have been willing to accept the unfair offers because they came from old pals.

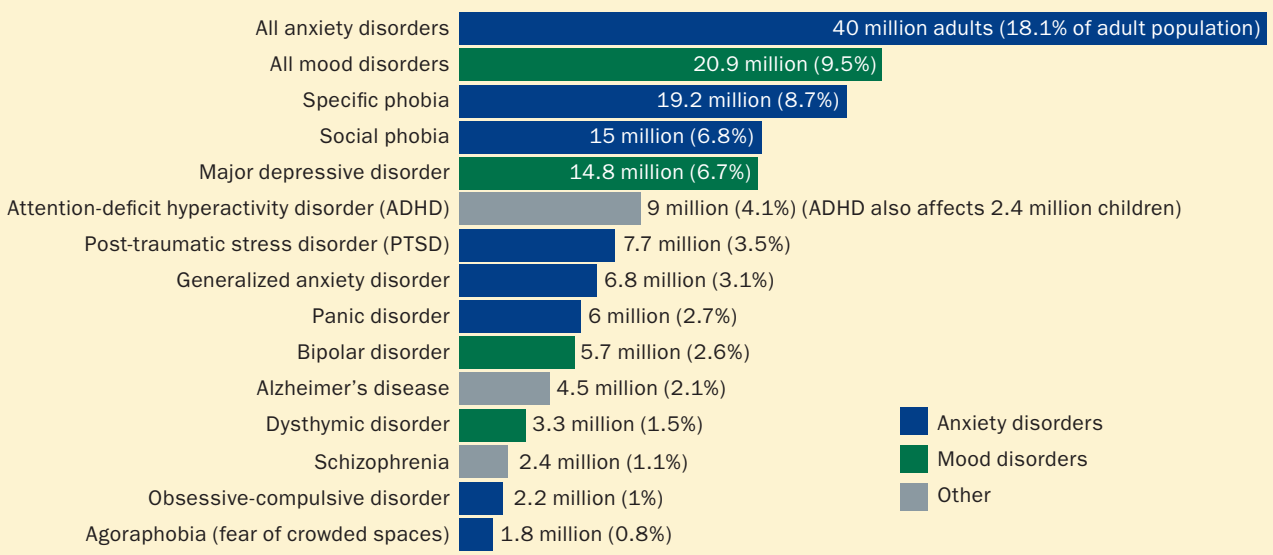
Studying animal fairness could ultimately help us understand human cooperation and justice—but the jury is still out. *—Lucas Laursen*

>> STATS

Mental Illness in America

More than a quarter of adults are afflicted

In any given year 26 percent of American adults suffer from mental disorders, based on guidelines in the official handbook for diagnosing mental illness, the *DSM-IV.* Only about a fifth of the cases are serious enough to cause a major disruption of everyday life, however, which has prompted some experts to call for more stringent diagnostic criteria. Others counter that tracking mild symptoms is important for preventing their escalation into more severe illness. The chart below lists many of the most prevalent mental illnesses in Americans older than 18 years, according to a 2005 survey by the National Institute of Mental Health. Nearly half of all people who have one illness also suffer from at least one more. *—Peter Sergo*



Getting Duped

Statements made in the media can surreptitiously plant distortions in the minds of millions. Learning to recognize two commonly used fallacies can help you separate fact from fiction

BY YVONNE RALEY AND ROBERT TALISSE

BOB THOMAS *Getty Images*

IN 2003 nearly half of all Americans falsely assumed that the U.S. government had found solid evidence for a link between Iraq and al Qaeda. What is more, almost a quarter of us believed that investigators had all but confirmed the existence of weapons of mass destruction in Iraq, according to a 2003 report by the University of Maryland's Program on International Policy Attitudes and Knowledge Networks, a polling and market research firm. How did the true situation in Iraq become so grossly distorted in American minds?

Many people have attributed such misconceptions to a politically motivated disinformation campaign to engender support for the armed struggle in Iraq. We do not think the deceptions were premeditated, however. Instead they are most likely the result of common types of reasoning errors, which appear frequently in discussions in the news media and which can easily fool an unsuspecting public.

News shows often have an implicit bias that may motivate the portrayal of facts and opinions in misleading ways, even if the information presented is largely accurate. Nevertheless, by becoming familiar with how spokespeople can create false impressions, media consumers can learn to ignore certain claims and thereby avoid getting duped. We have detected two general types of fallacies—one of them well known and the other newly identified—that have permeated discussion of the Iraq War and that are generally ubiquitous in political debates and other discourse.

Spinning Straw into Fool's Gold

One common method of spinning information is the so-called straw man argument. In this tactic, a person summarizes the opposition's position inaccurately so as to weaken it and then refutes that inaccurate rendition. In a November 2005 speech, for example, President George W. Bush responded to questions about pulling troops out of Iraq by saying, "We've heard some people say, pull them out right now. That's a huge mistake. It'd be a terrible mistake. It sends a bad message to our troops, and it sends a bad message to our enemy, and it sends a bad message to the Iraqis." The statement that unnamed "people" are advocating a troop withdrawal from Iraq "right now" is a straw man, because it exaggerates the opposing viewpoint. Not even the most stalwart Bush adversaries backed an immediate troop withdrawal. Most proposed that the soldiers be sent home over several months, a more reasonable and persuasive plan that Bush undercut with his straw man.

The straw man is used in countless other contexts as well. In his acceptance speech at the 1996 Democratic Convention, for instance, Bill Clinton opined: "... with all respect [to Bob Dole], we do not need to build a bridge to the past. We need to build a bridge to the future." Dole did discuss restoring the values of an earlier America, but Clinton falsely implied that Dole was only looking backward (whereas Clinton was looking forward). People may use a straw man to discredit theories to which they do not subscribe. Characterizing evolution, for example, as "all random chance" is a straw man argument; it misrepresents a complex theory that only partly rests on the randomness of mutations that may lead to better chances of survival.

Recently, in a 2006 paper co-authored with Scott F. Aikin, one of us (Talisse) documented a twist on the straw man tactic. In what Talisse dubs a weak man argument, a person sets up the opposition's weakest (or one of its weakest) arguments or proponents for attack, as opposed to misstating a rival's position as the straw man argument does. In a July 2007 edition of *Talking Points,* Bill O'Reilly took on a claim by the *New York Times* that we had lost the war in Iraq by saying that "the *New York Times* declared defeat in Iraq Sunday on its editorial page, and there's no question the antiwar movement has momentum." (The editorial actually said that "some oppo-

nents of the Iraq war are toying with the idea of American defeat," but let us assume that O'Reilly's characterization was correct.)

O'Reilly then offered a weak man explanation for the purported defeat: "The truth is the Iraqi government and many of its citizens are simply not doing enough to defeat the terrorists and corruption. The U.S.A. can't control that country. No nation could.... Unfortunately, the Iraqi failure to help themselves has come true." Although Iraq's failure to aid in fighting terrorism and corruption could be why we are losing the war, the troubles in Iraq could also stem from a host of logistical reasons, some of which may shed a negative light on the current administration. O'Reilly, however, kept any discussion of these reasons offstage, suppressing the various other possible—and possibly more likely—reasons for "defeat" in Iraq. Meanwhile his claims that the "U.S.A. can't control that country" and that "no nation could" deflected blame from the U.S. government.

Weak man arguments are pervasive. In a 2005 editorial in Denver's *Rocky Mountain News*, conservative writer and activist David Horowitz picked on ethnic studies scholar Ward Churchill, formerly at the University of Colorado at Boulder, whose views he described as "hateful and ignorant." Horowitz then went on to claim that Churchill's radical "hate America" convictions "represent" those of a "substantial segment of the academic community." Thus, he used the example of Churchill (the weak man) to argue that "tenured radicals" have made universities into leftist political institutions and subverted the academic enterprise, thereby failing to acknowledge the presence of more highly regarded and politically mainstream scholars in academia.

Trolling for Truth

Weak man tactics are harder to detect than those of the straw man variety. Because straw man arguments are closely related to an opponent's true position, a clever listener might be able to spot the truth amid the hyperbole, understatement or other corrupted version of that view. A weak man argument, however, is more opaque because it contains a grain of truth and often bears little similarity to the stronger arguments that should also be presented. Therefore, a listener has to know a lot more about the situation to imagine the information that a speaker or writer has cleverly disregarded.

Nevertheless, an astute consumer of the news can catch many straw man and weak man fallacies by knowing how they work. Another strategy is to always consider a speaker's or writer's motivation or agenda and be especially alert for skewed statements of fact in editorials, television opinion shows, and the like. It is also wise to obtain news from more balanced news sources [*see box above*]. An alternative approach is to try to construct, in your own mind, the *best* argument against what you have heard before accepting it as true. Or simply ask yourself: Why should I *not* believe this? M

YVONNE RALEY is assistant professor of philosophy at Felician College in Lodi, N.J. Her forthcoming book, on applied ethical reasoning, will be published by Oxford University Press in 2008. ROBERT TALISSE is associate professor of philosophy and political science at Vanderbilt University. He has written about political legitimacy, public ignorance and fanaticism.

Popular Delusions

According to polls conducted in 2003 and 2007, Americans held several misperceptions about the war in Iraq. For example:

- In March 2003, only 35 percent of Americans correctly perceived that most people in the world at large were opposed to the decision to go to war with Iraq.
- In May 2003, 22 percent of Americans said that Iraq had actually used chemical or biological weapons against U.S. troops.
- In September 2003, 24 percent of Americans believed that the U.S. had found evidence of weapons of mass destruction in Iraq.
- In 2007, 33 percent of Americans still believed Saddam Hussein was personally involved in the 9/11 attacks.

The prevalence of such misconceptions varied according to respondents' favored news source, even among people who shared demographic traits such as education level and party identification. Among those who used Fox News as their primary news source, 80 percent held at least one such erroneous notion about the Iraq War. By comparison, 55 percent of CNN watchers, 47 percent of print newshounds and only 23 percent of the PBS-NPR audience believed in at least one such myth. We believe this shows that Fox News is relatively biased, creating false impressions about facts, and that PBS-NPR is less so, perhaps in part because of a difference in the prevalence of straw man and weak man arguments [*see main article*], although further research is needed to bear this out. —*Y.R. and R.T.*

(Further Reading)

- **Two Forms of the Straw Man.** Robert Talisse and Scott F. Aikin in *Argumentation,* Vol. 20, No. 3, pages 345–352; September 2006. Available at **http://people.vanderbilt.edu/~robert.talisse/StrawMan_argumentation.pdf**
- **Misperceptions, the Media, and the Iraq War.** Poll by the Program on International Policy Attitudes (PIPA) and Knowledge Networks. Available at **http://65.109.167.118/pipa/pdf/oct03/IraqMedia_Oct03_rpt.pdf**

Sizing Things Up

When you hoist two items of equal weight, your brain may be doing some heavy lifting

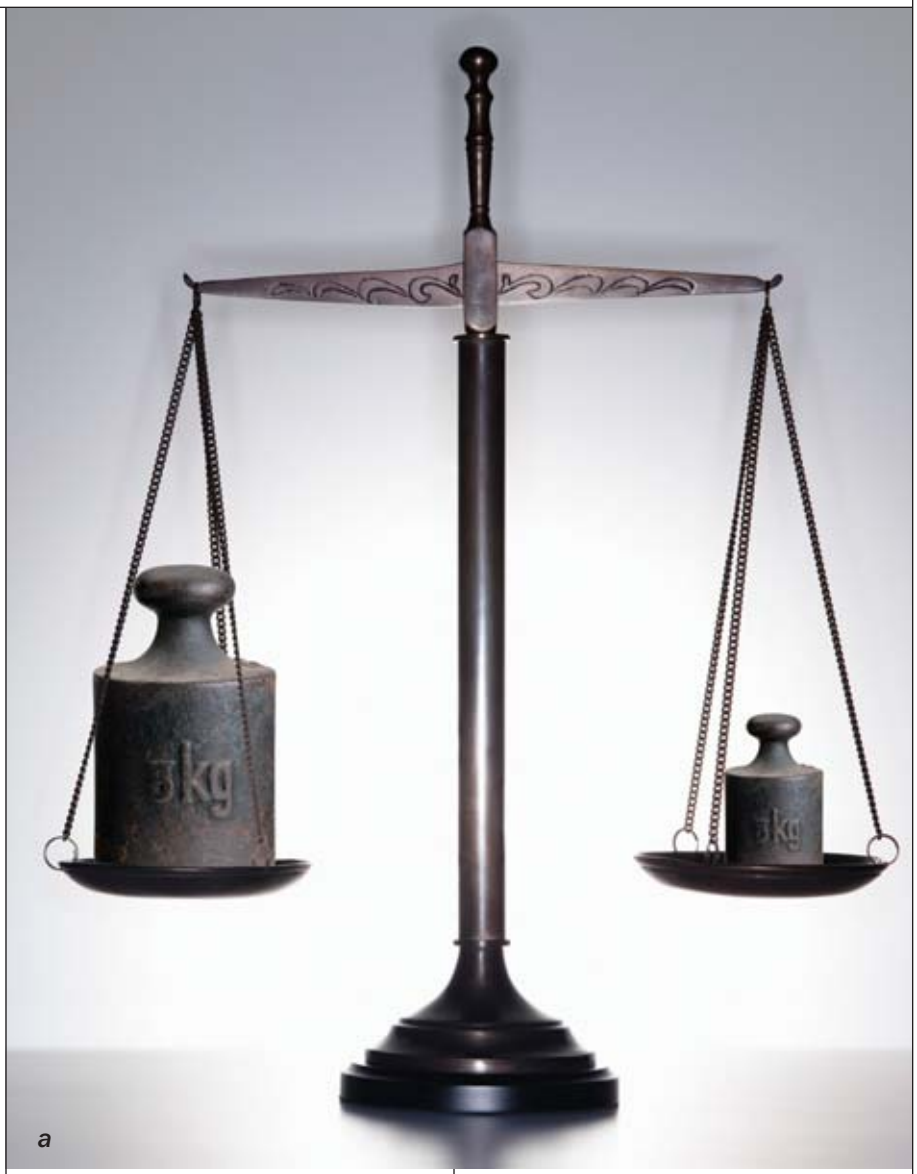
BY VILAYANUR S. RAMACHANDRAN AND DIANE ROGERS-RAMACHANDRAN

THE GREAT German physicist Hermann von Helmholtz not only discovered the first law of thermodynamics (the conservation of energy) but also invented the ophthalmoscope and was first to measure nerve impulse velocity. He is, in addition, widely regarded as the founding father of the science of human visual perception—and is, to both of us, an inspiration.

We have often emphasized in our column that even the simplest act of perception involves active interpretation, or "intelligent" guesswork, by the brain about events in the world; it involves more than merely reading out the sensory inputs sent from receptors. In fact, perception often seems to mimic aspects of inductive thought processes. To emphasize perception's thoughtlike nature, von Helmholtz used the phrase "unconscious inference." Sensory input (for example, an image on the retina at the back of the eye) is interpreted based on its context and on the observer's experience with, and knowledge of, the world. He used the word "unconscious" because, unlike for many aspects of thinking, no conscious cogitation is typically required for perception. By and large it is on autopilot.

Weighing the Evidence

A powerful demonstration of the predictive power of perception is seen with the size-weight, or Charpentier-Koseleff, illusion (conceptual representation at *a*), which you can easily construct and use to mesmerize your friends. This perceptual trick was one of von Helmholtz's favorites, and we shall soon see why.



a

To set up, take two objects that are similar in shape, color and texture but different in size—such as hollow metal or plastic cylinders. Hide enough weight inside the smaller one so that its weight is identical to that of the larger object. Because the two containers appear similar, except for size, observers will naturally assume the larger one is proportionally heavier than the smaller one. Now ask a friend to pick them up and compare their weight.

She will surprise you by reporting that the objects are not equal in physi-

Because the two containers appear similar, except for size, one assumes the larger one is **proportionally heavier**.

GETTY IMAGES

We neuroscientists say that perception is immune to intellectual correction—that it is "**cognitively impenetrable.**"

cal weight. She will insist the larger object feels much lighter than the smaller one. She will continue to assert this incorrect fact even if you tell her that you want her to report absolute weight, not density (weight per unit volume).

Try it yourself. Remarkably, even though you know the objects weigh the same (after all, you constructed them), you will experience the larger object as feeling considerably lighter than the smaller one. As with many illusions, knowledge of reality is insufficient to correct or override the misperception. We neuroscientists say that perception is immune to intellectual correction—that it is "cognitively impenetrable."

Impervious Illusion

Furthermore, the visual information continuously overrides the feedback from muscle signals telling you that the weights are physically identical. The illusion is impervious not only to high-level conceptual knowledge that the objects weigh the same but also to "bottom up" signals from other sources, such as feedback from muscle receptors, telling you they weigh the same. You can repeat this experiment many times, but you will still experience the illusion.

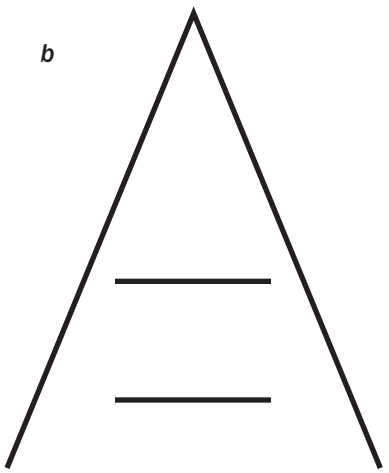
Why does the effect occur? When you reach out for the bigger object, you *expect* it to weigh more (given the assumption that it is made of the same stuff) and you exert greater lifting force. Because it weighs the same as the smaller object (which you expected to weigh less), however, you actually experience it as being lighter, relative to the smaller object.

As an analogy, imagine you run into someone who looks unintelligent and you initially expect him to be so. If he then starts talking normally he seems even brighter than average! It is as if you calibrate your judgment of a person's capabilities by the way he looks, and therefore your final "reading" of his true skills—based on his verbal output—is an overestimate.

Insight from a Visual Trick

The size-weight illusion may be easier to understand if we couch it in terms of a more familiar visual illusion, the Ponzo, or railroad track, illusion (*b*) [see "The Quirks of Constancy," Illusions; Scientific American Mind, August/September 2006]. Two horizontal bars are shown lying between two longer converging lines. Although the bars are identical, they are not seen as such: the top bar appears longer than the bottom bar. We can explain the illusion in terms of a visual effect called size constancy; if two objects of identical physical size are at different distances from a viewer, they are correctly perceived as being the same physical size, even though the images cast by them on the retina are different sizes. Quite simply, the brain "understands" there is a trade-off between retinal image size and distance and, in effect, says, "That object's image is small because it is far; its actual size must be much bigger." To evaluate distance, the visual system uses various sources of information called "cues," such as perspective, motion parallax, texture gradients and stereopsis. It then applies the appropriate correction for distance in order to judge true size.

But with the Ponzo illusion, the two horizontal bars are the same physical size on the retina. The converging lines provide a powerful trigger to read them—falsely in this case—as lying at different distances away (as though you are peering down a railroad track and see the railroad ties at increasing distance). Because your visual system "believes" the top line is farther away, it infers that the top line must really be larger than its size



on the retina would indicate (relative to the other line). You therefore perceive it as being larger.

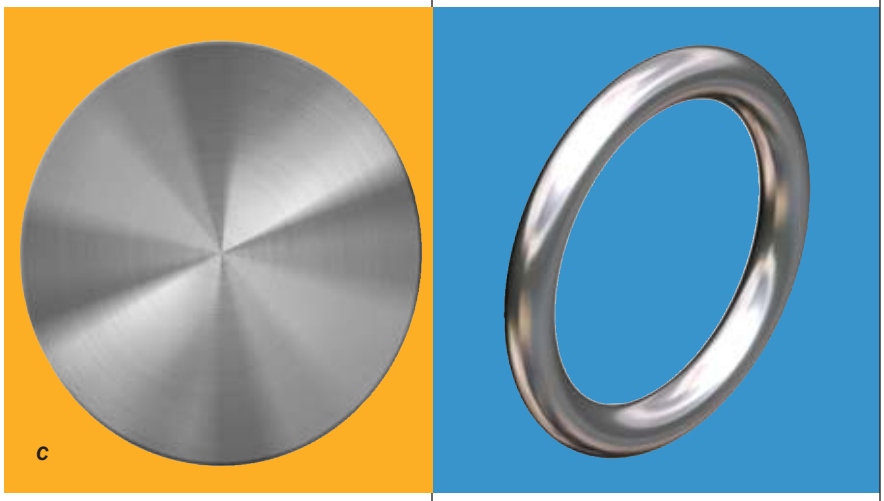
To put it differently, size constancy scaling enables you to perceive accurately the size of objects when you correctly perceive distance to those objects. In the Ponzo illusion, however, the misleading depth cue from the converging lines causes you to *misapply* the size constancy algorithm so that the top line is seen as being larger. Remarkably, the illusion overrides the visual signals from the retina informing the visual size-judgment centers in the brain that the two bars are exactly the same length. And because these mechanisms are all on autopilot, knowing that they are identical in size does not correct the illusion.

Brain Expectations

The situation with size and weight is analogous. (Read "actual weight signaled by muscles" for "actual retinal image size.") Your brain says, "For the big object, I expect the muscle tension to be much greater in order to lift it." But because the muscle tension required is much lower than expected, the object is felt as unexpectedly light. This experience overrides your judgment of actual weight signaled by your muscles.

Remember that we said the size-

What if we now use as test objects a disk and a ring of equal size and **identical weight**?



weight judgment system is on autopilot. So we can ask how dumb or smart it is on its own. What if we now use as test objects a disk and a ring of the same outer diameter (*c*), and, as with the standard size-weight illusion, we adjust each of them so that they have the identical physical weight? Of course, as before, anyone picking up the ring will expect it to weigh much less because it looks as if it has less total volume. But you (the experimenter, aware of the size-weight illusion) would predict the reverse—that the hollow ring would be felt as being much heavier than the solid disk. In fact, in collaboration with Edward M. Hubbard, now at INSERM in France, we have found that a subject will experience *no* size-weight illusion; she will correctly judge the objects to be the same weight. The brain seems to merely utilize the *outer* diameter in making the judgment, rather than the overall volume. This experiment shows that the visual system is not sophisticated enough to understand that what is relevant is the total mass, not the outer diameter alone.

In addition to size, the brain takes other factors into account for gauging anticipated weight. For example, if you pick up a plastic beer mug, it will feel unusually light. Again, this effect occurs because you expect it to be made of glass and, therefore, to be heavy. The original size-weight illusion may turn out to be largely hardwired (we do not know), but surely the beer mug weight illusion must be learned. Our hominid ancestors were not exposed to mugs.

Felt vs. Real

What other insights can we gain from this illusion? Perhaps there is a practical application. Our house (which is very tall) has many stairs, and we expect to fatigue more quickly running up and down while carrying heavy loads than we would carrying light ones. Physical exertion increases when you are carrying greater weight; your heart beats faster, your blood pressure rises and you sweat. One typically assumes that this extra effort is because the muscles consume more glucose, and this information is fed back into the brain to generate the adaptive response of increased heart rate, blood pressure and sweating to allow for, and to anticipate, increased oxygen consumption resulting from hard work.

But is it conceivable that part of this preparation may also involve the *felt* weight of the object sending direct brain signals to the body? Imagine you run up and down a staircase with a large object and then compare the degree of tiredness you feel with that produced when carrying a much smaller object whose physical weight is the same as the larger item (and therefore *feels* heavier because of the illusion). Does the additional felt weight, as opposed to real weight, increase your sense of exertion or tiredness? In other words, is the fatigue determined by actual physical exertion? And would such imagined work actually increase your heart rate, blood pressure and sweating?

If so, the implication would be that merely feeling excess exertion causes the brain to send more signals to the heart to raise blood pressure, heart rate and tissue oxygenation. There have been sporadic reports that repeated imagined exercise can increase muscle strength, but precious little evidence. (We have started to explore this area in collaboration with neuroscientist Paul McGeoch of the University of California, San Diego.)

If it turns out that the felt weight determines how tired you feel, then next time you buy a suitcase for travel you should buy a large one; it will *feel* much lighter even if you stuff it with exactly the same amount of material! Quirks of perception have profound theoretical implications—but they can have practical consequences, too. M

VILAYANUR S. RAMACHANDRAN and DIANE ROGERS-RAMACHANDRAN are at the Center for Brain and Cognition at the University of California, San Diego. They serve on *Scientific American Mind*'s board of advisers.

(Further Reading)

◆ **The Size-Weight Illusion, Emulation, and the Cerebellum.** Edward M. Hubbard and Vilayanur S. Ramachandran in *Behavioral and Brain Sciences*, Vol. 27, pages 407–408; 2004.

STEVEN VAN SOLDT (*left*) AND STEVE O'CONNOR (*right*) *iStockphoto*

(calendar)

February

2 The Exploratorium science museum presents a discussion of art, emotion and the mind—the third in a series of five Saturday afternoon mind-themed lectures. Also, visit an exclusive exhibit of renowned psychologist **Paul Ekman**'s photographs, featuring a study of the facial expressions of the isolated South Fore people in New Guinea. The exhibition marks the 40th anniversary of his influential work, which led to a new understanding of the universal nature of facial expressions and emotions.
San Francisco
www.exploratorium.org

7–9 What makes us who we are? Find out from researchers who study emotion, judgment, relationships and self-identity at the annual meeting of the **Society for Personality and Social Psychology**.
Albuquerque, N.M.
www.spspmeeting.org

14 This **Valentine's Day** cuddle up with that special someone and contemplate the odors on which your love is based. No, really. For decades scientists suspected that the sense of smell (that is, airborne chemical detection) probably plays an important role in human sexual attraction, just as it does in other mammals. But despite the claims displayed on the countless bottled "pheromones" on the market, scientists had no luck proving the existence of a chemical that could influence desire. Finally, a year ago this month, researchers found evidence that androstadienone, a component of male armpit sweat, increases arousal in women who smell it. And you thought romance was dead....

26 Neuroscientist Donald W. Pfaff of the Rockefeller University discusses his new book, ***The Neuroscience of Fair Play*** (Dana/University of Chicago Press, 2007), in which he draws on decades of his research to formulate a theory about what exactly happens in the brain when we follow the Golden Rule. Learn more about Pfaff's book in "Do unto Others," by Kurt Kleiner [Reviews], in *Scientific American Mind,* December 2007/January 2008.
New York City
www.nyas.org/events

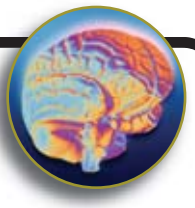
March

3 On this day in 1947 *Life* magazine ran an enthusiastic article about the promise of a medical breakthrough, the **lobotomy**. The article hailed prefrontal lobotomies as the cure for society's ills only a few years before the advent of antipsychotic drugs rendered the procedure obsolete. For a review of a new *PBS* documentary about the maverick doctor who started the American lobotomy craze, flip over to page 83.

8–23 Neuroscience meets performance art in "**Waves of Mu**," a blend of visual art, installations and performances by artist Amy Caron. Inspired by mu waves, the electromagnetic oscillations that arise from mirror-neuron activity in the brain, the piece is designed to inform audiences about the brain while triggering their own mirror-neuron systems. Caron worked for years with researchers, including Vilayanur S. Ramachandran, to refine her understanding of the science. The show will tour the U.S. after its Vermont premiere.
Burlington, Vt.
www.amycaron.com/html_pages/waves_of_mu.html

28 Six students from the Massachusetts Institute of Technology fly to Las Vegas for a weekend of blackjack and return to college hundreds of thousands of dollars richer. Is this a tale of genius gone bad? Or a well-earned revenge of the nerds? Find out in **21**, a new movie based on the true story of an M.I.T. professor (Kevin Spacey) and his team of card-counting whiz kids who used their unusual mathematical intelligence to take the gambling world by storm.
Columbia Pictures
www.sonypictures.com/movies

SEASON OF THE BRAIN



March 10–16 marks the 13th annual International Brain Awareness Week. The celebration lasts for months, however, as research institutes around the world open their doors to kids and adults who want to learn more about the mind. Here are a few of the dozens of activities planned.

Portland, Ore.
The Oregon Health & Science University hosts **a star-studded lecture series**, kicking off with Eric Kandel of Columbia University. Discuss sleep, memory and love with the experts at postlecture receptions.
February 11, 19 and 25; March 3

Baltimore
Do you know how many neurons are in the brain or where the biological clock is located? The contestants in the national **Brain Bee Championship** do. Watch the fun at the University of Maryland as you see how you size up to these brainy high school students.
March 14–15

Houston
It's **Brain Night** at the John P. McGovern Museum of Health & Medical Science. Mini lectures tailored to children and brain-related demonstrations for all ages are guaranteed to fill your head with something new.
March 20

To find events near you, visit http://brainweek.dana.org

PAUL EKMAN (*boy and man*); STEVEN HUNT Getty Images (*rainbow brain*); GETTY IMAGES (*brain with molecules*)

Compiled by Karen Schrock and Peter Sergo. Send items to editors@SciAmMind.com

Researchers are revealing hidden complexities behind the simple act of kissing, which relays powerful messages to your brain, body and partner

Affairs of the Lips

By Chip Walter

AARON GOODMAN

When passion takes a grip, a kiss locks two humans together in an exchange of scents, tastes, textures, secrets and emotions. We kiss furtively, lasciviously, gently, shyly, hungrily and exuberantly. We kiss in broad daylight and in the dead of night. We give ceremonial kisses, affectionate kisses, Hollywood air kisses, kisses of death and, at least in fairytales, pecks that revive princesses.

Lips may have evolved first for food and later applied themselves to speech, but in kissing they satisfy different kinds of hungers. In the body, a kiss triggers a cascade of neural messages and chemicals that transmit tactile sensations, sexual excitement, feelings of closeness, motivation and even euphoria.

Kissing might have evolved from mouth-to-mouth feeding of primate infants by their mothers. It could then have morphed into a strategy for comforting hungry children in the absence of food—and later into a more general way of expressing affection.

Not all the messages are internal. After all, kissing is a communal affair. The fusion of two bodies dispatches communiqués to your partner as powerful as the data you stream to yourself. Kisses can convey important information about the status and future of a relationship. So much, in fact, that, according to recent research, if a first kiss goes bad, it can stop an otherwise promising relationship dead in its tracks.

Some scientists believe that the fusing of lips evolved because it facilitates mate selection. "Kissing," said evolutionary psychologist Gordon G. Gallup of the University at Albany, State University of New York, last September in an interview with the BBC, "involves a very complicated exchange of information—olfactory information, tactile information and postural types of adjustments that may tap into underlying evolved and unconscious mechanisms that enable people to make determinations … about the degree to which they are genetically incompatible." Kissing may even reveal the extent to which a partner is willing to commit to raising children, a central issue in long-term relationships and crucial to the survival of our species.

FAST FACTS

Kiss and Tell

1» A kiss triggers a cascade of neural messages and chemicals that transmit tactile sensations, sexual excitement, feelings of closeness, motivation and even euphoria.

2» Kisses can convey important information about the status and future of a relationship. At the extreme, a bad first kiss can abruptly curtail a couple's future.

3» Kissing may have evolved from primate mothers' practice of chewing food for their young and then feeding them mouth-to-mouth. Some scientists theorize that kissing is crucial to the evolutionary process of mate selection.

Satisfying Hunger

Whatever else is going on when we kiss, our evolutionary history is embedded within this tender, tempestuous act. In the 1960s British zoologist and author Desmond Morris first proposed that kissing might have evolved from the practice in which primate mothers chewed food for their young and then fed them mouth-to-mouth, lips puckered. Chimpanzees feed in this manner, so our hominid ancestors probably did, too. Pressing outturned lips against lips may have then later developed as a way to comfort hungry children when food was scarce and, in time, to express love and affection in general. The human species might eventually have taken these proto-parental kisses down other roads until we came up with the more passionate varieties we have today.

Silent chemical messengers called pheromones could have sped the evolution of the intimate kiss. Many animals and plants use pheromones to communicate with other members of the same species. Insects, in particular, are known to emit pheromones to signal alarm, for example, the presence of a food trail, or sexual attraction.

Whether humans sense pheromones is controversial. Unlike rats and pigs, people are not known to have a specialized pheromone detector, or vomeronasal organ, between their nose and mouth [see "Sex and the Secret Nerve," by R. Douglas Fields; Scientific American Mind, February/March 2007]. Nevertheless, biologist Sarah Woodley of Duquesne University suggests that we might be able to sense pheromones with our nose. And chemical communication could explain such curious findings as a tendency of the menstrual cycles of female dormitory mates to synchronize or the attraction of women to the scents of T-shirts worn by men whose immune systems are genetically compatible with theirs. Human pheromones could include androstenol, a chemical component of male sweat that may boost sexual arousal in women, and female vaginal hormones called copulins that some researchers have found raise testosterone levels and increase sexual appetite in men.

KARL AMMANN *Corbis*

Kissing unleashes a cocktail of chemicals that govern stress, motivation, social bonding and sexual stimulation.

If pheromones do play a role in human courtship and procreation, then kissing would be an extremely effective way to pass them from one person to another. The behavior may have evolved because it helps humans find a suitable mate—making love, or at least attraction, quite literally blind.

We might also have inherited the intimate kiss from our primate ancestors. Bonobos, which are genetically very similar to us (although we are not their direct descendants), are a particularly passionate bunch, for example. Emory University primatologist Frans B. M. de Waal recalls a zookeeper who accepted what he thought would be a friendly kiss from one of the bonobos, until he felt the ape's tongue in his mouth!

Good Chemistry

Since kissing evolved, the act seems to have become addictive. Human lips enjoy the slimmest layer of skin on the human body, and the lips are among the most densely populated with sensory neurons of any body region. When we kiss, these neurons, along with those in the tongue and mouth, rocket messages to the brain and body, setting off delightful sensations, intense emotions and physical reactions.

Of the 12 or 13 cranial nerves that affect cerebral function, five are at work when we kiss, shuttling messages from our lips, tongue, cheeks and nose to a brain that snatches information about the temperature, taste, smell and movements of the entire affair. Some of that information arrives in the somatosensory cortex, a swath of tissue on the surface of the brain that represents tactile information in a map of the body. In that map, the lips loom large because the size of each represented body region is proportional to the density of its nerve endings [*see illustration on page 29*].

Kissing unleashes a cocktail of chemicals that govern human stress, motivation, social bonding and sexual stimulation. In a new study, psychologist Wendy L. Hill and her student Carey A. Wilson of Lafayette College compared the levels of two key hormones in 15 college male-female couples before and after they kissed and before and after they talked to each other while holding hands. One hormone, oxytocin, is involved in social bonding, and the other, cortisol, plays a role in stress. Hill and Wilson predicted that kissing would boost levels of oxytocin, which also influences social recognition, male and female orgasm, and childbirth. They expected this effect to be particularly pronounced in the study's females, who reported higher levels of intimacy in their relationships. They also forecast a dip in cortisol, because kissing is presumably a stress reliever.

But the researchers were surprised to find that oxytocin levels rose only in the males, whereas it decreased in the females, after either kissing or talking while holding hands. They concluded that females must require more than a kiss to feel emotionally connected or sexually excited during physical contact. Females might, for example, need a more romantic atmosphere than the experimental setting provided, the authors speculate. The study, which Hill and Wilson reported in November 2007 at the annual meeting of the Society for Neuroscience, revealed that cortisol levels dropped for both sexes no matter the form of intimacy, a hint that kissing does in fact reduce stress.

To the extent that kissing is linked to love, the act may similarly boost brain chemicals associated with pleasure, euphoria and a motivation to connect with a certain someone. In 2005 anthropologist Helen Fisher of Rutgers University and her colleagues reported scanning the brains of 17 individuals as they gazed at pictures of people with whom they were deeply in love. The researchers found an unusual flurry of activity in two brain regions that govern pleasure, motivation and reward: the right ventral tegmental area [*see illustration on next page*] and the right caudate nucleus. Addictive drugs such as cocaine similarly stimulate these reward centers, through the release of the neurotransmitter dopamine. Love, it seems, is a kind of drug for us humans.

Kissing has other primal effects on us as well. Visceral marching orders boost pulse and blood pressure. The pupils dilate, breathing deepens

(The Author)

CHIP WALTER is Author in Residence at the Mellon Institute at Carnegie Mellon University. His most recent book is *Thumbs, Toes, and Tears: And Other Traits That Make Us Human* (Walker & Company, 2006). He is currently writing a book about how genes and primal drives subconsciously shape much of human behavior.

and rational thought retreats, as desire suppresses both prudence and self-consciousness. For their part, the participants are probably too enthralled to care. As poet e. e. cummings once observed: "Kisses are a better fate / than wisdom."

Litmus Test

Although a kiss may not be wise, it can be pivotal to a relationship. "One dance," Alex "Hitch" Hitchens says to his client and friend in the 2005 movie *Hitch,* "one look, one kiss, that's all we get … one shot, to make the difference between 'happily ever after' and, 'Oh? He's just some guy I went to some thing with once.'"

Can a kiss be that powerful? Some research indicates it can be. In a recent survey Gallup and his colleagues found that 59 percent of 58 men and 66 percent of 122 women admitted there had been times when they were attracted to someone only to find that their interest evaporated after their first kiss. The "bad" kisses had no particular flaws; they simply did not feel right—and they ended the romantic relationship then and there—a kiss of death for that coupling.

The reason a kiss carries such weight, Gallup theorizes, is that it conveys subconscious information about the genetic compatibility of a prospective mate. His hypothesis is consistent with the idea that kissing evolved as a courtship strategy because it helps us rate potential partners.

From a Darwinian perspective, sexual selection is the key to passing on your genes. For us humans, mate choice often involves falling in love. Fisher wrote in her 2005 paper that this "attraction mechanism" in humans "evolved to enable individuals to focus their mating energy on specific others, thereby conserving energy and facilitating mate choice—a primary aspect of reproduction."

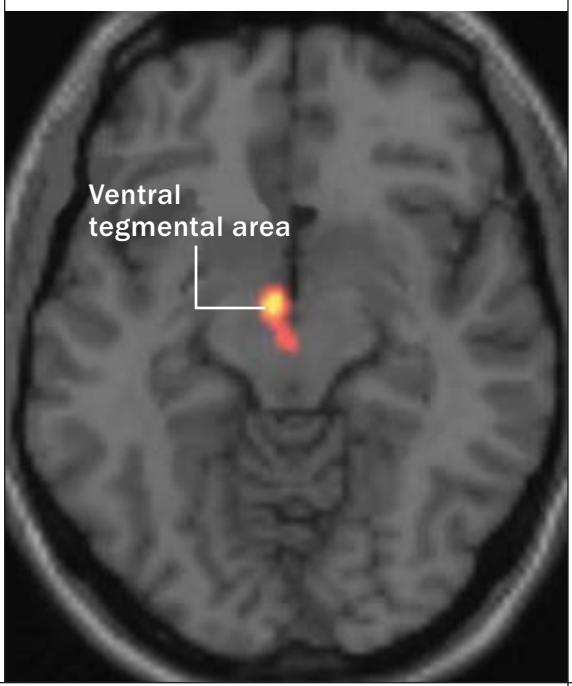
According to Gallup's new findings, kissing may play a crucial role in the progression of a partnership but one that differs between men and women. In a study published in September 2007 Gallup and his colleagues surveyed 1,041 college undergraduates of both sexes about kissing. For most of the men, a deep kiss was largely a way of advancing to the next level sexually. But women were generally looking to take the relationship to the next stage emotionally, assessing not simply whether the other person would make a first-rate source of DNA but also whether he would be a good long-term partner.

> A kiss may convey subconscious information about the genetic compatibility of a potential mate.

"Females use [kissing] … to provide information about the level of commitment if they happen to be in a continuing relationship," Gallup told the BBC in September. The locking of lips is thus a kind of emotional barometer: the more enthusiastic it is, the healthier the relationship.

Because women need to invest more energy in producing children and have a shorter biological window in which to reproduce, they need to be pickier about whom they choose for a partner—and they cannot afford to get it wrong. So, at least for women, a passionate kiss may help them choose a mate who is not only good at fathering children but also committed enough to stick around and raise them.

That said, kissing is probably not strictly necessary from an evolutionary point of view. Most other animals do not neck and still manage to produce plenty of offspring. Not even all humans kiss. At the turn of the 20th century Danish scientist Kristoffer Nyrop described Finnish tribes whose members bathed together but considered kissing indecent. In 1897 French anthropologist Paul d'Enjoy reported that the Chinese regard



Looking at someone with whom you are deeply in love, one study showed, activates the brain's ventral tegmental area, a pleasure center that addictive drugs also stimulate. If kissing is linked to love, it may similarly act like a drug in the brain.

COURTESY OF HELEN FISHER *Rutgers University*

mouth-to-mouth kissing to be as horrifying as many people deem cannibalism to be. In Mongolia some fathers do not kiss their sons. (They smell their heads instead.)

In fact, up to 10 percent of humanity does not touch lips, according to human ethology pioneer Irenäus Eibl-Eibesfeldt, now head of the Max-Planck-Society Film Archive of Human Ethology in Andechs, Germany, writing in his 1970 book, *Love and Hate: The Natural History of Behavior Patterns*. Fisher published a similar figure in 1992. Their findings suggest that some 650 million members of the human species have not mastered the art of osculation, the scientific term for kissing; that is more than the population of any nation on earth except for China and India.

Lopsided Love

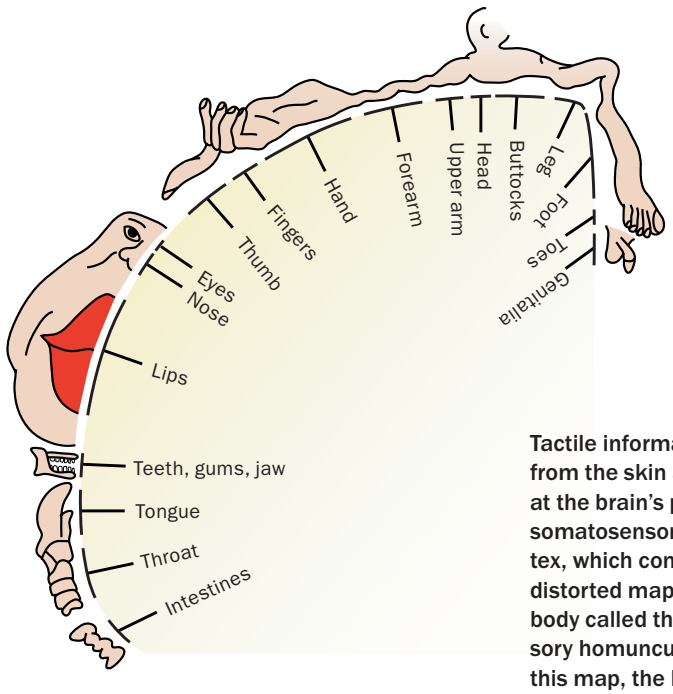
For those cultures that do kiss, however, osculation conveys additional hidden messages. Psychologist Onur Güntürkün of the Ruhr-University of Bochum in Germany recently surveyed 124 couples kissing in public places in the U.S., Germany and Turkey and found that they tilted their heads to the right twice as often as to the left before their lips touched. Right-handedness cannot explain this tendency, because being right handed is four times more common than is the act of kissing on the right. Instead Güntürkün suspects that right-tilted kissing results from a general preference that develops at the end of gestation and in infancy. This "behavioral asymmetry" is related to the lateralization of brain functions such as speech and spatial awareness.

Nurture may also influence our tendency to tilt to the right. Studies show that as many as 80 percent of mothers, whether right-handed or left-handed, cradle their infants on their left side. Infants cradled, face up, on the left must turn to the right to nurse or nuzzle. As a result, most of us may have learned to associate warmth and security with turning to the right.

Some scientists have proposed that those who tilt their heads to the left when they kiss may be showing less warmth and love than those who tilt to the right. In one theory, tilting right exposes the left cheek, which is controlled by the right, more emotional half of the brain. But a 2006 study by naturalist Julian Greenwood and his colleagues at Stranmillis University College in Belfast, Northern Ireland, counters this notion. The researchers found that 77 percent of 240 undergraduate students leaned right when kissing a doll on the cheek or lips. Tilting to the right with the doll, an impassive act, was nearly as prevalent among subjects as it was among 125 couples observed osculating in Belfast; they tilted right 80 percent of the time. The conclusion: right-kissing probably results from a motor preference, as Güntürkün hypothesized, rather than an emotional one.

Despite all these observations, a kiss continues to resist complete scientific dissection. Close scrutiny of couples has illuminated new complexities woven throughout this simplest and most natural of acts—and the quest to unmask the secrets of passion and love is not likely to end soon. But romance gives up its mysteries grudgingly. And in some ways, we like it like that. M

Sensory Homunculus



Tactile information from the skin arrives at the brain's primary somatosensory cortex, which contains a distorted map of the body called the sensory homunculus. In this map, the lips are disproportionately large because they are densely populated with sensory receptors and, therefore, acutely sensitive to touch.

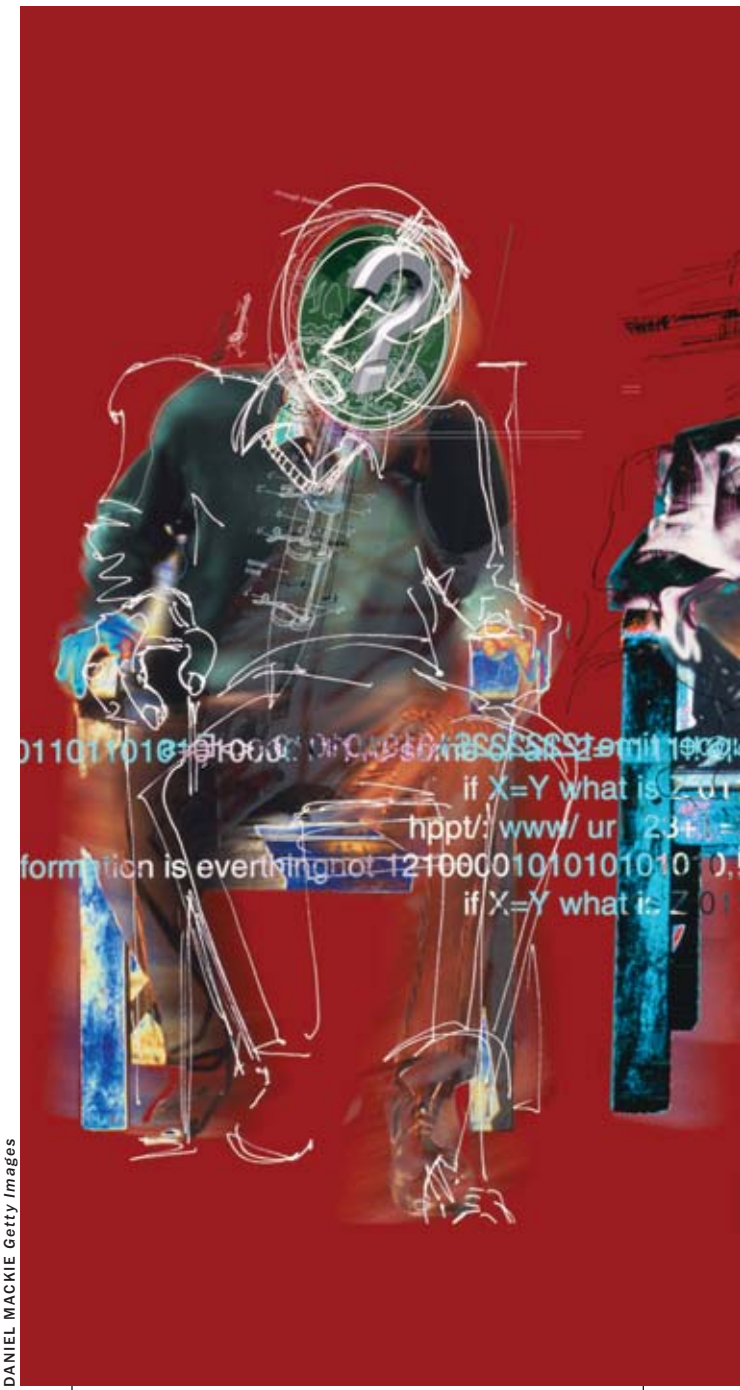
(Further Reading)

- **Love and Hate: The Natural History of Behavior Patterns.** First translated edition. Irenäus Eibl-Eibesfeldt. Holt, Rinehart and Winston, 1972.
- **Adult Persistence of Head-Turning Asymmetry.** Onur Güntürkün in *Nature,* Vol. 421; February 13, 2003.
- **Human Pheromones and Sexual Attraction.** Karl Grammer, Bernhard Fink and Nick Neave in *European Journal of Obstetrics & Gynecology and Reproductive Biology,* Vol. 118, No. 2, pages 135–142; February 1, 2005.
- **Romantic Love: An fMRI Study of a Neural Mechanism for Mate Choice.** Helen Fisher, Arthur Aron and Lucy L. Brown in *Journal of Comparative Neurology,* Vol. 493, No. 1, pages 58–62; December 5, 2005.
- **Kissing Laterality and Handedness.** Dianne Barrett, Julian G. Greenwood and John F. McCullagh in *Laterality: Asymmetries of Body, Brain, and Cognition,* Vol. 11, No. 6, pages 573–579; November 2006.
- **Sex Differences in Romantic Kissing among College Students: An Evolutionary Perspective.** Gordon G. Gallup, Jr., Susan M. Hughes and Marissa A. Harrison in *Evolutionary Psychology,* Vol. 5, No. 3, pages 612–631; 2007.

GEHIRN & GEIST/SIGANIM; SOURCE: PENFIELD AND RASMUSSEN, 1950

When Morality Is Hard to Like

How do we juggle evidence and emotions to make a moral decision?



DANIEL MACKIE *Getty Images*

On August 2, 1939, as the specter of the second World War loomed, Albert Einstein wrote President Franklin D. Roosevelt a letter he knew could affect the war and the future of humanity. The subject was the possibility of developing nuclear weapons. "Certain aspects of this situation," Einstein wrote,

> *... seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations....*

Einstein's letter encapsulates key aspects of moral judgment: moral sentiment (his concern about the outcome of World War II); recognition of a moral dilemma (whether to disclose scientific evidence that could lead to a fearsomely lethal new weapon) and a utilitarian calculus (Would more lives be spared if America rather than Germany eventually built such a weapon?). It must have been a terrible struggle deciding whether to write that letter.

Half a century later cognitive neuroscience is gaining the ability to explain the brain mechanisms that underlie such moral judgments and ethical deliberations. Empirical studies have examined issues such as how a sense of morality arises in a child's developing brain, how various kinds of brain damage affect moral judgment, which brain areas seem to be at play when we feel moral disgust, and how we think our way through confusing moral dilemmas. The results have been compelling; carry out an Internet search for "brain and morality," and you will get a taste of this rich and growing literature.

A crucial issue that remains poorly understood, however, is the

By Jorge Moll and Ricardo de Oliveira-Souza

relation between moral reasoning and emotion. How does emotion affect our judgment about what is moral? A study published last April in *Nature* offers important new insight into this question. Michael Koenigs, now a postdoctoral fellow at the National Institute of Neurological Disorders and Stroke, Liane Young, a graduate student in cognitive psychology at Harvard University, and their colleagues found that damage to a brain area known as the ventromedial prefrontal cortex (VMPFC, a region of the prefrontal cortex located above our eye sockets) increases a preference for "utilitarian" choices in moral dilemmas—judgments that favor the aggregate welfare over the welfare of fewer individuals. The study adds to an already hot debate about how we juggle facts and emotion to make moral decisions.

Rationalizing Morality

Koenigs, Young and their collaborators gave a test on moral decision making to three different groups of people: six patients with bilateral VMPFC damage, another group of neurologically normal control subjects and a group of patients with lesions in other brain regions. The test subjects confronted decision-making scenarios in four main classes. One class contained "high conflict" (morally ambiguous) and emotionally salient "personal" moral scenarios, such as whether to push a bulky stranger onto the track of a runaway trolley (thus killing the stranger) if doing so would save the lives of five workers down the line. A second class contained "low conflict" (morally unambiguous) but highly personal scenarios, such as whether it would be moral for a man to hire someone to rape his wife so he could later comfort her and win her love again. A third class offered morally ambiguous but relatively nonpersonal scenarios, such as whether it would be okay to lie to a security guard and "borrow" a speedboat to warn tourists of a deadly impending storm. A fourth class consisted of ambiguous but nonmoral scenarios, such as whether to take the train instead of the bus to arrive somewhere punctually.

In the clear-cut, low-conflict personal scenarios, the VMPFC patients and controls performed alike, unanimously responding "no" to examples such as the one mentioned above. But when pondering the more emotionally charged high-ambiguity situations, the VMPFC patients were much more likely than others to endorse utilitarian decisions that would lead to greater aggregate welfare. They were far more willing than others were, for instance, to push that one fellow passenger in front of the train to save the group of workers down the track.

Reason vs. Emotion?

Why should people who have damage to the VMPFC show greater preference for utilitarian choices? It is tempting to attribute this preference to a general emotional blunting—a trait commonly found in patients with prefrontal damage. Reduced emotion would presumably make these patients more prone to utilitarian reasoning. But an earlier study that Koenigs and Daniel Tranel, a neurology professor at the University of Iowa Hospitals and Clinics, did with VMPFC-damaged patients argues otherwise. In that study, VMPFC patients played the "ultimatum game."

In this game, a pair of players is offered a sum of money. Player A proposes some division of the money with player B; if player B rejects the proposed division, neither player gets any money. For player B, the strictly utilitarian decision is to accept any proposal, even if he or she gets only 1 percent of the money, because rejecting the offer means no gain at all. But most people will reject highly imbalanced offers because such offers of-

FAST FACTS

Where Morality Resides

1» In the past decade or so cognitive scientists have begun examining what happens in the brain when we struggle with moral and ethical decisions.

2» A recent paper in *Nature* examined this question by comparing moral judgments made by neurologically normal people with those made by people with damage to a brain area known to be active in moral sentiment—the ventromedial prefrontal cortex, or VMPFC.

3» The study found that people with VMPFC damage were more likely to make utilitarian choices in moral dilemmas—judgments that favor the aggregate welfare over the welfare of fewer individuals.

4» VMPFC patients, for instance, were more likely to say it was okay to push a man in front of a moving train if you knew the resulting stoppage would save the lives of five workers down the track.

5» These responses concur with recent research indicating that the VMPFC plays an important role in "prosocial sentiments," such as guilt, compassion and empathy—the lack of which may make it easier to make utilitarian judgments that might otherwise feel abhorrent.

The Virtue in Being Morally Wrong

By David Pizarro

... a Utilitarian may reasonably desire, on Utilitarian principles, that some of his conclusions should be rejected by mankind generally ...

—Henry Sidgwick, *The Methods of Ethics* (1884)

It once seemed obvious to most scholars that our ability to reason was what made us moral creatures. Unlike the lowly animals, we could reason our way to a set of moral principles and (sometimes even) adhere to them. Yet along the way a few insightful thinkers, such as 18th-century philosophers David Hume and Adam Smith, argued that it was the "warm" feelings of sympathy and compassion, not the cold rules of logic, that seemed most responsible for our moral sense.

A century after psychology's move out of the armchair and into the laboratory, the debate over the roots of morality is receiving more attention than ever. As Jorge Moll and Ricardo de Oliveira-Souza describe in the accompanying article, much of that attention comes from cognitive neuroscientists. A paper by Michael Koenigs, Liane Young and their colleagues in *Nature* adds some interesting wrinkles to the long debate over morality's wellsprings. The authors show that patients with damage to the ventromedial prefrontal cortex, or VMPFC, are consistently utilitarian in their moral decisions. The judgments of these patients, who appear unmoved by the prospect of shoving someone to his or her death so long as the math works out, look less like the frequent nonutilitarian judgments of normal participants and more like the responses of sociopaths.

What about Ought?

As Moll and de Oliveira-Souza note, these findings elucidate the relative contributions of reason and emotion to moral judgment. They also have implications for a more controversial question: What should our moral judgments in these scenarios be? Are the normal people in the Koenigs study making the right call by rejecting utilitarianism if the utilitarian option is emotionally daunting? This line of questioning is often brushed aside with a reminder that empirical findings should have no say over questions of ethics; crossing the line between what is and what ought to be is a no-no. But if sociopaths and brain-damaged patients make judgments that normal people find morally abhorrent, isn't that good evidence that the normal people are right? Shouldn't we be proud of our nonutilitarian tendencies?

This conclusion might hold water if it were not for the fact that some people other than sociopaths and brain-injured patients also stubbornly endorse utilitarianism. Many nonsociopathic, healthy-brained philosophers and social scientists take utilitarianism quite seriously. For them, the emotions that make us sheepish about acting for the greater good should not play a role in moral judgment at all.

Are Utilitarians Good Roommates?

So, unlike, say, choosing a basketball team to root for, it is hard to know where to stand on utilitarianism by taking a look at the team's fans. Does this fact mean that psychology can contribute nothing to this debate?

Imagine that you are in charge of fashioning a new species of humanlike creature from scratch. Would you strip this new species of the brain regions and emotional reactions responsible for our nonutilitarian tendencies, ensuring they would have no problem sacrificing a few for the sake of many? Even for utilitarians this notion can be disturbing, as exemplified by Sidgwick's statement. As one of my economist colleagues put it, if you know a man who is perfectly fine with the notion of tossing someone off a bridge (even if it is for the greater good), it is a pretty good bet that he is not the kind of person who is going to win father of the year, donate to charity or be loyal to his team.

Utilitarianism may, in the end, be the right moral theory. But we want people who are utilitarians not because they are emotionally blunted (such as sociopaths and brain-damaged patients) but because they have decided that their warm, tender emotions should be set aside in a few specific cases. Maybe some people are capable of this subtle emotional regulation. But for most of us, being good utilitarians would require sacrificing emotions that, although they might make us morally superior, would also make us jerks.

David Pizarro is assistant professor of psychology at Cornell University.

ALAN THORNTON Getty Images

fend their sense of fairness. The VMPFC players, however, rejected imbalanced offers more often than control subjects did—apparently because they allowed an insult over the inequitable but profitable proposal to overrule utilitarian reason. Overall emotional dullness and increased utili-

(The Authors)

JORGE MOLL is director of and RICARDO DE OLIVEIRA-SOUZA is a researcher at the Cognitive and Behavioral Neuroscience Unit at Labs D'Or, a research institute in Rio de Janeiro, where they investigate the neural underpinnings of altruism and antisocial behavior.

We Get Comments ...

Like most blogs, Mind Matters invites reader comments and questions. Below are excerpts from the exchange that followed a post by Moll and de Oliveira-Souza and a post by Pizarro.

Carol Hatcher: No, I would not push a bulky person in front of a train in attempt to stop it to save five. Why? (1) Physics: there is no way in God's green earth that a 200- or 300-pound person is going to stop several thousand tons going even 30 miles an hour. Children should be raised with that understanding, and anyone who does not understand that should go back to grade school. Even assuming that (1) is negated, I still would not. Why? Physics again. If I could stop the train with a body on the tracks—it will not be a simple stop—it will be a train wreck. Train wrecks are messy, and many people will be killed or hurt on and around the train. Increased body count here beyond the five workmen and the bystander. Now if we were able to stop the train with a body on the tracks, why should we choose the person in the station? Why shouldn't one of the workers on the tracks ahead do just as well? After all, the train in this mythical universe can't hit them all at the same time. The closest workman will stop the train, and the rest will be saved. People who chose a dangerous profession versus someone who did not choose at all.

Yes, I am not in the "spirit" of the question. Yet the moral dilemma was presented to me to THINK about, to evaluate and respond. So I did. How can anyone even begin to question the great physicist Einstein's response to his moral dilemma if you do not understand the physical world around you?

Munish Ratanpal: It would be interesting to ask the VMPFC patients if they would push themselves in front of the train to save the five workers below. Is their utilitarian reasoning strong enough to override their survival instincts? What if not five but 100 workers were involved? If they are so cool about throwing a stranger in front of a train (for the greater good!), logically they shouldn't make an exception for themselves.

Mind Matters editor David Dobbs: To address Hatcher's reservations about physics and such: First, I should clarify that regarding the "physics" question—that is, how would a bulky man stop the train?—I believe the assumption in this hypothetical ethical problem is not that the man's bulk would stop the train but that the resulting accident would cause the train operators to stop the train, thus (unknowingly) sparing the workmen down the track. The problem also assumes you won't be caught for pushing the man on the tracks and thus be accused of murder. It is obviously an artificial question, meant to address ethical and moral matters rather than practical matters.

One of the authors noted, in a phone conversation as we were discussing these pieces, a similar ethical scenario that is a bit more disturbing to contemplate: If you were with a group of people being hunted by killers (who, it is assumed, will kill everyone in your group), would it be moral to smother a crying baby, unrelated and previously unknown to you, to save the group? Refugees fleeing from genocidal militia have had to face this question in real life—with the cruel twist that in many cases it is a parent faced with killing or abandoning an infant to save the rest

tarian reasoning thus seem unlikely explanations for the behavior of VMPFC patients.

A more parsimonious account, hypothesized in a *Nature Reviews Neuroscience* paper, is that reason and emotion cooperate to produce moral sentiments. The VMPFC would be especially important for the so-called prosocial sentiments. These feelings include guilt, compassion and empathy, and they emerge when states such as sadness and affiliation, which rise from limbic areas, are integrated with other mechanisms mediated by anterior sectors of the VMPFC, such as prospective evaluation of salient outcomes. Functional imaging studies support this idea. As we describe in a 2007 paper in *Social Neuroscience* and in previous research, the VMPFC is engaged not just when people make explicit moral judgments but also when they are passively exposed to stimuli evocative of prosocial moral sentiments (such as a hungry child). Interestingly, the anterior VMPFC was engaged when volunteers chose to sacrifice money to donate to charities—a decision that is both utilitarian and emotional—as we describe in a 2006 paper in the *Proceedings of the National Academy of Sciences USA*.

The impairment of prosocial sentiments, resulting from damage to the ventral part (or underside) of the prefrontal cortex, along with a preserved capacity to experience aversive emotional reactions associated with anger or frustration (relying more on lateral sectors of the PFC and subcortical connections), could explain the otherwise puzzling results of the two Koenigs studies. The VMPFC-damaged patients playing the ultimatum game, for instance, let emotions such as anger and contempt steer nonutilitarian decisions to reject unfair offers. VMPFC patients were more utilitarian when facing difficult moral

of a large family. Some, I have read—I can't recall where; sorry—choose to save families by leaving noisier and nutritionally costlier infants behind; others don't. The utilitarian spectrum has infinite and disturbing variation.

Even as a hypothetical situation, this crying-baby scenario raises a slightly different set of considerations than the train-platform question does: it assumes that the baby will die whether you smother it or not (either you kill it or the murderers will), whereas the man on the platform will live if you don't push him. But the noisy-baby scenario gets at some of the same questions of agency and utilitarianism—and a deeper squirm factor—while forgoing issues of physics.

Ratanpal's notion of asking patients seems to me a natural and inevitable one to ask. The answer is both obvious (of *course,* most people would treat that scenario differently) and wildly obscure (but *why* is that scenario so different—even, presumably, to a utilitarian?). I think we all recognize that sacrificing oneself differs in many ways from sacrificing another. I would bet that the different feelings and calculations the self-sacrifice prospect evokes involve additional sets of brain areas than the scenario involving sacrificing others does. To me, one of the interesting questions that difference raises regards empathy (or its lack). Do VMPFC patients generally feel less empathy for others? Does empathy depend on prosocial sentiments—or does it generate them? Or are they one and the same?

These scenarios are so disturbing and the questions so difficult—of necessity, given that the studies seek to evoke and examine heavily laden moral decisions.

Vivek Viswanathan: I think there may be a bit of a misunderstanding. Utilitarians would be extremely likely to give to a charity that distributes bed nets in Africa, for example, because the good of saving lives far exceeds anything that person could spend money on (assuming he is relatively well off). Recognizing the good to humanity of raising a good, functional child, he may well win father of the year. Recognizing the good that affection brings, he may well be very affectionate and loving. Utilitarianism does not imply acting robotically. It just means that one acts in a way that attempts to maximize the happiness of all sentient beings from now until infinity.

Furthermore, all morality is based on assumptions. There is no "right" ethical system. But utilitarianism in particular can be constructed by combining notions of valuing happiness and having infinite empathy (valuing every individual as one values oneself). It's not a lack of empathy that brings about utilitarianism. It is full empathy.

David Boshell: And the moral is: never stand between a utilitarian and a train.

Each week in Mind Matters, www.SciAmMind.com's expert-written "blog seminar," researchers of mind and brain explain and discuss their disciplines' most notable recent findings. In this installment, Jorge Moll and Ricardo de Oliveira-Souza consider the interface of reason and morality.

Mind Matters examines a new finding every week. Join the discussion at www.SciAmMind.com

dilemmas, however, because the damage to the ventral parts of their prefrontal cortex reduced their prosocial sentiments, giving a relative advantage to coldhearted reasoning.

Not So Simple Juggling

This explanation returns us to Einstein's dilemma. Einstein's letter to Roosevelt helped to prepare the U.S. to build the first atomic bombs. Those bombs killed tens of thousands of civilians—but in doing so, they ended World War II. Was Einstein's utilitarian choice cold-blooded, resulting from emotions being overpowered by pure cognition? We do not think so. Einstein's reason and sentiments seem to have been working together just fine, reflecting fully the interplay of thought, emotion, empathy and foresight—as well as anguish and ambivalence—that complex moral decisions entail. M

(Further Reading)

- **Opinion: The Neural Basis of Human Moral Cognition.** J. Moll, R. Zahn, R. de Oliveira-Souza, F. Krueger and J. Grafman in *Nature Reviews Neuroscience,* Vol. 6, No. 10, pages 799–809; October 2005.
- **Human Fronto-mesolimbic Networks Guide Decisions about Charitable Donation.** J. Moll, F. Krueger, R. Zahn, M. Pardini, R. de Oliveira-Souza and J. Grafman in *Proceedings of the National Academy of Sciences USA,* Vol. 103, No. 42, pages 15623–15628; October 17, 2006.
- **The Science of Good and Evil.** Michael Shermer. Times Books, 2006.
- **The Self as a Moral Agent: Linking the Neural Bases of Social Agency and Moral Sensitivity.** J. Moll, R. de Oliveira-Souza, G. J. Garrido, I. E. Bramati, E.M.A. Caparelli-Daquer, M.L.M.F. Paiva, R. Zahn and J. Grafman in *Social Neuroscience,* Vol. 2, Nos. 3–4, pages 336–352; January 2007.
- **Irrational Economic Decision-Making after Ventromedial Prefrontal Damage: Evidence from the Ultimatum Game.** Michael Koenigs and Daniel Tranel in *Journal of Neuroscience,* Vol. 27, No. 4, pages 951–956; January 24, 2007. Available at **http://tinyurl.com/2uzjy3**
- **Kill One to Save Many? Brain Damage Makes Decision Easier.** Nikhil Swaminathan on www.SciAm.com, March 21, 2007. Available at **http://tinyurl.com/27bhme**
- **Damage to the Prefrontal Cortex Increases Utilitarian Moral Judgments.** M. Koenigs, L. Young, R. Adolphs, D. Tranel, F. Cushman, M. Hauser and A. Damasio in *Nature,* Vol. 446, pages 908–911; April 19, 2007.

TIM RIDLEY *Getty Images*

An Odd Sense of Timing

THE QUESTION OF HOW CHANGES IN THE ENVIRONMENT GIVE RISE TO THE SUBJECTIVE EXPERIENCE OF TIME IN OUR BRAIN CONTINUES TO CHALLENGE PSYCHOLOGISTS AND BRAIN RESEARCHERS BY PASCAL WALLISCH

In a classic scene in the science-fiction blockbuster *The Matrix*, life starts to run in slow motion. Guns are fired at the main character Neo, but the bullets fly as if through molasses—and our hero's quickened reflexes allow him to jump out of harm's way. Many of us have experienced a similar deceleration of events during accidents or other life-and-death situations. You see the tree branch on the road, hit the brakes, and it seems like an eternity before you know if you avoided the collision or were too late.

Of course, we know that physical time does not objectively slow down just because we are subjectively stressed out. But can we really think and act more quickly in a fear-provoking situation? Recently neuropsychologist David M. Eagleman of the Baylor College of Medicine decided to find out by asking psychology graduate students to jump 150 feet from a high metal scaffolding into the center of a safety net.

Eagleman's tower: Students plunging through the air experience a prolonged sense of time—but do not have quickened senses.

During their free fall his human projectiles wore displays on their wrists on which numbers appeared in rapid succession. The digital figures flickered just fast enough so that they were not legible under normal conditions. Eagleman wanted to know if the test subjects could take in more information per time interval under conditions of intense fear. In other words, would a slowing of subjective time allow them to pick out the otherwise indecipherable speeding numbers?

Not surprisingly, his students were scared out of their wits. In addition, they reported that their fall appeared to take about twice as long as it actually did. Nevertheless, they were not significantly better at reading the numbers on the display than someone under less death-defying circumstances would be.

What Eagleman's experiment demonstrates dramatically is that the conscious human mind—despite astonishing powers of observation, cognition and reason—can be a remarkably lousy clock. Our sense of time speeds up or slows down in response to many factors, including fear and stress. Our mind easily enters such states of "temporal illusion" in which our judgment of time (and our perceived ability to dodge bullets) certainly cannot be trusted. For more than a century, cognitive scientists have been investigating the timekeeping abilities of our brain and how they relate to our conscious sense of time. Despite these efforts, understanding the underlying mechanisms remains one of the greatest challenges of modern cognitive neuroscience.

FAST FACTS

Internal Clocks

1» Our perception of time varies. In the here and now, busy phases seem short, monotonous ones long. In our memories, the opposite is true.

2» Two events may look simultaneous but sound sequential because our sense of hearing is much better than our vision is at resolving tightly spaced events.

3» The brain contains a variety of internal clocks and rhythm detectors that might influence the experience of time.

The Good Clocks

The poor sense of timing demonstrated by our conscious minds is all the more puzzling because in other ways our brains prove to be rather precise chronometers. Consider, for example, the unconscious control of movements. Anyone who has ever tried tennis knows that players have just a few tenths of a second to anticipate where the ball will land, how to position their bodies and at what angle to direct their return. Other motor tasks such as walking, juggling or driving also rely on accurately timed motor actions on a subsecond scale.

The execution of such precise movements suggests that animals' brains contain one or more biological clocks. Just like the watches that adorn our wrists and chronometers that appear on everything from car dashboards to microwave ovens, these biological clocks presumably depend on the detection and counting of periodically occurring invariant patterns. In our case, periodic salvos of nerve cell impulses in the brain—much like the beat of a metronome—make for a perfect timing signal that could be "counted" by other neurons.

In the case of movement control, a number of regions in the brain have to be coordinated to create appropriate motor actions. These regions include a network of cortical areas as well as subcortical nuclei such as the basal ganglia, but the timing or pacing information seems to originate in the cerebellum. Because of its architecture, this region is particularly suited for the task of timing. The dendritic trees of large Purkinje cells in the outer layers of the cerebellum form a parallel and evenly spaced grid through which the axons of other neurons run perpendicularly. As electrical impulses tend to run through these perpendicular axons at the same speed, motor signals can be timed and synchronized with great precision.

It is not just the sudden twitch, however, that the brain can measure accurately. Longer timescales seem to be involved as well. For instance, even when deprived of external time cues for a few days, people will complete the cycle of sleeping, waking and eating on a somewhat regular schedule. In the 1930s physiologist Hudson Hoagland, then at Clark University, hypothesized that a central clock driven by chemical processes in the body could be responsible for this regularity. But only by the early 1980s did researchers hit on a likely candidate in the brain: the suprachiasmatic nucleus (SCN).

This tiny cluster of barely more than 3,000 neurons is situated directly above the crossing of

COURTESY OF ZERO GRAVITY THRILL AMUSEMENT PARK

Although the brain seems to have accurate biological clocks, our mind's eye appears unable to read them.

the optic nerves—more or less immediately behind the eyes—and plays a crucial role in regulating the sleep-wake cycle of the organism, which involves body temperature, hormone metabolism and general level of alertness. The SCN emits rhythmic signals to the nearby pituitary gland, which then releases messenger substances into the blood, as well as to the pineal gland, which is responsible for the production and release of melatonin. This is a natural cycle of slightly more than 24 hours—which is why it is referred to as the circadian rhythm (the Latin *circa* means "approximately," and *dies* means "day").

Frequent fliers and shift workers know all too well how persistent circadian rhythms can be. The symptoms of jet lag after intercontinental flights or the particular disorientation that results from working different shifts may take days to subside as the body's natural rhythm adapts to its new surroundings or schedule.

Tell Me When

The irony is that although the brain seems to have accurate biological clocks at its disposal, our mind's eye appears unable to read them. Instead exactly how long or short a minute, an hour or a day appears to us varies dramatically and can depend on a multitude of diverse influences, including physiological factors such as body temperature and fatigue or mental disorders such as schizophrenia and depression. It has been shown that even drugs such as LSD and cocaine can have profound effects, accelerating or decelerating the subjective passage of time.

Thus, the psychological experience of time—as is the case in all other senses—can be predictably affected by our physical state. This is probably best established in the case of body temperature: high temperatures are associated with an expansion of subjective time, whereas low body temperatures correspond to a shortening of subjective time. In other words, a person with a fever is bound to experience a given period as longer than someone without the fever.

But Eagleman's "high jump" experiment and many others demonstrate that it is easy to manipulate our temporal sense using psychological triggers, shrinking and expanding our sense of a minute or hour by simply changing sensory inputs or emotional states.

DAVID NAGEL *Getty Images*

Playing any sport requires the precise control of muscles by timing centers in the brain.

For instance, time passes very quickly whenever we are subjected to a large number of new, fast-changing or complex stimuli, such as when we are playing an engrossing video game. Presumably the limited resources of our attention are absorbed by the demands of the fast-paced perceptual situation. In contrast, during periods of low stimulation—such as when waiting in a long line or when performing routine tasks—time seems to crawl very slowly.

In hindsight, matters look quite different, as British psychologist John Wearden of Keele University in England demonstrated in 2005. He showed a group of test subjects a nine-minute clip

JOHN LUND Getty Images

No magazines? Time spent in waiting rooms and in line can seem endless, unless the mind has something engaging to focus on.

from the movie *Armageddon*. A second group spent the same amount of time in a waiting room without anything to do. Which group experienced time as subjectively faster? No question about it, the minutes flew by for those watching the film clip.

When the researchers questioned the test subjects again some time later, however, those who had sat in the waiting room twiddling their thumbs during the experiment estimated the time as a good 10 percent shorter than those who had watched the movie. In retrospect, an eventful period appears longer, phases of boredom shorter. What seems to be crucial is the quantity of amassed memory. Rich and varied memories are associated with long periods, less intense or similar memories with shorter ones. This neatly illustrates that the subjective experience of time arises from the interplay—some say as the by-product—of processes in attention and memory.

Three-Second Rule

Yet humans estimate at least one time interval accurately. This oddly persistent ability was first described in 1868 by an early pioneer of time research, Karl von Vierordt, who dubbed this time interval the "point of indifference." Study subjects estimated that tones shorter than three seconds in duration lasted longer than their actual duration while those longer than three seconds were reported as being shorter.

The three-second point of indifference—the interval at which the subjective impression and objective duration are about the same—has remained unchanged throughout the past century. In view of the technological and social revolutions—and cultural speedup—of the past 100 years, this consistency seems rather remarkable. Modern high-speed transportation and rapid communications make for a hurried way of life. Television and video clips accelerate our visual habits. Nevertheless, this critical three-second threshold seems to remain invariant, suggesting it is hardwired into the brain.

Some experts believe this same time window may be related to another aspect of time, our experience of the present. Brain researchers such as Ernst Poeppel of the University of Munich take this view. Poeppel coined the term "subjective present" for the narrow saddle in time of that which is not quite yet past and that which is barely not still in the future—the mental "now."

Poeppel draws his conclusion from observations such as the following example: try to speak a series of meaningless syllables such as "ba kyoo ba kyoo ba kyoo" as fast as possible. After even a short time, the sounds will fuse into units. At some point, they will automatically remind you either of Baku, the capital of Azerbaijan, or Cuba. The semantic order does not remain constant, however; the grouping of syllables changes rather quickly from Baku to Cuba and then back again. As controlled experiments have shown, this turnaround occurs on average every three seconds.

Then and Now

Another way our mind constructs our rich notion of time is illustrated by the quality of temporal order—the mind determines the order of events. Chronopsychologists have discovered some interesting features of this ability, especially in the perception of nonsimultaneity and sequence. The chronological resolution of perception determines whether two light flashes, needle pricks or sounds appear to occur separately or simultaneously. If stimuli are presented below a particular threshold—in other words, in rapid succession—they fuse together, and we experience them as synchronous or continuous.

Each sensory channel has its own so-called fusion threshold—our hearing is very acute with a chronological resolution of two milliseconds; our sense of vision, in contrast, is usually overwhelmed by 40-millisecond intervals. If this timing were not the case, the action on television screens would appear to us as rapid successions of instant snapshots instead of the smoothly moving objects that we actually perceive. It is the "lazy" visual apparatus that links these impressions together in space and time.

In addition, experiments have shown that detecting chronological synchronicity and discerning the sequences of sensory impressions are two entirely different animals. Test subjects may perceive two clicks that occur at an interval of 20 milliseconds as nonsynchronous; however, they may be unable to tell which of the two different sounds came first. For that, the stimuli need to be spaced at least 40 milliseconds apart.

Timekeeper or Follower of the Rhythm Section?

It remains unclear how many parts of our brain are involved in creating our sense of time or what, exactly, they do. One of the most active areas of research has centered on identifying tissue regions that affect time estimation. Studies of patients with brain damage, for example, have revealed that if the cerebellum is partially knocked out as a result of an accident or stroke, the patient typically experiences great difficulty in the execution of fine-motor tasks—but also in the ability to identify intervals of a few seconds' duration. If the neural insult involves the frontal lobe, a person may report that a sound lasting several seconds was nothing more than a "click."

In a 2003 study Giacomo Koch and his coworkers at the University of Rome Tor Vergata took a different approach by distorting time-interval estimates in healthy people using transcranial magnetic stimulation. This technique focuses a strong electromagnetic field on one region of the brain, temporarily disrupting local neuronal function. These researchers found that when the frontal lobe of their subjects was targeted, subjects consistently underestimated the duration of a sound.

From this work, one thing becomes immediately apparent. Our mind does not depend on a single clock in our brain—potentially countless neuronal modules may contribute to our sense of time. More fundamentally, though, researchers debate whether any of the brain's neuronal circuits are actually dedicated to the conscious measurement of time or if time perception mechanisms are completely diffuse throughout the brain. In support of the former idea stands a 2005 experiment conducted by neurobiologist Michael Shadlen of the University of Washington. He trained rhesus monkeys to fixate their gaze on a point on a computer screen; the point would disappear after a certain variable period. This

Our rich notion of time is illustrated by the quality of temporal order—our mind determines the order of events.

(The Author)

PASCAL WALLISCH received his Ph.D. in psychology from the University of Chicago. He is currently a postdoctoral fellow at the Center for Neural Science at New York University.

disappearance was a signal for the animals to wait for a specified amount of time and then observe a particular section of their visual field, for which they were rewarded with fruit juice.

At the same time, Shadlen recorded the electrical activity of individual neurons in the parietal lobe or, more precisely, in the lateral intraparietal area (LIP). The researchers found that the activity pattern of these neurons was closely associated with the elapsed period as well as with the timing of anticipated rewards—they reflected the probability that the wait interval of up to several seconds would end soon. To be overly simplistic, these neurons function somewhat like an egg timer. Shadlen argues that in their natural habitats, many animals regularly seek out certain food sources, and to accomplish this task they need a cognitive representation of elapsed time. Shadlen's report is the first description of a direct correlate of such representations—on the level of specialized nerve cells in the LIP.

Alternatively, Warren Meck of Duke University and Matthew Matell of Villanova University question the existence of specific "time neurons." Rather they have identified a highly sensitive rhythm detector, the striatum, which is a part of the basal ganglia. Meck and Matell also trained animals (in this case, rats) to adapt to specific time intervals. If the rodents pressed on a key at the right moment, feed pellets dropped into their cage. As cell tracings of the striatum showed, the end of a learned interval was accompanied by furious bursts of activity in this region. But these researchers believe this activity is the result of the striatum sampling signals from across the brain—as suggested by the fact that the basal ganglia are closely connected to most cortical brain areas. Meck and Matell compare the brain to a symphony orchestra during a concert, with the striatum in the role of the listener; the recurrence of periodic patterns in the music indicates when a learned time interval has come to an end.

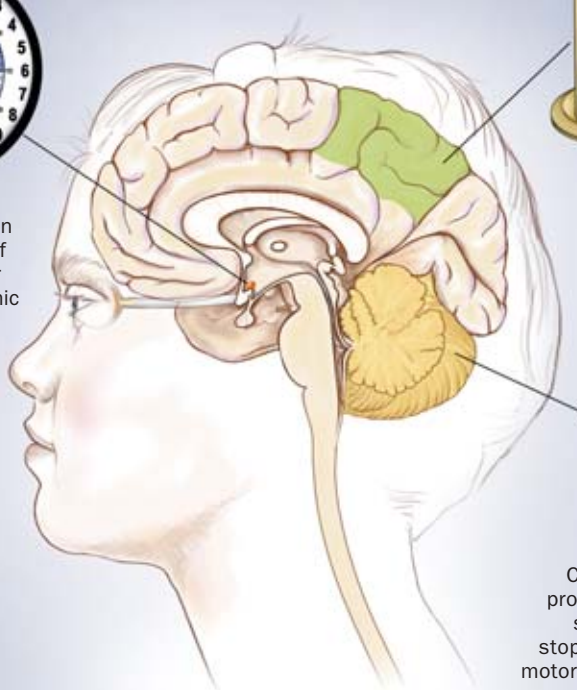
In other words, they suggest that there is no dedicated stopwatch. Our sense of time comes about as a result of the flurry of rhythmic activities that the brain carries out for other reasons, in line with the psychological research showing that

Internal Timekeepers

Our brain does not depend on a single clock—potentially countless neuronal modules could contribute to our sense of time. Researchers have found that three tissue regions are associated with specific timing functions.

Suprachiasmatic nucleus, working on the longer scale of roughly a 24-hour clock, emits rhythmic signals that help to regulate the sleep-wake cycle.

Parietal lobe works over moderate timescales—helping us gauge elapsed time, somewhat like an egg timer.



Cerebellum is involved in processing very precise, very short timescales, like a stopwatch, helping us time our motor actions with great accuracy.

TERESE WINSLOW

We may never really know why evolution left us with a sense of time that is so easily distorted.

Mental clock watcher: Scientists debate whether our mind's capacity to measure intervals is aided by dedicated timekeeper neurons or arises as a by-product of other brain activity.

attention and memory effects can easily distort the time experience. The problem with this model, however, is that in the symphony of the brain, myriad voices sing in unison at any given time. What enables the striatum to recognize that one periodic convergence is more significant than another? This question is open for future research.

Open Field

The debate surrounding the existence of dedicated timekeeping neurons highlights a characteristic of time perception research that makes it exciting to follow and participate in: it is one area of cognitive neuroscience in which fundamental questions still remain to be answered. In contrast, scientists had established the existence of dedicated neurons for various visual functions, along with analogous neurons in other senses, years or even decades ago. In the next few years, advances in brain imaging and other techniques are expected to yield new important insights for time researchers in this respect.

We may never really know, however, why evolution endowed us with several highly dependable senses that are true marvels of neural engineering but left us with a sense of the passage of time that is so easily distorted. Although all evolutionary explanations are highly speculative, I will suggest one possible reason. Each passing second represents a finite resource of opportunity in the life of an organism. If I am a food gatherer and spend hours without bagging some dinner, the slow drag of dull moments helps to alert me to move on and cut my losses. On the other hand, if I am finding food in every corner, the hours will fly by like minutes, and I am happy to keep stuffing my sack. So this elastic sense of time could plausibly help animals manage their activities better than an exact one would. It is something to think about, when you find yourself with time on your hands. M

(Further Reading)

- **Representation of Time by Neurons in the Posterior Parietal Cortex of the Macaque.** M. I. Leon and M. N. Shadlen in *Neuron,* Vol. 38, No. 2, pages 317–327; April 24, 2003.
- **The Effect of Predictability on Subjective Duration.** V. Pariyadath and D. Eagleman in *PLoS ONE,* Vol. 2, No. 11, page e1264; November 28, 2007. Available at **www.plosone.org/article/info:doi/10.1371/journal.pone.0001264**

YO OURA Getty Images

The Medicated Americans

Close to 10 percent of men and women in America are now taking drugs to combat depression. How did a once rare condition become so common?

By Charles Barber

Adapted from *Comfortably Numb: How Psychiatry Is Medicating a Nation*, by Charles Barber (Pantheon Books, 2008).

GETTY IMAGES

I am thinking of the Medicated Americans, those 11 percent of women and 5 percent of men who are taking antidepressants.

It is Sunday night. The Medicated American—let's call her Julie, and let's place her in Winterset, Iowa—is getting ready for bed. Monday morning and its attendant pressures—the rush to get out of the house, the long commute, the bustle of the office—loom. She opens the cabinet of the bathroom vanity, removes a medicine bottle and taps a pill into her palm. She fills a glass of water, places the colorful pill in her mouth and swallows. The little pill could be any one of 30 available drugs used as antidepressants—such as Prozac or Zoloft or Paxil or Celexa or Lexapro or Luvox or Buspar or Nardil or Elavil or Sinequan or Pamelor or Serzone or Desyrel or Norpramin or Tofranil or Adapin or Vivactil or Ludiomil or Endep or Parnate or Remeron. The pill makes a slight flutter as it passes down her throat.

Julie examines her face in the mirror and sighs. She hopes that by some Monday morning in the future—if not tomorrow morning, then some mythical, brilliant and shimmering Monday morning a month from now, or two months from now, or three—the pills will have worked some kind of inexorable magic. Corrected a chemical imbalance, or something, as the Zoloft commercial had said. "Zoloft, a prescription medicine, can help. It works to correct chemical imbalances in the brain," the voiceover on the ad had intoned. Julie didn't know she had a chemical imbalance, nor does she actually know what one is, and it had never really occurred to her that she could have a mental illness (could she?). But she does hope, fervently, that her life will become a little easier, a little less stressed—soon. She hopes, desperately, that the pills will make her feel better—that the little white powder hidden in the green capsule will dissolve in her stomach, enter her bloodstream, travel to her brain and do something. Brushing her teeth, she hopes that one day she will simply feel better.

FAST FACTS

Rising Prescriptions

1» In the past three generations, increasing numbers of Americans have been prescribed antidepressants. In many cases, such prescriptions are the only mental health care the patients receive.

2» One cause of the rise in antidepressant use is that many doctors conflate conventional sadness—as from the loss of a loved one or a life-changing event such as a divorce—with the more serious and life-quashing condition of clinical depression.

3» A second contributing factor, the author argues, is a change in the standard diagnostic guide, which caused many milder mental ailments to fall under the seemingly neutral label of "disorder."

Mental Illness by the Numbers

If statistics serve, we know a number of things about the Medicated American. We know there is a very good chance she has no psychiatric diagnosis. A study of antidepressant use in private health insurance plans by the New England Research Institute found that 43 percent of those who had been prescribed antidepressants had no psychiatric diagnosis or any mental health care beyond the prescription of the drug. We know she is probably female: twice as many psychiatric drugs are prescribed for women than for men, reported a 1991 study in the *British Journal of Psychiatry*. Remarkably, in 2002 more than one in three doctor's office visits by women involved the prescription of an antidepressant, either for the writing of a new prescription or for the maintenance of an existing one, according to the Centers for Disease Control and Prevention.

We know that most likely a psychiatrist did not prescribe her antidepressants: family doctors

LAURA CROSTA *Getty Images*

frequently now prescribe such medications. We know that Julie in Iowa was far more likely to ask her doctor for an antidepressant after having seen it advertised on TV or in print; one fifth of Americans have asked their doctor for a drug after they have seen it advertised. And when Julie asked for her antidepressant, her doctor was likely to comply with the request, even if he or she felt ambivalent about the choice of drug or diagnosis.

It is unlikely that the doctor spent much time talking to Julie about the nature of the drugs, the common side-effect profiles and the remote but potentially dangerous side effects. Based on taped sessions, a 2006 study at the University of California, Los Angeles, showed that when prescribing a new medicine, two thirds of doctors said nothing to the patient about how long to take the medication, and almost half did not indicate the dosage amount and frequency. Only about a third of the time did doctors talk about adverse side effects. In the case of antidepressants, failure to review possible side effects and to monitor the patient's progress in the weeks and months after starting the drugs is deeply irresponsible. A 2004 study in the *Journal of the American Medical Association* stated that "the risk of suicidal behavior is increased in the first month after starting antidepressants, especially during the first one to nine days." Worse, there is no longer any need to deal with an actual physician: all these drugs are readily available, with a few clicks and a credit card.

We further know that Julie's managed care insurance was more than happy to cover the prescription, especially if it meant that the company did not have to pay for therapy, which Julie is less and less likely, and less and less able, to pursue—an unsurprising fact given that there are only about 40,000 psychiatrists in the country. As a result, after starting antidepressants and taking them for three months, three quarters of adults and more than half of children do not see a doctor or therapist specifically for mental heath care, found a study by Medco Health Solutions. Another report, referenced in the *New York Times*, reported that only 20 percent of people who take antidepressants have any kind of follow-up appointment to monitor the medication.

Between 1987 and 1997, while the rate of pharmacological treatment for depression doubled, the number of psychotherapy visits for depression decreased, as cited in a study in the Jan-

Diagnosis confusion: If she were actually experiencing severe depression, she couldn't have summoned the energy to get to the party.

Julie's managed care insurance was more than happy to cover the prescription.

A clinically depressed person may not be able to drag herself out of bed.

GHISLAIN & MARIE DAVID DE LOSSY *Getty Images*

uary 9, 2002, issue of the *Journal of the American Medical Association*. These days only about 3 percent of the population receives therapy from a psychiatrist, psychologist or social worker, according to a 2006 study in *Archives of General Psychiatry*. The strong likelihood is that the fluttering of the pill down her throat will be the extent of Julie's mental health treatment.

A Growing Trend

Antidepressant SSRIs (selective serotonin reuptake inhibitors) were first approved as treatment for clinical depression, and other uses were steadily added during the 1990s: indications came, one after the other, for obsessive-compulsive disorder, eating disorders, anxiety and premenstrual dysphoric disorder. The drugs were also used for paraphilias, sexual compulsions and body dysmorphic disorder. With each new utilization, the market got bigger, lines between distress and disease got blurrier, and the drugs began to be prescribed for problems beyond those indicated by the Food and Drug Administration. As a result, a good number of Americans are now taking SSRIs for non-FDA-approved uses, termed "off label" prescriptions. A 2006 study found that three quarters of people prescribed antidepressant drugs receive the medications for a reason not approved by the FDA. This practice is legal and intended to give physicians the flexibility to prescribe the drugs that are best suited to their patients' needs. The problem is that "most off-label drug mentions have little or no scientific support," says study co-author Jack Fincham of the University of Georgia College of Pharmacy. "And when I say most, it's like 70 to 75 percent. Many patients have no idea that this goes on and just assume that the physician is writing a prescription for their indication."

So, if not for a severe mental illness, why exactly is Julie taking the antidepressants? One reason traces to the existence of the catchall term "depression." Depression, once considered a rare disease usually associated with elderly women, is overwhelmingly the mental health diagnosis of choice of our time. About 40 percent of mental health complaints result in its diagnosis, according to the CDC. Martin E. P. Seligman of the University of Pennsylvania, perhaps America's most influential academic psychologist, has stated: "If you're born around World War I, in your lifetime the prevalence of depression, severe depression, is about 1 percent. If you're born around World War II, the lifetime prevalence of depression seemed to be about 5 percent. If you were born starting in the 1960s, the lifetime prevalence seemed to be between 10 and 15 percent, and this is with lives incomplete." (When entire life spans are ultimately taken into account, the rate could grow further.) Moreover, Seligman notes, the age of onset of the first depressive episode has dropped. A generation or two ago the onset of depression pur-

portedly occurred on average at age 34 or 35; recent studies have found the mean age for the first bout of depression to be 14 years old.

It is as if from the early 1990s on (nicely coinciding with the mass penetration of Prozac), we have been living in the Age of Depression—just as Valium arrived in, or helped to create, the Age of Anxiety. In contemporary America, it has been broadly accepted for some time that everybody, at some level, is depressed at least some of the time. As Americans have become more aware of their feelings in the past few therapy-oriented decades, it has become acceptable and eminently appropriate to say when someone asks how you are feeling (particularly if it's late March): "A little depressed." Or to respond to the query, "How was the movie the other day?": "A little depressing." Or to say in response to "How did you feel about last year's minuscule raise?": "Depressed."

In contemporary America, it is broadly accepted that everybody is depressed at least some of the time.

But to anyone reasonably experienced in the mental health field, there is depression and then there is Depression. The first type is a terribly broad and bland term, indicating "the blues," "feeling down," "bummed out," "in the dumps," "low," "a little tired," "not quite myself," each a standard part of the daily human predicament. Major depressive disorder, however, is a harrowing and indisputably profound and serious medical condition. To confuse the two, depression with Depression, is to compare a gentle spring rain to a vengeful typhoon.

A true diagnosis of major depression involves some combination of most of the following: inability to feel pleasure of any kind whatsoever, loss of interest in everything, extreme self-hatred or guilt, inability to concentrate or to do the simplest things, sleeping all the time or not being able to sleep at all, dramatic weight gain or loss, and wanting to kill yourself or actually trying to kill yourself. Truly depressed people do not smile or laugh; they may not talk; they are not fun to be with; they do not wish to be visited; they may not eat and have to be fed with feeding tubes so as not to die; and they exude a palpable and monstrous sense of pain. It is a thing unto itself, an undeniably physical and medical affliction and *not,* as psychiatrist Paul McHugh writes, "just the dark side of human emotion."

One feels such patients' anguish at a primal, physiological level. "Very often patients with major depression will say the emotional pain they feel is worse than the pain of any physical illness," said J. John Mann, chief of neuroscience at the New York Psychiatric Institute, in a 1997 article in *BrainWork*. Many depressed people really, really want to die, and thinking about dying, or planning their death, takes up a great deal of their time. So horrific is the incapacitation that the highest risk of suicide actually comes when people are feeling slightly better. In the throes of an episode, depressed patients are too dissipated to even muster the energy to kill themselves. I thought I knew the difference between the blues and major depression until I saw the disease in its full and malicious force. The only treatments are hospitalization, supervision, rest, quiet, sedatives, sleep medications, an appropriate level of antidepressants and electroshock therapy. Despite its side effects (such as short-term memory loss), electroshock therapy remains the single most effective treatment for major depression.

Dicey Diagnosis

What modern psychiatry has done, I am convinced, is to conflate and confuse the two, Depression and depression. David Healy, in *Let Them Eat Prozac* (NYU Press, 2004), calls it "a creation of depression on so extraordinary and unwarranted a scale as to raise questions about whether pharmaceutical and other health care companies are more wedded to making profits from health than contributing to it." A 2007 study at New York University showed that about one in four people who appears to be depressed and is treated as such is in fact dealing with the aftermath of a recent emotional blow, such as the end of a marriage, the loss of a job or the collapse of a business.

Each successive edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM*) has proclaimed an ever increasing number of di-

(The Author)

CHARLES BARBER is a psychiatry lecturer at the Yale University School of Medicine.

Psychiatry has traversed a slippery slope—jettisoning the impoverished mentally ill for the cash-carrying worried well.

agnoses that cover an ever widening terrain of normal, if painful, human behavior. *DSM-I,* published in 1952, covered some 150 diagnoses. *DSM-IV,* which came out in the 1990s, had more than 350. The next version, *DSM-V,* due in 2011, will introduce even more.

In contrast, large percentages of people with severe and persistent mental illness get no care whatsoever. "The majority of those with a diagnosable mental disorder [are] not receiving treatment," wrote the U.S. surgeon general in a 1999 report. Studies published in 1985, 2000 and 2001 found that 50, 42 and 46 percent, respectively, of people with serious mental illness were receiving no treatment for their conditions. A massive study in the early 2000s on the prevalence of mental illness led by health care policy researcher Ronald C. Kessler of Harvard Medical School, in collaboration with the World Health Organization, revealed that in developed countries 35 to 50 percent of people with serious cases had not been treated in the previous year; in poor countries the figure was 80 percent. A separate study, published in 2002, found that of those in the U.S. receiving treatment for serious mental illness, only 40 percent were receiving what is considered minimally adequate treatment. Of all those with serious mental disorders, then, only 15 percent were getting the high-quality care they needed.

The same tragic imbalance exists in the research world. Although people with severe mental illness account for more than half of the direct costs associated with all mental illness, only about a third of National Institute of Mental Health research awards from 1997 to 2002 went to the study of serious mental illness.

The slippery slope that psychiatry has traversed—jettisoning the impoverished mentally ill for the cash-carrying worried well—can perhaps be traced to a single word choice in *DSM-III,* the totally revised diagnostic manual of 1980. But not for the selection of that one word, the recent history of psychiatry might be entirely different.

The prevailing term to describe specific psychiatric conditions in *DSM-I* in 1952 was an odd one: "reaction." Schizophrenia, for example, was described as a "schizophrenic reaction." Depression was a "depressive reaction." The concept of "reaction" derived from psychoanalytic thinking, and, as such, mental torment was thought to come about as a result of a reaction to environmental, psychological and biological problems. By *DSM-II,* in 1968, the term "reaction" had been tossed aside. *DSM-II* described depression in more psychological terms such as depressive neurosis and depressive psychosis.

DSM-III, which was the brainchild of one man, Robert Spitzer of Columbia, was an attempt to strike a middle ground between the psychoanalytic camp, which had no interest in biology, and the budding brain scientists, who were starting to gain traction as psychiatric drugs were becoming more prevalent and often successfully treating people with severe mental illness. Spitzer, who is probably, after Sigmund Freud, the most influential psychiatrist of the 20th century, worked on *DSM-III* for six years, often up to 80 hours a week. To appease both groups, Spitzer brought a centrist, "theory-neutral" approach to his work. He based diagnoses not on theories and traditions about how they might have arisen but on objective observation and symptom lists, on

Antidepressants may be the only mental health therapy many patients receive.

GETTY IMAGES

ANDY RYAN Getty Images

Pharmaceutical remedies have expanded along with diagnoses for new "disorders."

the "here and now." Although this strategy was no doubt well intentioned, the lack of theoretical constraint meant that just about any painful and unhappy human predicament could be entertained for inclusion.

Spitzer presided over an extraordinary expansion of the *DSM*. "Bob never met a new diagnosis that he didn't at least get interested in," said Allen Frances, a psychiatrist who worked closely with Spitzer on *DSM-III,* in a 2005 interview with the *New Yorker*. "Anything, however against his own leanings that might be, was a new thing to play with, a new toy." Spitzer was a technician of diagnosis and loved to compose symptom lists, sometimes drawing them up on the spot. It should be noted that in his centrist approach, Spitzer also presided over many positive developments. For example, he removed homosexuality as a diagnosis, which had been notoriously included in *DSM-II*. Spitzer also excised "hysterical personality" disorder—which had become unfairly identified with female instability. (The word "hysteria" itself comes from "uterus"—hence the term "hysterectomy.")

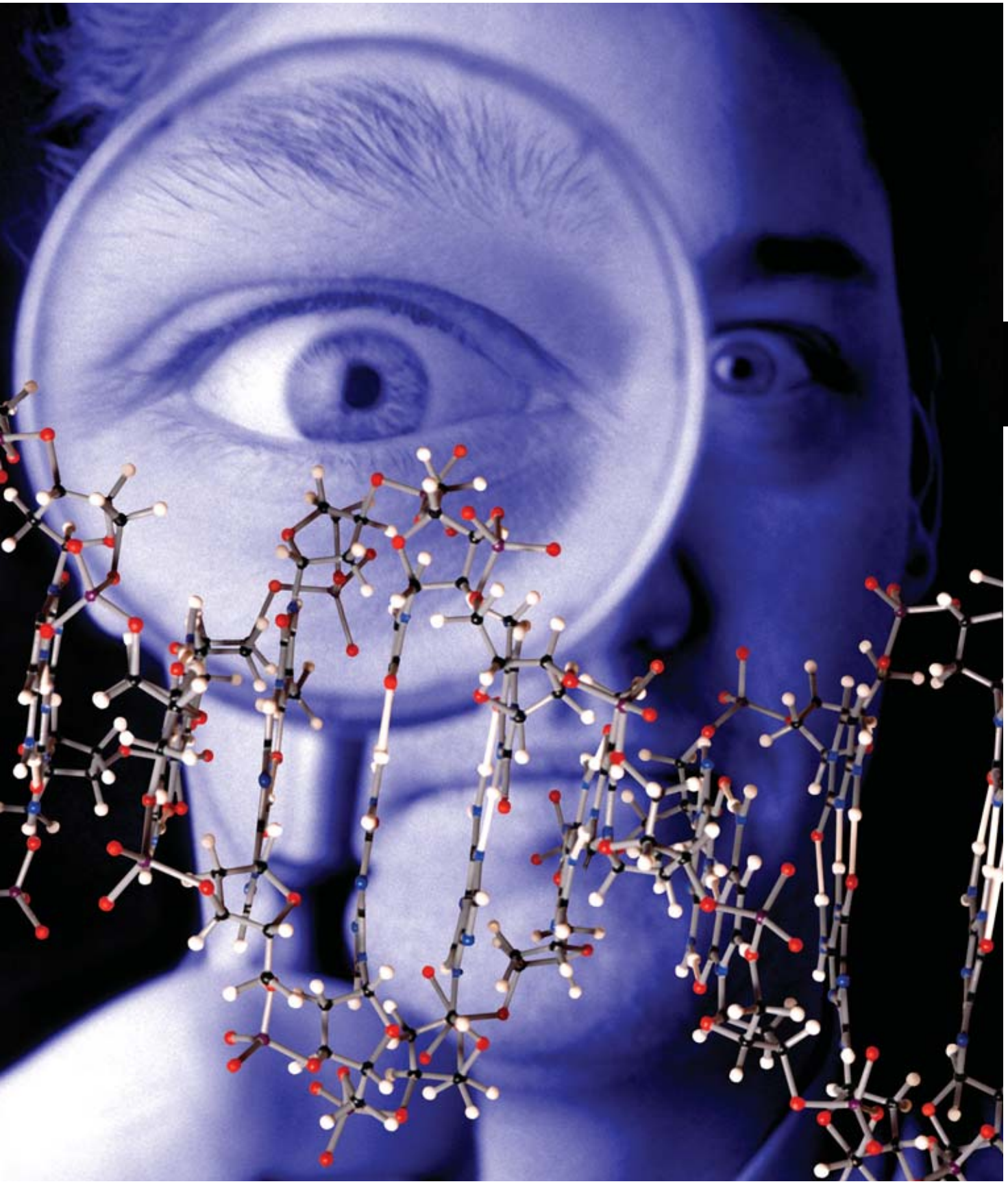
The word that Spitzer settled on, to cover the vast majority of all the roughly 300 diagnoses, was "disorder." "Disorder" was not entirely new: it had appeared briefly in earlier editions of the *DSM* to describe general categories of distress. The problem is that "disorder," so bland and toothless, so appeasing to all parties, has little meaning. There are few constraints on the word "disorder." Just about everything can be a disorder.

Spitzer's word choice created the slippery slope that psychiatry occupies today. Had Spitzer settled on, say, the word "disease" instead, it is conceivable that the course of modern psychiatry would have been different. Diseases are scary, upsetting, painful, often chronic and potentially lethal. You stay in bed with diseases. People do not like to be around you when you have a disease. You generally do not look well when you have a disease.

I think we have got to get beyond the absurd vapidity of disorder categories such as "phase of life problem" and "sibling relational problem." We should get a little more specific about Julie's angst. Let us take the daring step of calling life problems what they are and what they were up until about 20 years ago: life problems. M

(Further Reading)

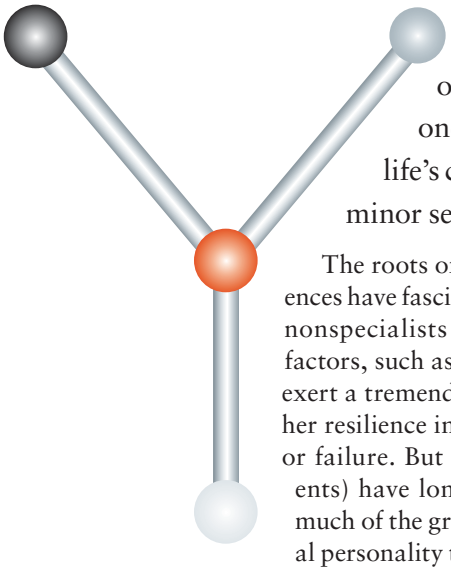
- **Blaming the Brain: The Truth about Drugs and Mental Health.** Eliot S. Valenstein. The Free Press, 2000.
- **Of Two Minds: An Anthropologist Looks at American Psychiatry.** T. M. Luhrmann. Alfred A. Knopf, 2000.
- **Let Them Eat Prozac.** David Healy. NYU Press, 2004.



VICTOR DE SCHWANBERG *SPL/Photo Researchers, Inc.*

Researchers have found a gene
that influences our ability to cope with stress and to bounce back from the misfortunes of life

THE CHARACTER CODE



By Turhan Canli

You are diagnosed with a crippling illness. You lose your job. Someone close to you suddenly dies. Some people recover rapidly from life's calamities and disappointments, whereas others are devastated by minor setbacks, becoming depressed and even suicidal.

The roots of such emotional differences have fascinated psychologists and nonspecialists alike. Environmental factors, such as a person's upbringing, exert a tremendous influence on his or her resilience in the face of misfortune or failure. But as biologists (and parents) have long suspected, genes lay much of the groundwork for individual personality traits. Studies that compare the traits of identical twins, who have all the same genes, with those of fraternal twins, who share just half their DNA, suggest that genes account for 40 to 60 percent of the individual variation in anxiety levels and susceptibility to depression.

Recently scientists have begun to identify specific genes that shape facets of human personality. Based on an early understanding of the chemical underpinnings of mood and mood disorders, they have pinpointed genetic quirks that may contribute to curiosity, attention deficits and impulsive violence [*see box on page 56*].

The roots of anxiety and emotional resilience reside partially in a gene that affects brain levels of serotonin—a chemical messenger that influences sleep, thought and mood, among other functions. The anxiety-provoking form of this gene is very common; more than half of the Caucasian population has inherited it from at least one parent. Recent work has not only connected this gene with anxiety-related personality traits but has also established a basis in the brain for the gene's effects on anxiety.

This "anxiety gene" raises the risk of depression, however, only in the wake of very difficult life circumstances, the latest data show, illustrating the importance of an interaction between genes and particular life experiences in molding personality. Revealing such molecular ties to anxiety, along with their partners in the environment, may lead not only to a new understanding of human behavior but also to better treatments for—and possibly ways to prevent—mood disorders.

Anxiety Gene

Scientists have long speculated that problems with serotonin signaling underlie much of the pathology of mood disorders. A key mole-

A single gene accounts for 3 to 4 percent of the variation in human anxiety levels, one study suggests.

cule in this process is a protein called the serotonin transporter, which pumps serotonin from the space outside neurons, the synapse, back into neurons [*see box on opposite page*].

Indeed, research reported in the 1980s and 1990s hinted that people with depression and certain anxiety disorders bore either fewer or less efficient serotonin transporters than normal. Meanwhile scientists discovered an association between heightened anxiety levels in animals and people and increases in serotonin-induced communication between neurons. (Paradoxically, Prozac and similar antidepressants *reduce* anxiety and depression by inhibiting serotonin reuptake, and thus boosting levels of serotonin outside neurons—something scientists are still struggling to explain.)

Such observations led clinical psychiatrist Klaus-Peter Lesch of the University of Wuerzburg and his colleagues at the National Institute of Mental Health (NIMH) and the National Cancer Institute to wonder whether variations in the gene, or molecular blueprint, for the serotonin transporter might influence a person's anxiety level and possibly his or her susceptibility to depression. Lesch and his colleagues discovered that the gene came in two lengths—long and short. Both produced functional proteins, but as the researchers reported in 1996, the long form of the gene causes a neuron to churn out more of the transporter than the short one does.

This quantitative difference does affect anxiousness, Lesch's team found. Among 505 people who took a test for anxiety-associated traits, those who had inherited at least one copy of the short version of the serotonin transporter gene received higher scores than did those who inherited the long version of the gene from both parents. Lesch and his co-workers concluded that the serotonin transporter gene accounts for 3 to 4 percent of the total variation—and 7 to 9 percent of the inherited variation—in anxiety-related personality traits.

Angst in the Brain

Researchers have since identified a neurological basis for this effect: having a short serotonin transporter gene boosts the excitability of the amygdala, an almond-shaped group of neurons deep in the brain that processes fear and other emotions. In 2002 psychiatry researcher Ahmad R. Hariri, then at the NIMH, and his colleagues reported showing 28 healthy volunteers faces conveying fear or anger or bearing neutral expressions while they scanned their brains using functional magnetic resonance imaging (fMRI). They found that in the 14 people who had inherited at least one copy of the short transporter gene the amygdala was especially enlivened by the emotive faces. It was less active in the individuals with two long forms of the gene.

Additional studies have buttressed the theory that this genetic variant has consequences for the emotional brain. In a 2004 study a team led by psychologist Tomas Furmark of Uppsala University in Sweden showed that patients with social phobia who carried the short form of the serotonin transporter gene showed more activity in the amygdala during a public speaking task than did those with two long versions of the gene. Other researchers found that a part of the prefrontal cortex charged with the processing of risk and fear was also more aroused in response to negative images in bearers of the short transporter gene.

Research from my laboratory suggests, however, that the effect of this gene on brain activity may be more general; rather than controlling the response to negative stimuli, it may instead fine-

FAST FACTS

Blueprints for Personality

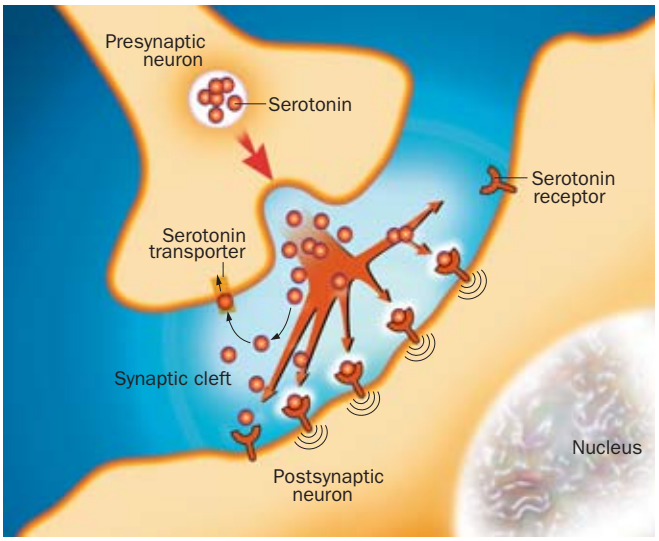
1» Scientists are identifying specific genes that contribute to human personality traits. For instance, they have discovered genetic variants that may influence anxiety, curiosity, attention deficits and impulsive violence.

2» The roots of anxiety and emotional resilience reside partly in a gene that affects brain levels of serotonin, a chemical messenger that regulates sleep, thought and mood, among other functions. This gene is now thought to influence the arousal of the amygdala, a brain region that helps to process emotions such as fear.

3» This "anxiety gene" can also increase a person's susceptibility to depression—but only in the aftermath of adverse experiences, illustrating the importance of gene-environment interactions in shaping mood and personality.

Serotonin Switch

Throughout the nervous system, serotonin passes between neurons in a chemical process that can influence mood, sleep or cognition, among other brain and body functions. At the small gaps between neurons called synapses, a so-called presynaptic neuron secretes this neurotransmitter, which promptly crosses the divide, or synaptic cleft. The postsynaptic neuron receives the serotonin via specialized molecular receptors and thereby becomes chemically excited or inhibited. The neuron then reverts to its original state after serotonin transporters capture the remaining serotonin from the synaptic cleft and return it to the presynaptic cell in a process called reuptake. —*T.C.*



tune the background level of neural activity in the emotional brain. Lesch and I, along with several colleagues, measured activation levels in the amygdala and other brain regions in 41 people while they viewed negative, neutral and positive words—or just stared at a spot on a computer screen.

Corroborating Hariri's work, we found that the people with at least one short transporter gene showed higher activity in the amygdala in response to negative stimuli—words, in this case—than did the individuals carrying two long forms of the gene. More surprisingly, however, as we reported in 2005, the amygdala of those who had the short gene was unusually dynamic while the subjects were simply staring at the computer screen, and we discovered that this resting-state dynamism could account for the amygdala's enhanced response to negative stimuli. We also observed greater neural activation in response to positive stimuli in other brain regions in the individuals carrying the short transporter gene.

Our data thus suggest that the amygdala and other parts of the emotional brain are naturally more aroused in people who have inherited the short serotonin transporter gene. We hypothesize that this chronic arousal may lead to anxiety, fearfulness and, possibly, a predisposition to mood disorders such as depression.

Surviving Stress

But carrying this genetic variant is unlikely to beget depression unless your environment also conspires against you. Studies show that the gene variant boosts depression risk only in the presence of significant stress from misfortune or failure. In 2003 psychiatry researcher Avshalom Caspi of King's College London and his colleagues reported analyzing the serotonin transporter gene in 847 New Zealanders whom they also surveyed about stressful life events such as illness, financial difficulties and romantic disappointments that had occurred between ages 21 and 26.

Although a person's transporter gene did not budge depression risk in the absence of stress, it did influence his or her tendency toward gloominess in response to adversity. The risk of depression and suicidal thoughts rose as the number of stressful events mounted—but only in those with at least one short copy of the transporter gene. And after four or more traumatic occurrences, 33 percent of the subjects who carried at least one short transporter gene became depressed as compared with just 17 percent of those who bore two copies of the lengthier blueprint, suggesting that the long gene protects against depression in the wake of acutely negative experiences.

In 2005 psychiatric geneticist Kenneth S. Kendler and his colleagues at Virginia Commonwealth University replicated this finding in 549 twins whom they interviewed about signs of major depression and anxiety within the past year, along with the occurrence—dated to the nearest month—of 15 types of stressful life events, including divorce, job loss, robbery and illness in the family. The researchers found that individuals with two short forms of the serotonin transporter gene were more likely to become depressed after mild stressors than were those with one or

(The Author)

TURHAN CANLI is associate professor in the graduate program in genetics and the department of psychology at Stony Brook University, New York.

GEHIRN & GEIST/SIGANIM

Genes of the Psyche

Researchers have picked out genes that influence various personality traits, including:

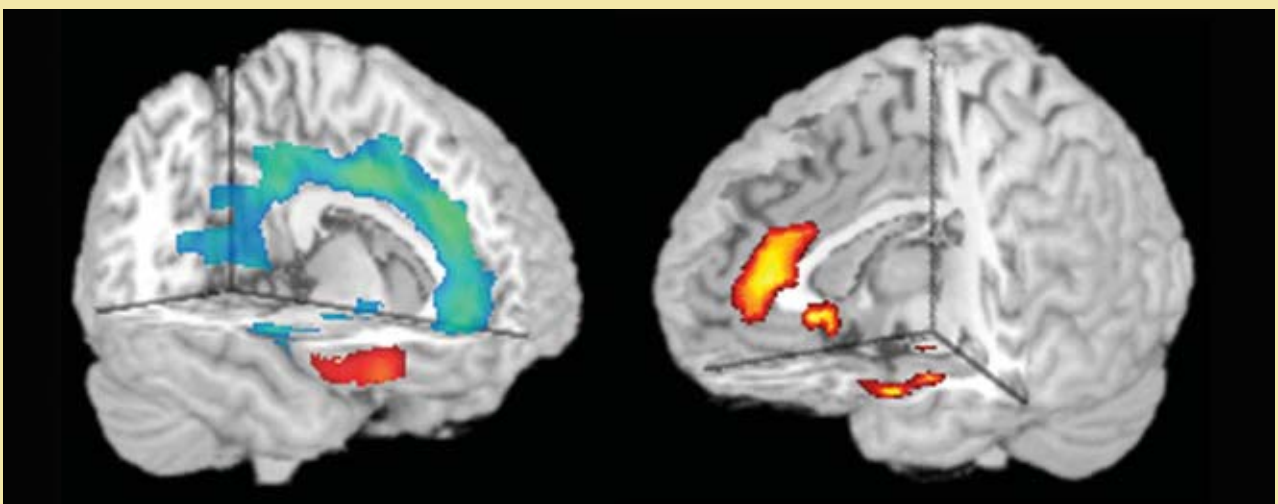
» Novelty seeking. In 1996 psychologist Richard Ebstein of Herzog Hospital in Jerusalem and his colleagues identified a peculiarity in the genetic blueprint for a receptor that responds to the neurotransmitter dopamine that is more common among people who score high on a test of novelty seeking. Such people tend to be relatively impulsive, exploratory, fickle, excitable, quick-tempered and extravagant.

Recent work confirms the potential of variation in the same dopamine receptor gene, dubbed *DRD4,* to influence such traits—this time in birds. In 2007 biologist Bart Kempenaers and his colleagues at the Max Planck Institute for Ornithology in Seewiesen, Germany, reported that another even smaller oddity in this same gene is associated with exploratory behavior—an expression of novelty seeking—in great tits, birds that are native to Europe and Asia.

» Attention deficit. Researchers have gathered considerable evidence that genes play a role in attention-deficit hyperactivity disorder (ADHD) in children. Because defects in dopamine transmission have also been linked to ADHD in young people, scientists have sought variants of dopamine receptor genes that pose a greater risk for the disorder. So far they have identified several. In 2007 for example, psychiatry researcher Philip Shaw of the National Institute of Mental Health (NIMH) and his colleagues reported evidence for a connection between the human novelty-seeking *DRD4* variant and ADHD and also unveiled a possible neurological basis for its effect. In a study of 105 children with ADHD and 103 unaffected kids, the researchers found that those who had both ADHD and the risky form of the gene bore unusually thin tissue in two regions of the brain that govern attention. The brain tissue in these regions was somewhat thicker in children who had either the genetic variant or the disorder and was thickest in those who had neither a diagnosis nor that genetic peculiarity, hinting that this dopamine receptor variant might influence attention by affecting the thickness of the brain in certain places.

» Antisocial behavior. In 2002 Avshalom Caspi of King's College London and his colleagues reported that one version of the gene for monoamine oxidase A (MAOA)—an enzyme that breaks down key mood-regulating chemicals, among them serotonin—is more common among violent, antisocial men. But men bearing this form of the gene, which is thought to decrease enzyme activity and thereby boost serotonin levels, were more prone to impulsive violence only if they had been abused as children.

In 2006 psychiatrist Andreas Meyer-Lindenberg, now at the Central Institute of Mental Health in Mannheim, Germany, and his NIMH colleagues reported a possible neural mechanism for this interaction. Carriers of the violence-linked version of the gene showed reduced volume in areas of the brain that govern emotion and displayed heightened activity in their brain's fear processor, the amygdala, while looking at angry and fearful faces. They also displayed depressed activity in higher brain regions that regulate the fear hub. *—T.C.*



People who carry one version of the gene for an enzyme called MAOA are prone to violent behavior in the face of adversity. Such people show reduced volume in brain areas that regulate emotion (*left image*): the blue-green signifies reductions found in both sexes; the red indicates shrinkage that occurs in men only. These carriers also display increased blood flow (*red and yellow in right image*) to the amygdala, the brain's fear hub, among other regions.

COURTESY OF ANDREAS MEYER-LINDENBERG, CENTRAL INSTITUTE OF MENTAL HEALTH, MANNHEIM, GERMANY

two long forms. The next year geneticist Peter R. Schofield of the Prince of Wales Medical Research Institute in Sydney and his co-workers reported that serious adversity was more likely to produce a bout of major depression within five years in those carrying two short transporter genes, as compared with those who had at least one long transporter gene.

Lesch and I, along with several colleagues, observed these differing vulnerabilities to life's misfortunes in the brain. We surveyed 48 healthy volunteers to determine how many times they had experienced significant tension from, say, work, relationships, finances or illness; some of them were also assessed for their tendency to ruminate, a risk factor for depression. We then used noninvasive imaging techniques such as fMRI to measure brain activity while the subjects focused on various facial expressions or just stared at a spot on a computer screen.

In the individuals carrying a short serotonin transporter gene, life stress was not associated with a boost in brain activation in response to moody facial expressions but did lead to a higher *resting* level of activity in the amygdala and hippocampus—a memory-processing region that is vulnerable to stress—and to a greater tendency to ruminate. The opposite was true for people who carried two long forms of the gene: the more crises these people had faced, the lower the background level of activity in their amygdala and hippocampus—and the less they dwelled on things, we reported in 2006. These results support the theory that stress interacts with a short serotonin transporter gene to produce a highly vigilant emotional brain that predisposes a person toward depression.

Stress that is combined with a deficit in the serotonin transporter protein perturbs the emotional brains of mice as well. In a study published in 2007 geneticist Andrew Holmes of the National Institute on Alcohol Abuse and Alcoholism and his colleagues deleted the serotonin transporter gene in mice, creating a lack of the transporter protein meant to mimic the less pronounced deficit in people who inherit the abbreviated transporter gene.

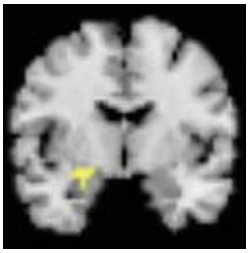
The genetically altered mice showed signs of depression—they stood still more than normal mice—after several stressful swim tests. The animals also had unusual difficulty getting over a fear of a sound the researchers had instilled in them—by pairing the sound with a shock to the foot—and then subsequently tried to extinguish. The DNA disruption also affected the rodents' brains: in the genetically manipulated mice, the researchers found structural oddities in the amygdala and in an area of the prefrontal cortex that plays a role in stress and fear.

Molecules of the Mind

Despite such findings, variation in the serotonin transporter gene is thought to explain only a small part of people's differing sensitivities to the stresses of life. Geneticists estimate that at least 15 genes, along with various environmental factors, most likely contribute to anxiety and a person's susceptibility to stress. Only if researchers can complete this genetic and environmental mosaic will they be able to confidently gauge the propensity to develop anxiety and depression in each of us—or to pinpoint the causes of such disorders in those who have them.

Moreover, with a more complete picture, those of us at high risk might be able to act to prevent the emergence of such mood disorders. And an ability to home in on a molecular cause of anxiety or depression in psychiatric patients might enable doctors to select the treatment most likely to work for each patient.

Meanwhile the unraveling of the entire human genetic code under the auspices of the Human Genome Project and of human genetic variation in the so-called Human HapMap Project is expected to accelerate the outing of genes that work in the brain to shape our personalities. As these genes come to light, psychologists will have to increasingly incorporate these molecules of inheritance into their explanations of human behavior, mental illness and temperament. M



Part of the brain's amygdala (*represented in yellow*) is significantly more active at rest in people who carry one or two short copies of the serotonin transporter gene than it is in individuals who have two long forms of this gene.

(Further Reading)

- **Association of Anxiety-Related Traits with a Polymorphism in the Serotonin Transporter Gene Regulatory Region.** K.-P. Lesch, D. Bengel, A. Heils, S. Z. Sabol, B. D. Greenberg, S. Petri, J. Benjamin, C. R. Mueller, D. H. Hamer and D. L. Murphy in *Science,* Vol. 274, pages 1527–1531; November 29, 1996.
- **Serotonin Transporter Genetic Variation and the Response of the Human Amygdala.** A. R. Hariri, V. S. Mattay, A. Tessitore, B. Kolachana, F. Fera, D. Goldman, M. F. Egan and D. R. Weinberger in *Science,* Vol. 297, pages 400–403; July 19, 2002.
- **Influence of Life Stress on Depression: Moderation by a Polymorphism in the 5-HTT Gene.** A. Caspi, K. Sugden, T. E. Moffitt, A. Taylor, I. W. Craig, H. Harrington, J. McClay, J. Mill, J. Martin, A. Braithwaite and R. Poulton in *Science,* Vol. 301, pages 386–389; July 18, 2003.
- **Neural Correlates of Epigenesis.** T. Canli, M. Qiu, K. Omura, E. Congdon, B. W. Haas, Z. Amin, M. J. Herrmann, R. T. Constable and K.-P. Lesch in *Proceedings of the National Academy of Sciences USA,* Vol. 103, No. 43, pages 16033–16038; October 24, 2006.
- **Long Story Short: The Serotonin Transporter in Emotion Regulation and Social Cognition.** Turhan Canli and Klaus-Peter Lesch in *Nature Neuroscience,* Vol. 10, pages 1103–1109; September 2007.

FROM "NEURAL CORRELATES OF EPIGENESIS," BY T. CANLI ET AL., IN *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES USA*, VOL. 103, NO. 43; 2006

GETTY IMAGES

Don't Be Evil

Enron, Google and the evolutionary psychology of corporate environments

By Michael Shermer

DK LIMITED/CORBIS

In the 1987 film *Wall Street*, Michael Douglas's character, the high-rolling corporate raider Gordon Gekko, explains why America has lost its standing atop the industrial world: "The new law of evolution in corporate America seems to be survival of the unfittest. Well, in my book you either do it right or you get eliminated." He elaborates:

> *The point is, ladies and gentlemen, that greed—for lack of a better word—is good. Greed is right. Greed works. Greed clarifies, cuts through, and captures the essence of the evolutionary spirit. Greed, in all of its forms—greed for life, for money, for love, knowledge—has marked the upward surge of mankind. And greed—you mark my words—will not only save Teldar Paper but that other malfunctioning corporation called the USA.*

Adapted from ***The Mind of the Market: Compassionate Apes, Competitive Humans, and Other Tales from Evolutionary Economics,*** by Michael Shermer (Henry Holt/Times Books, 2008).

In the now famous "greed" speech, we find several myths that I hope to bust in this article: that capitalism is grounded in and depends on cutthroat competition; that businesspeople must be self-centered and egotistical to achieve success; that evolution is selfish and only winnows and never creates; and, of course, that greed is good.

Humans are by nature tribal and xenophobic, and thus evolution has enabled in all of us the capacity for evil. Fortunately, we are also by nature prosocial and cooperative. By studying how modern companies work, we can gain insights into the evolutionary underpinnings of our morality, including concepts such as reciprocity, altruism and fairness. When we apply these evolutionary findings to economic life, we learn that Enron and the Gordon Gekko "Greed Is Good" ethic are the exception and that Google's "Don't Be Evil" motto is the rule. Two conditions must be present to accentuate the latter: first, internal trust reinforced by personal relationships, and, second, external rules supported by social institutions. The contrast between Enron and Google here serves to demonstrate what in corporate environments creates trust or distrust.

FAST FACTS

It's Not "Just Business"

1» People compete against one another to come out on top—*and* they also collaborate with others to succeed. This yin and yang of our natures expresses itself in the working world today just as it did in our ancestors as they struggled to survive and thrive.

2» Studies of how corporations work give us insights into the evolutionary underpinnings of our morality, including concepts such as reciprocity, altruism and fairness.

3» Examining the history of two companies, Enron and Google, illuminates the interplay of personal relationships and social institutions in the modern world.

The Evil of Enron

When President George W. Bush made a public statement about the Enron disaster, he attributed the company's downfall to a "few bad apples," as he would later also explain the Iraqi prisoner abuses at Abu Ghraib. The theory about a few bad apples, however, does not explain what happened at Enron, nor does it give us any deeper insight into the psychology of corporate malfeasance. In a comprehensive study of the evolution of Enron's corporate culture, management analysts Clinton Free and Norman Macintosh of the Queen's University School of Business in Ontario found that something happened between the time of Richard D. Kinder's term as president from 1986 to 1996, when Enron operated with a highly effective managerial system that included transparent governance practices, and Jeffrey Skilling's era, from 1996 to 2001, in which openness and the opportunity for checks and balances were neutralized. What was it?

Enron began in 1985, when Kenneth Lay orchestrated the merger of the Houston Gas Company with Internorth, Inc., becoming CEO of the new energy corporation. Lay then hired Kinder to run it for him while he brokered deals and curried political favors in Washington. During part of the Kinder era, from 1990 to 1996, Enron's reported earnings increased from $202 million to $584 million, while its revenues skyrocketed from $5.3 billion to $13.4 billion.

The keys to Kinder's management style were transparency, accountability and his own personal involvement at every level of the company. At regular meetings with managers and department heads, Kinder expected everyone to come prepared to be grilled in great detail about every

MARTIN GALLAGHER *Corbis (apple-rotting sequence)*

Downfall: Richard D. Kinder, former Enron president, emphasized transparency (*left*); Jeffrey Skilling, who replaced Kinder, focused on cutthroat competition (*center*); Enron's tilted E logo displayed in a computer store after its sale at auction (*right*).

DAVID J. PHILLIP *AP Photo (left)*; LM OTERO *AP Photo (center)*; PAT SULLIVAN *AP Photo (right)*; OXFORD UNIVERSITY PRESS (*Dawkins book*)

aspect of their job, and with a near photographic memory Kinder was not easily fooled. As one manager later remembered, "You could give him a budget number and explain where it came from and he'd say, 'That's not what you told me last year.' And then he'd go to his desk and retrieve the year-earlier budget and prove you wrong. It was amazing." Another unit leader said that Kinder "was impossible to bullshit," and if managers "lied to him about their numbers, Rich would eat them for lunch."

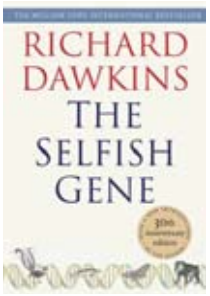
Evil often happens in hidden places, removed from social accountability, such as in the deep recesses of Abu Ghraib. The first line of defense against evil, then, is transparency, open communication and the constant surveillance of every aspect of a system. Kinder—known at Enron as "Doctor Discipline"—demanded up-to-the-minute reports such that he always knew who was doing what to whom and when. As one long-term Enron executive recollected, "Kinder would sit in that room with his yellow pad, and he knew every goddamned thing happening in that company."

Kinder accentuated trust and accountability through a management style that included closely reading his managers' reports, then challenging and debating them at regularly scheduled face-to-face meetings; in turn, he had these managers do the same thing with the employees under them, such that at every level Enron was transparent and thus less susceptible to mismanagement and corruption. Further, Kinder fostered a familylike atmosphere at Enron, for example, showing care and concern for the personal lives of his employees (for instance, paying the travel expenses for one of his managers to return home for a family funeral), which tends to engender respect and loyalty.

Social Shift

Everything changed in 1997, when Skilling replaced Kinder as president. A graduate of Harvard Business School and a fan of Richard Dawkins's epochal book *The Selfish Gene* (Oxford University Press, 1976), Skilling misread the theory to mean that evolution is driven exclusively by cutthroat competition and self-centered egotism. Enamored of the notion of "survival of the fittest," he implemented a policy at Enron called the Peer Review Committee (PRC) system, known among the workforce as "Rank and Yank." PRC was based on the mistaken presumption that people are primarily motivated by greed and fear. Skilling ranked employees on a scale of 1 to 5, with 5s being given the boot. As a result of this strategy, 10 to 20 percent of his employees got axed every six months, leaving

The inspiration for Skilling's "survival of the fittest" management style.



As Enron's Lay described it, "Our culture is a tough culture. It is a very aggressive culture."

everyone on edge and in a state of anxiety over job security. The formal reviews were posted on a company Web page along with a photograph of the employee, increasing the potential for personal humiliation. Those who received a 5 in the relative ranking system—no matter how good their absolute performance may have been—were automatically sent to "Siberia." From that purgatory the 5s had two weeks to find another position at Enron, after which they were "out the door."

As Lay described it, "Our culture is a tough culture. It is a very aggressive culture." Charles Wickman, one of Enron's energy traders, described the corporate ethos under Skilling this way: "If I'm on my way to the boss's office to argue about my compensation, and if I step on somebody's throat on the way and that doubles it, well I'll stomp on the guy's throat. That's how people were."

Skilling's evaluation and bonus system led to a lot of behind-the-scenes wheeling and dealing between department heads and managers, who swapped review evaluation points like so much horse trading. Here is one typical conversation recounted by an unnamed manager: "'I was wondering if you had a few minutes to talk some PRC.' She replied, 'Why—you want to cut a deal?' 'Done,' I said—and just like that we cut our deal." Another manager described the PRC system as creating "an environment where employees were afraid to express their opinions or to question unethical and potentially illegal business practices. Because the Rank and Yank system was both arbitrary and subjective, it was easily used by managers to reward blind loyalty and quash brewing dissent." By pitting employees against one another, the PRC system established an environment that brought out the worst in Enron's employees: selfishness, competitiveness and greed.

While he was producing his 2005 documen-

DAVID J. PHILLIP *AP Photo*

Skilling (*center*) and his defense attorneys pause for questions from reporters during the Enron trial.

tary film on Enron, director Alex Gibney presented a cache of audio tapes from a West Coast energy company, in which Enron traders can be heard requesting that power station engineers manufacture the shutdown of energy stations to decrease energy supplies along a particular grid, thereby boosting energy prices from which Enron directly benefited. In 2000 this decreased supply led to rolling blackouts in California, significant increases in energy bills and, of course, a huge spike in Enron's stock price. When fire season exploded in California, further disrupting the energy grid and driving prices through the ceiling, one trader could be heard on tape excitedly saying, "Burn, baby, burn."

In addition to his belief in the outdated and untenable doctrine of applying "survival of the fittest" to people, Skilling was a high risk taker, driving him to take ever greater chances with both his body and his company. Adventurous corporate trips, such as a motorcycle expedition down the ragged terrain of Baja California, only reinforced the macho competitive atmosphere of Enron's corporate environment. Skilling's bonus system, based on the PRC database rankings in which employees were arrayed on a bell curve, further eroded any sense of team spirit. Because bonuses ranged from 10 to 26 percent of an employee's take-home pay, there was considerable motivation to manipulate the ratings to boost one's rankings in the hierarchy, as well as backstabbing and sabotaging deals put together by other employees and departments. One executive said that the bonus system "had a hard Darwinian twist" that made "a humongous difference on Enron by instilling a competitive streak in every employee." Ultimately, what causes corporate corruption is an environment of evil established by the founders, executives, directors and managers within a corporation—in short, its corporate social psychology—which then creates situations that encourage our hearts of darkness to beat faster.

PAUL SAKUMA *AP Photo (top)*; AGE FOTOSTOCK *(bottom)*

The Good of Google

In contrast to the Gordon Gekko theory of economics that produces a bad-barrel corporate environment that can readily turn good apples into bad, the Google Guys' theory of economics generates a good-barrel corporate environment that optimizes the "good appleness" of its employees and customers.

A campuslike atmosphere encourages openness among employees at Google.

I first met Google co-founders Sergey Brin and Larry Page in 2003 at a weekend gathering in Seattle for gifted high school students called Adventures of the Mind and later at a function at the Googleplex headquarters in Mountain View, Calif., whose lobby features a giant whiteboard called Google OS (operating system), chockablock full of multicolored Expo marker–produced flowchart goals for the company, such as Develop AI, Orbital Mind Control, Google Football League, Buy New Zealand, Build Singularity, Crop Circles and, appropriately, Elimination of Evil. It is toward this last goal that the Google milieu is structured, starting with its corporate slogan, "Don't Be Evil."

Environments are both physical and psychological, and the Google lobby sets the tone for what awaits inside the glass doors. Speaking of which, glass doors and walls are transparent, and such openness is one of the foundations of trust. Hallways contain bicycles and large rubber exercise balls. Googlers—as employees are known—work in small group clusters, sharing space with couches and dogs. Googlers work hard because they play hard, and the Google campus is loaded with workout rooms, video games, foosball tables, pool tables, Ping-Pong tables, volleyball

(The Author)

MICHAEL SHERMER is publisher of *Skeptic* magazine (www.skeptic.com) and a monthly columnist for *Scientific American* (www.SciAm.com). He is author of *Why People Believe Weird Things* (Henry Holt/Owl Books, 1997), *How We Believe* (W. H. Freeman, 1999), *The Science of Good and Evil* (Henry Holt/Times Books, 2004) and *Why Darwin Matters* (Henry Holt/Times Books, 2006).

courts and assorted other recreational conveniences. And if all that were not enough to make employees think 27 times before pilfering pens and Post-it notes or embezzling checks and click-ad funds, free meals are available at assorted restaurants, and numerous snack bars offer a variety of goodies to munch on between meals. Professional chefs prepare healthy and delicious meals, which nine out of 10 employees cited as what they most liked about their job.

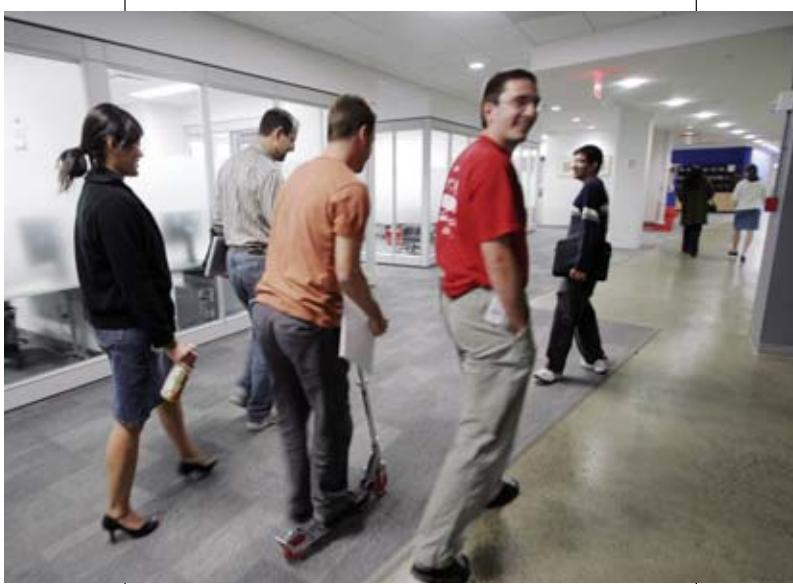
Of course, all economists know that there is no free lunch. The business model to justify feeding thousands of people a day is as obvious as it is logical: feeding your employees means that they will not leave the Googleplex grounds for meals and will thus spend more time in the office and less time driving, parking and eating somewhere off-property. And taking care of laundry, going for a haircut, getting a car wash or enjoying a massage—all can be done at the Googleplex. It is an environment that fosters both a sense of teamwork and of independence. "People talk over lunch about the things they are playing with," one Google software engineer noted. "It is like they are the CEO of their own little company."

There is another reason for offering employees free food and convenient amenities: reciprocity. The fundamental principle of reciprocity evolved in its most base form as food sharing among primates and has since developed into complex networks of exchange employed by everyone from mass-mailing merchants to Madison Avenue marketers—if I give you something for free, you will feel obligated to reciprocate.

Hunter-gatherer groups accumulate social credit with other groups by throwing a feast (for example, the Native American potlatch), which must be paid back in kind to maintain political capital, build economic trust and generate social goodwill. Consumer-traders accumulate psychic credit by throwing the equivalent of a potlatch, which must be reciprocated in kind to maintain political, economic and social equilibrium. Give a small gratis token to potential customers, and you increase your chances of turning them into actual customers. Readers my age and older will recall Hare Krsishnas in the 1970s handing out flowers at airports (no longer allowed) in hopes of guilting people into making a donation. More recently, one of the more blunt instruments of reciprocity I have seen is by pollsters who include a crisp new dollar bill with the survey they hope you will then complete.

The Google environment accentuates amity and attenuates enmity by minimizing corporate hierarchy and maximizing cross-pollination among people in different departments. "Because everyone realizes they are an equally important part of Google's success, no one hesitates to skate over a corporate officer during roller hockey," explains a statement on corporate culture employees are encouraged to read. Googlers are even expected to devote 20 percent of their time toward exploring new ideas and projects, without hierarchical supervision. A horizontal corporate structure generates an atmosphere of equalitarianism and nonelitism that taps into the environment of our Paleolithic ancestors, who evolved in what are believed to have been largely egalitarian bands and tribes.

That atmosphere expands beyond the Google-



Google's co-founders, CEO Larry Page (*at left in photograph below*) and chairman Sergey Brin (*at right*), at the casual headquarters in 2000. Google employees in New York City get scooters to zip around the open office space (*far right*).

RANDI LYNN BEACH *AP Photo (left)*; MARK LENNIHAN *AP Photo (right)*

"Trust is the foundation upon which our success and prosperity rests," according to Google.

plex and throughout the world. Consider the implications of the Google Print Library Project, in which millions of books from the New York Public Library and the university libraries at Stanford, Harvard, Oxford and Michigan are being scanned and made available online, for free, and searchable by anyone from anywhere in the world. There are copyright issues with this project still to be resolved, of course, but such projects reinforce an environment of trust and are thus an important step in the millennia-long march toward greater freedom and prosperity for more people in more places. As Brin and Page wrote in their document released with the company's Initial Public Offering: "We believe a well functioning society should have abundant, free and unbiased access to high quality information. Google therefore has a responsibility to the world." Those who control information control the world, but if everyone has access to that information no one can control the world. Information transparency trumps political hegemony.

The central pillar of Google's code of conduct is its now familiar slogan, "Don't Be Evil." But what does this phrase really mean? "It means making sure that our core values inform our conduct in all aspects of our lives as Google employees," according to the code of conduct posted on Google's Web site. And what are those core values? Brin and Page's answer shows how markets can be moral when they are grounded in a foundation of trust. "Being a Googler means holding yourself to the highest possible standard of ethical business conduct. This is a matter as much practical as ethical; we hire great people who work hard to build great products, but our most important asset by far is our reputation as a company that warrants our users' faith and trust. That trust is the foundation upon which our success and prosperity rests, and it must be re-earned every day, in every way, by every one of us."

The code of conduct goes on for pages detailing all manner of potential evils to avoid, for example, dealing with competitors' private information. Here we see a return to the most basic code of conduct—the golden rule: "The level of business ethics to which we aspire requires that we apply the same rules to our competitors' information as we do to our own, and that we treat our competitors as we hope they will treat us. We respect our competitors and, above all else, believe in fair play in all circumstances; we would no sooner use a competitor's confidential information to our advantage than we would wish them to use ours. So, although gathering publicly available information about competitors is certainly a legitimate part of business competition, you should not seek out our competitors' confidential information or seek to use it if it comes into your possession. If an opportunity arises to take advantage of competitors' confidential information, remember: don't be evil. We compete, but we don't cheat."

Of course, I am well aware of the controversies that have arisen with Google's growth, including click fraud, the use of competitors' trademarked keywords in Google's AdWords advertisements, the inclusion of morally questionable content in Google Groups (most notably pornographic content and racial hate speech), copyright issues associated with Google's purchase of YouTube, and the high-profile case of Google in China, in which the company was forced to make concessions for the censorship of politically sensitive material to gain access into the country. Controversies of this nature are inevitable for any company that grows as rapidly as Google has, and no matter how lofty a company philosophy may be, perfection will always be an unattainable goal.

"Don't Be Evil" is a moral standard toward which to aim, not a sinless existence whose unattainability means no such norm should be invoked. The point of having moral codes—whether you are a hunter-gatherer or a consumer-trader—is to construct an environment of trust that encourages the expression of moral behavior. M

(Further Reading)

- **Enron: The Rise and Fall.** Loren Fox. John Wiley & Sons, 2003.
- **Conspiracy of Fools.** Kurt Eichenwald. Broadway Books, 2005.
- **Enron: The Smartest Guys in the Room.** Alex Gibney. Documentary film. Independent Lens, 2005.
- **The Google Story: Inside the Hottest Business, Media, and Technology Success of Our Time.** David Vise and Mark Malseed. Delacorte Press, 2005.
- **The Search: How Google and Its Rivals Rewrote the Rules of Business and Transformed Our Culture.** John Battelle. Portfolio Books, 2005.
- **Influence: The New Psychology of Persuasion.** Robert Cialdini. William Morrow, 2006.
- **The Lucifer Effect: Understanding How Good People Turn Evil.** Philip Zimbardo. Random House, 2007.

Misery in Motherhood

A deep despair mars the first year of motherhood for as many as one in five women. Without treatment, postpartum depression can weaken critical bonds between a mother and her child

By Katja Gaschler

The psychologist smiles at Manuela, a new mother in her late thirties. "Please play with your baby for two minutes," the therapist instructs her and then leaves the room. Two video cameras film Manuela (which is not her real name) and her three-month-old daughter. In the next room, a split-screen monitor shows the mother's profile on the left and her infant in a baby chair on the right.

At first, Manuela appears to be at a loss for what to do. Then, her face noticeably stiff, she begins to talk softly to her baby. Her baby fidgets, briefly makes eye contact and then turns away. Manuela eventually stops talking and stares into the distance, unsure again how to act. She absentmindedly strokes her baby's foot with one hand. The psychologist knocks on the door; the videotaping is over. The new mother is now on the verge of tears.

CORDELIA MOLLOY SPL/Photo Researchers, Inc.

Hormonal changes that occur after delivery contribute to postpartum depression in some women.

Manuela is undergoing therapy at the Clinic for General Psychiatry in Heidelberg, Germany, for postpartum depression, an ailment that has strained her relationship with her baby. Although the vast majority of mothers experience periods of crying and irritability along with concentration lapses and exhaustion, these so-called baby blues disappear within a few hours or days of delivery. But 10 to 20 percent of women in the U.S. develop, in the first year after childbirth, the more disabling despair that afflicts Manuela. These mothers succumb to a deep sadness that, if untreated, may persist for months to years.

Manuela frequently feels exhausted and emotionally empty. When her baby cries, she sometimes wants to flee or hide. She is wracked with guilt because she cannot show love to her daughter. Mothers with symptoms of postpartum depression [*see box on page 70*] are often overwhelmed by the feeling that they might harm their babies. Although they rarely cause any outright harm, depressed mothers may have difficulty caring for their infants—and that fact can heighten their distress.

These emotional problems plague women worldwide. A 2006 review of 143 studies in 40 countries documents that postpartum depression is especially common in Brazil, Guyana, Costa Rica, Italy, Chile, South Africa, Taiwan and Korea, with prevalence rates as high as 60 percent in some countries.

The causes of the disorder are not fully known, but the dramatic hormonal fluctuations that occur after delivery may contribute to it in susceptible women. A bout of previous depression is a huge risk factor for the postpartum variety, new research shows. Whatever its cause, depression can weaken the nascent bond between a mother and her child, studies suggest, and thereby make a toddler more passive, insecure and socially inhibited—although a child's intellectual development usually remains unimpaired.

Thus, in addition to treating the mother's depression, psychologists and psychiatrists increasingly focus on strengthening the relationship between the mother and her child—for example, by using a video camera to record and analyze their interactions. "We need to change the unfavorable behavioral patterns that develop between mother and child during depression," says University of Heidelberg psychologist Corinna Reck.

FAST FACTS

Postpartum Gloom

1» Bouts of crying and irritability, along with concentration lapses and exhaustion, affect 80 percent of new mothers. But these baby blues disappear within a few hours or days of delivery. In contrast, 10 to 20 percent of women in the U.S. develop a more disabling and longer-lasting disorder called postpartum depression in the first year after childbirth that often impairs their ability to care for their babies.

2» Dramatic hormonal fluctuations that occur after delivery may contribute to postpartum depression in susceptible women, but causes of the disorder are not fully understood.

3» Postpartum depression can weaken the developing bonds between a mother and her child and thereby make a toddler more passive, insecure and socially inhibited. As a result, therapy often focuses on repairing the mother-child bond by changing the negative behavior patterns that develop between mother and child during depression.

Hormonal Havoc

Women seem to be particularly vulnerable to depression during their reproductive years: rates of the disorder are highest in females between the ages of 25 and 45. New data indicate that the incidence of depression in females rises, albeit modestly, after giving birth. In the October 2007 *American Journal of Psychiatry,* epidemiologist Patricia Dietz of the U.S. Centers for Disease Control and Prevention and her colleagues reported that 10.4 percent of 4,398 mothers had been depressed in the nine months following childbirth, compared with 8.7 percent in the nine months before pregnancy and 6.9 percent during pregnancy. More than half of the women with postpartum depression had also been depressed during or before pregnancy, suggesting that a previous occurrence of depression may be the biggest risk factor for acquiring the illness postpartum.

But the hormonal changes that occur in a new mother's body are also thought to contribute to postpartum depression in some cases. During

On Camera

Some psychologists stage three scenarios to analyze an infant's interactions with his or her mother. After a two-minute play phase (*1*), the mother is asked to sit with the child for two minutes with a blank expression on her face (*2*). If the mother-child relationship is intact, the baby tries to get mom's attention by, say, smiling and gurgling. And if mom stays so-called still-faced for too long, her child starts to protest. Babies of depressed mothers, on the other hand, often sit silently, resigned to the presence of an unresponsive mother. An infant of a depressed mother will also frequenty fail to respond to friendly gestures from a stranger (*3*). (A mentally healthy mother posed for these photographs, and psychologist Corinna Reck played the stranger.) —*K.G.*

GEHIRN & GEIST/CHRISTINA HOF

pregnancy, a woman experiences a surge in blood levels of estrogen and progesterone. Then, in the first 48 hours after childbirth, the amount of these two hormones plummets almost 50-fold back to normal levels. This chemical seesaw could contribute to depression just as smaller hormonal changes before a woman's menstrual period may affect her moods.

Of course, hormonal flux does not fully explain postpartum depression. After all, this biochemical oscillation occurs in all new mothers, and yet only a small proportion of them become depressed. In addition, studies have shown that pregnancy hormone levels in a woman do not predict her risk of depression.

Nevertheless, the rapid rise and fall of female sex hormones may buffet the emotions of a subset of women who are predisposed to depression and thus may be acutely sensitive to the hormones' effects. In 2000 endocrinologist David R. Rubinow, then at the National Institute of Mental Health, and his colleagues reported that simulating the hormonal ebb and flow that occurs during pregnancy and childbirth in 16 women precipitated depressive symptoms in five of the eight women with a history of postpartum depression but not in subjects who had no such history.

The demands of motherhood very likely play a role as well. Many women feel exhausted from a baby's broken sleep and become overwhelmed by new child care duties. Some may lament the loss of the life they led before having the baby or of their former figure. Women who must endure such stresses on top of marital problems, a complicated birth, job loss or lack of support from family and friends are more likely to succumb to depression.

Broken Bonds

The consequences of depression inevitably reach beyond the mother. In a fog of sadness, a mother often lacks the emotional energy to relate appropriately to her baby. Overwhelming grief prevents her from properly perceiving a child's smiles, cries, gestures and other attempts to communicate with her. Getting no response from mom, the child quits trying to relate to her [*see box above*]. Thus, three-month-old infants of depressed mothers look at their mothers less often and show fewer signs of positive emotion than do babies of mentally healthy moms.

In fact, infants of depressed mothers display something akin to learned helplessness, a phenomenon University of Pennsylvania psychologist Martin E. P. Seligman and his colleagues

Are You Depressed?

Do activities you used to enjoy seem dull and meaningless? Do you think you have failed as a mother? Do you feel extremely anxious about your baby's health and welfare? Such sentiments are signs of postpartum depression. Other symptoms include a fear that you might harm your baby (although few mothers ever do) and thoughts of suicide. Mothers with postpartum depression also often suffer from sleep and concentration disorders, headaches, heart palpitations, chest pains, and fast and shallow breathing. In one or two of every 1,000 births, a mother experiences a complete break with reality within six weeks of delivery; she hallucinates and suffers from delusions, rapid mood swings and obsessive thoughts about the baby. In such postpartum psychosis, a mother might even act on thoughts of harming her child.

If you think you might be depressed after giving birth, take the following test. It is based on the Edinburgh Postnatal Depression Scale, which was developed in the 1980s by psychiatrist John Cox and his co-workers at the University of Keele in England. This screening tool can size up your risk but does not formally diagnose depression, which must be done by a professional. For each of the 10 statements, circle the number next to the response that best describes how you have been feeling during the past week. Add up the numbers you circled. If the sum is nine or greater or if you score one or higher on the last question, you may be depressed and should seek a doctor's advice. *—The Editors*

IN THE PAST SEVEN DAYS:

I have been able to laugh and see the funny side of things.
0 As much as I always could
1 Not quite so much now
2 Definitely not so much now
3 Not at all

I have looked forward with enjoyment to things.
0 As much as I ever did
1 Rather less than I used to
2 Definitely less than I used to
3 Hardly at all

I have blamed myself unnecessarily when things went wrong.
3 Yes, most of the time
2 Yes, some of the time
1 Not very often
0 No, never

I have been anxious or worried for no good reason.
0 No, not at all
1 Hardly ever
2 Yes, sometimes
3 Yes, very often

I have felt scared or panicky for no very good reason.
3 Yes, quite a lot
2 Yes, sometimes
1 No, not much
0 No, not at all

Things have been getting on top of me.
3 Yes, most of the time I have not been able to cope at all
2 Yes, sometimes I have not been coping as well as usual
1 No, most of the time I have coped quite well
0 No, I have been coping as well as ever

I have been so unhappy that I have had difficulty sleeping.
3 Yes, most of the time
2 Yes, sometimes
1 Not very often
0 No, not at all

I felt sad or miserable.
3 Yes, most of the time
2 Yes, quite often
1 Not very often
0 No, not at all

I have been so unhappy that I have been crying.
3 Yes, most of the time
2 Yes, quite often
1 Only occasionally
0 No, never

The thought of harming myself has occurred to me.
3 Yes, quite often
2 Sometimes
1 Hardly ever
0 Never

JOHN BIRDSALL *age Fotostock (photograph);* "DETECTION OF POSTNATAL DEPRESSION: DEVELOPMENT OF THE 10-ITEM EDINBURGH POSTNATAL DEPRESSION SCALE," BY J. L. COX, J. M. HOLDEN AND R. SAGOVSKY, IN *BRITISH JOURNAL OF PSYCHIATRY*, VOL. 150, NO. 6; 1987 *(questionnaire)*

Baby face: Mothers intuitively adapt their facial expressions when interacting with their babies. Raising the eyebrows denotes an appropriate "eye greeting."

AGE FOTOSTOCK

A child of a depressed mother may become unusually fearful and socially inhibited.

described in the 1960s. In Seligman's experiments, an animal would conclude that a situation was hopeless after repeatedly failing to overcome it—and then remain passive even when it could effect change. A similar passivity characterizes depression. "Sometimes the infants mirror their mother's depressive behavior," Reck says.

Such reciprocal withdrawal can start to fray the critical emotional bond between mother and child, especially if the depression occurs early in the baby's life. Other work has shown that infants develop essential social skills in months two through six, building relationships with their mothers as well as other people. In a 2006 study of 101 new mothers, psychiatrist Eva Moehler, Reck and their Heidelberg colleagues found that maternal depression strongly diminished the quality of a mother's bond with her child at two weeks, six weeks and four months postpartum—but not at 14 months. Thus, depression during the first few months after birth may be particularly perilous for a child's social development.

A child of a depressed mother may even become more introverted and face a greater risk for social phobia, an extreme fear of social situations, among other emotional difficulties. In 2007 Reck, Moehler and their colleagues reported that in the same 101 mother-infant pairs, postpartum depression at six weeks, four months and 14 months after birth tended to make a 14-month-old toddler more fearful and inhibited as compared with same-age toddlers of healthy moms. Other work suggests that postpartum depression may produce behavioral problems and negativity in children.

Postpartum gloom usually does not have a long-lasting impact on children's cognitive development, however. In a 2001 study psychologists Sophie Kurstjens and Dieter Wolke of the University of Munich tested the intellectual skills of 1,329 children (92 of them born to mothers who had depression) at various ages from 20 months to eight years. The researchers generally found no cognitive deficits among the children of depressed mothers as compared with those of healthy mothers. They did find cognitive problems, however, in boys of low socioeconomic status who had chronically depressed mothers as compared with children whose mothers had less severe depression.

"We need to change the behavioral patterns that develop between mother and child during depression."

DAVID ATKINSON Getty Images

Nursing Mom

Despite the devastating fallout from postpartum depression, many mothers shy away from getting help—in some cases, out of shame for emotions they cannot justify. Manuela, for example, was initially afraid to talk about her feelings and fears. She felt no one would understand why she was sad after the birth of a healthy, beautiful baby. Eventually, however, at her breaking point, she sought treatment at the Heidelberg clinic.

Many new mothers require medication to take the sting out of their sadness. A doctor may prescribe an antidepressant such as Prozac and, in some cases, may recommend taking a hormone such as estrogen as well. In addition, a small 2007 study by Yale University psychiatrists Ariadna Forray and Robert B. Ostroff suggests that electroconvulsive therapy can ameliorate postpartum depression and its more severe cousin, postpartum psychosis, in women who do not respond to drug therapy.

Psychotherapy for the mother's depression may also be beneficial. One proven approach is cognitive-behavior therapy, in which a therapist tries to correct distorted and negative ways of thinking either by discussing them openly or by asking the patient to practice more adaptive behaviors.

But treating the mother in isolation is often not enough to prevent her illness from affecting her child. In a study published last year psychologist David Forman of Concordia University in Quebec and his colleagues compared 60 mothers who received psychotherapy for depression with a group of 60 untreated depressed mothers and 56 healthy mothers. Six months of therapy did lower parenting stress in depressed women as compared with untreated depressed women, but the treated women still viewed their infants more negatively than did mothers who had not been depressed. Perhaps as a result, after 18 months of therapy the affected mothers reported more behavior problems, a lower level of attachment security and a more negative temperament in their children as compared with moms who had not been depressed.

Now these and many other researchers be-

lieve that therapy for postpartum depression should also involve the child. Psychologist George Downing of Pitié-Salpêtrière Hospital in Paris developed video intervention therapy, for example, to improve mother-infant interaction. The technique helps mothers to correctly perceive their infants' behavior by recording and analyzing it—and to feel better about their own actions as mothers. "The goal of therapy is to reactivate the intuitive maternal behavioral repertoire that was covered over by the depression," explains Heidelberg clinic psychiatrist Thomas Fuchs.

Baby Talk

Tabea, a mother in her early thirties whose depression was severe enough to warrant hospitalization for several weeks after she gave birth, is still having difficulty interacting with her four-month-old son. At the Heidelberg clinic, a psychologist asks Tabea (which is not her real name) to sit in front of a video camera with her baby. Tabea speaks loudly to him. She raises her eyebrows and laughs. Her infant makes eye contact, and a smile flits across his face. His mother feels reinforced. But then the infant turns his head away. And Tabea says, "Well, what's the matter now? Sulking again, are we? Did mommy leave you by yourself too long?" Tabea feels guilty for having had to leave her baby to be treated for depression.

But it is normal for infants to turn away after a social interaction. That is how they regulate stimuli. It is not, as Tabea sees it, a personal affront or a sign that she is a bad mother. Nevertheless, Tabea's misinterpretation of her baby's actions can prompt a vicious cycle in which the child's apparent rejection hurts Tabea, making her feel insecure and sad, which in turn has a negative effect on the baby.

The therapist's job is to break that cycle, largely by correcting a mother's misimpressions and emphasizing what she has done well. Tabea's wide-open eyes, for example, signaled that she was paying attention to her child. The psychologist points out that Tabea's expressive face and melodious speech are similarly appropriate and helpful. Then she encourages Tabea to wait for her child to take the initiative, which will be her signal to respond.

Some hospitals have mother-infant treatment centers for postpartum depression so that the mother can remain with her infant during treatment. There hospital personnel help the mother feed, diaper and bathe her child while also providing behavior therapy. Fathers can play an important part, too. Assuming he is not depressed, a father can significantly ameliorate the effects of a mother's depression by building a close relationship with his son or daughter.

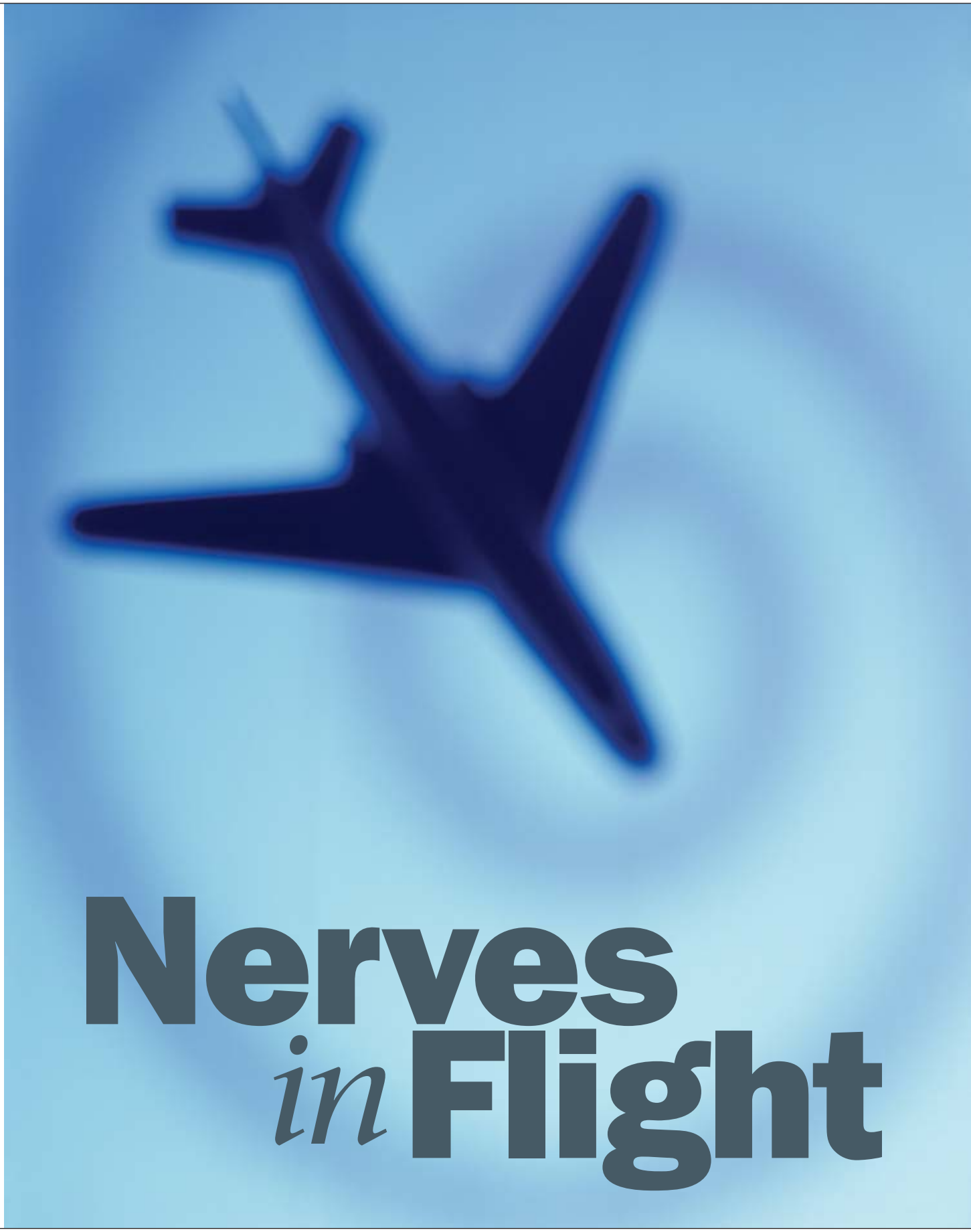
Meanwhile a mother can take steps to ease her emotional burden by asking for help from family and friends, sleeping more, spending time with her spouse, getting out of the house and putting less pressure on herself. In the end, most mothers who receive adequate treatment—often a combination of psychotherapy, medication and self-help—usually recover completely within about two months of starting treatment, according to psychiatrist Ricardo J. Fernandez of Princeton Family Care Associates in New Jersey. Some mothers even emerge from their cloud of sadness with a new sense of clarity. As one mother said of her depression, "It gave me the impetus to change my life." M

Breaking the cycle: The therapist and mother discuss the video sequences to eke out positive elements in the interaction. Their goal: to interrupt the negative feedback loop that often develops between a depressed mother and her child.

GEHIRN & GEIST/CHRISTINA HOF

(Further Reading)

- **Effects of Gonadal Steroids in Women with a History of Postpartum Depression.** M. Block, P. J. Schmidt, M. Danaceau, J. Murphy, L. Nieman and D. R. Rubinow in *American Journal of Psychiatry,* Vol. 157, No. 6, pages 924–930; June 2000.
- **Effects of Maternal Depression on Cognitive Development of Children over the First 7 Years of Life.** S. Kurstjens and D. Wolke in *Journal of Child Psychology and Psychiatry,* Vol. 42, No. 5, pages 623–636; July 2001.
- **Interactive Regulation of Affect in Postpartum Depressed Mothers and Their Infants: An Overview.** Corinna Reck et al. in *Psychopathology,* Vol. 37, No. 6, pages 272–280; November-December 2004.
- **Clinically Identified Maternal Depression before, during, and after Pregnancies Ending in Live Births.** P. M. Dietz, S. B. Williams, W. M. Callaghan, D. J. Bachman, E. P. Whitlock and M. C. Hornbrook in *American Journal of Psychiatry,* Vol. 164, No. 10, pages 1515–1520; October 2007.
- For general information about postpartum depression, see **www.emedicinehealth.com/postpartum_depression/article_em.htm** and **www.4women.gov/FAQ/postpartum.htm**



Nerves *in* Flight

Karsten Kramarczik, a magazine art director from Schriesheim, Germany, never liked to fly. Even as a child, he found that the prospect of enclosing himself in a long metal tube and hurtling through the ether at nearly the speed of sound made him shiver. Nevertheless, for much of his life Kramarczik forced himself to get on airplanes. Then, four years ago, doubt mysteriously turned into full-blown panic on a trip to Barcelona. He has not flown since.

According to a 2006 *USA Today*/CNN/Gallup poll, 27 percent of American adults are at least somewhat afraid to take to the skies; 9 percent are "very afraid." These statistics suggest a recovery since the September 11, 2001, attacks, shortly after which a Gallup poll indicated that 43 percent were wary about getting on an airplane, including 17 percent who were "very afraid."

Many of us feel anxious before getting on an airplane, but some people truly panic when they fly. Here's how several aviophobes got over their fear

By Rabea Rentschler

The body spews out **stress hormones** in response to imagined threats as well as real ones.

A fear of flying, termed aviatophobia or aviophobia, refers to a level of anxiety so great that a person refuses to travel by air or finds doing so extremely distressing. Experts estimate that at least 10 percent of Americans have such a phobia. These people worry obsessively that they will crash or even die of their own fear. In extreme cases, an individual suffers a full-blown panic attack, a sudden feeling of intense anxiety that is often accompanied by shortness of breath, chest pain, nausea and dizziness. Some may vomit at the mere sight or mention of an airplane.

Such intense fear can be debilitating. It may prevent a person from traveling to distant destinations on vacation or to see family or friends. It can also cripple the careers of those who must travel for their jobs.

Karsten Kramarczik, his ticket in hand, will try to overcome his fear of flying by getting on a plane.

Fortunately, fear of flying usually yields to treatments such as do-it-yourself DVDs, hypnosis and virtual reality [*see box on page 79*]. Perhaps the most effective technique, however, involves forcing a patient to face what he or she fears—by flying in a plane. The goal of such exposure therapy is habituation, a form of learning in which a response to a stimulus diminishes with repeated contact. Kramarczik has chosen a program that combines exposure with relaxation exercises and information about both flying and fear that puts the dangers in perspective.

The prognosis is promising. According to one German study, exposure therapy can eliminate or significantly ameliorate severe anxiety associated with flying in more than 90 percent of aviophobes. "People who look their fear in the eye have already taken the first step," explains psychologist Marc-Roman Trautmann, training facilitator at the German Flight Anxiety Center (GFAC) in Nieder-Wiesen, Germany.

Diffusing Dread

Kramarczik, along with three like-minded souls named Melanie, Stefan and Sven, took that first step in a seminar room in Raunheim, Germany, the meeting place for one of Trautmann's courses. Trautmann uses cognitive-behavior therapy, a type of psychotherapy that diminishes destructive emotions by correcting distorted cognitions and encouraging more adaptive behaviors. In this two-day program, the training facilitator would instruct participants about air travel as a way of calming overblown estimations of its dangers. He would also coach them to relax and, on day two, would accompany them on a flight to Vienna.

All the participants were determined to become fearless fliers. Melanie's husband and two children had acquiesced to her phobia for years, one time driving 11 hours to the coast of Spain on vacation. Now they want to fly, but Melanie is afraid of having an embarrassing panic attack. Stefan, who has not flown in eight years, wants to set a good example for his children. And Sven is an export manager who must fly for his job but has had no faith in the safety of air travel since 9/11.

Although Sven can pinpoint the origin of his fear, not every aviophobe can. When Trautmann asks Kramarczik to recount the details of his nightmarish trip from Frankfurt to Barcelona, no obvious trigger emerges. His fear of flying seems to have grown over time with the accumulation of negative experiences in the air such as turbulence, storms and a prior takeoff from Cuba that occurred during a hurricane warning.

Kramarczik's fear also stems in part from his

FAST FACTS

Flight Fright

1» A 2006 poll indicates that 27 percent of American adults are at least somewhat afraid to fly in an airplane; 9 percent are "very afraid."

2» People with aviophobia worry obsessively that they will crash or even die of their own fear. In extreme cases, an individual suffers a full-blown panic attack, which can include physical symptoms such as shortness of breath, chest pain, nausea and dizziness. Such intense fear may cripple careers and prevent people from visiting family or friends.

3» Fear of flying often yields to treatment with do-it-yourself DVDs, hypnosis or virtual reality. Perhaps the most effective therapy, however, involves confronting the fear with facts and exposing patients to what they fear—by putting them on an airplane.

KOOPMAN *Corbis (page 74)*; MIGUEL ÁNGEL MUÑOZ *age Fotostock (preceding page)*; GEHIRN & GEIST/STEPHANIE SCHMITT *(this page)*

Claustrophobia worsens some people's terror in the skies.

fear of heights, or acrophobia. Terror of tight spaces, or claustrophobia, as well as a feeling of not being in control can similarly exacerbate a fear of flying in some people. But the risk of breaking out in panic during a flight is often a function of a person's overall level of stress, Trautmann says. A person who feels pressure from various sources may lose control during a flight, whereas one who is under less tension will be better able to tolerate flying on any given day.

Whatever the causes of their angst, many aviophobes unwittingly aggravate their apprehension by focusing on it, and their anxiety spirals out of control. To interrupt that cycle, Trautmann tells the group that although their fright and its physical symptoms may seem significant, both are in fact a maladaptive distortion of a response that evolved for a different purpose.

Much of our anxiety stems from something called the fight-or-flight, or acute stress, response, which protects animals in the presence of real, immediate threats. When faced with possible danger, an animal or person releases a cocktail of hormones such as adrenaline and noradrenaline that produce a heightened state of alertness and facilitate a variety of physical changes, including a racing heartbeat, faster breathing, and blood vessel shrinkage and dilation. These bodily adjustments help prepare the muscles to act—to fight, perhaps, or freeze or flee. Once the threat is gone, the body returns to equilibrium, and the stress symptoms—tension, sweating and a quickened pulse—diminish.

Even though no acute danger exists, aviophobes perceive peril whenever they step onboard an aircraft. "I feel like I'm going to die," Melanie says. Trautmann counters: "No one dies of fear." It feels that way, he explains, only because the stress response surfaces inappropriately—and then refuses to dissipate. "The body cannot tell whether our fear is well founded or not," he says. It thus spews out stress hormones in reaction to imagined threats as well as real ones.

Flying is not the only example of a modern make-believe menace; an upcoming sports competition, math test or stage performance can also provoke an irrational stress response. In such situations, Trautmann advises, try to push past your unreasonable anxiety so that it does not stop you from doing something that is important to you, especially because avoidance only intensifies the fear.

Facts of Flight

Next Trautmann escorts the participants to a Condor hangar in which Boeing airplanes get routine maintenance and checks. There they will learn facts about air travel. According to Trautmann, a lack of information is a main cause of aviophobia, and thus a dose of the hard facts can help cure it.

Several jumbo jets are standing in a row in the huge hangar, some of them with exposed innards. Mechanics and engineers are methodically going down their checklists; a co-worker double-checks each step. The process relies on redundancy: engineers design all the important systems with backups that automatically take

(The Author)

RABEA RENTSCHLER is a theologian and philosopher who also worked for a year as a flight attendant.

GEHIRN & GEIST/STEPHANIE SCHMITT

Many people **falsely assume** that a failure of all engines will cause a plane to nose-dive.

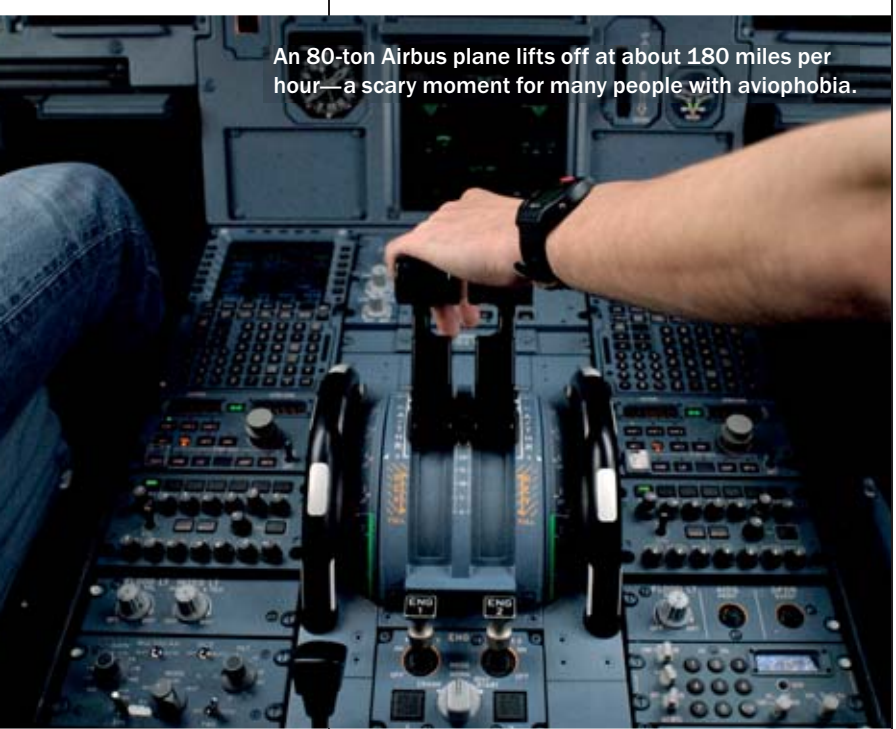
Aviophobes can release stress by performing exercises in which they tense and relax various muscle groups.

over their functions in the event of a failure. Still, an aircraft never even gets to the runway unless everything is working to specifications. The captain and first officer must also check off all systems before takeoff.

"What happens if an airplane banks too steeply when taking a turn?" Kramarczik wants to know. "More than once, it has occurred to me that it wouldn't take much more to tip us over." A technician explains that what he is seeing is an optical illusion. Although it may look to a passenger like the horizon is perpendicular to the aircraft, in actuality the airplane takes the curve at barely 25 degrees from horizontal, he says. And airplanes are built to take curves safely at 60 degrees, the technician maintains.

Many people also falsely assume that a failure of all engines will cause a plane to nose-dive. In reality, all airliners can glide without engines, although they will start to descend. A safe landing is possible if the plane is near a runway or suitable landing area. This scenario occurred with a flight from Canada to Portugal in 2004. There were no deaths among the 293 passengers and 13 crew members onboard.

Sven has another worry: "But what would happen if some nut gets control of the airplane, as happened at the World Trade Center?" Trautmann says that a high-security door now protects airplane cockpits and that even the flight attendants have to ring if they want to enter. The crew also monitors the cabin through a video camera and unlocks the door only when they are satisfied that all is clear.



An 80-ton Airbus plane lifts off at about 180 miles per hour—a scary moment for many people with aviophobia.

What is more, the overall risk of flying is very low. "Statistically, a passenger would have to fly 2.4 billion miles before experiencing an accident. That is about the same as 14 round-trips to the sun," reads a passage from the cockpit flight manual of the German airline Lufthansa, parroted in Trautmann's course. "The most dangerous part of the trip remains the drive to the airport."

But information alone does not always squelch fear, so Trautmann tries to attack it physically as well. He introduces the group to progressive muscle relaxation (PMR), a series of stress-reducing exercises developed by Edmund Jacobson, a physiologist formerly at the Laboratory for Clinical Physiology in Chicago.

"Think about your favorite place and let your thoughts take you there," Trautmann instructs the group. "Make a tight fist with your right hand, hold it, and then relax your hand and place it on your knee. Now do the same with both hands." He repeats the exercise with other parts of the body, including the arms, legs, stomach, shoulders and neck. After several times through the exercise, each person experiences a release of physical tension. But will these techniques work for tomorrow's flight?

Prepare for Takeoff

The next morning Trautmann urges the four reluctant fliers to replace any horrific images in their minds with positive thoughts. In a secluded corner of the departures hall, he guides them through more relaxation exercises; then they board a bus to the plane.

The enclosed gangway unnerves Kramarczik, but he, Sven and Stefan board the plane uneventfully. Melanie hesitates; her eyes tear up, and she is close to turning back. But just then the pilot—who turns out to be Austrian car-racing legend and aviator Andreas Niklaus "Niki" Lauda—introduces himself and offers to show Melanie the cockpit. Melanie momentarily forgets her fear as the pilot guides her into the cock-

GEHIRN & GEIST/STEPHANIE SCHMITT

Controlling the Fear

Those who dread flying can often overcome their apprehension with one of the following strategies:

Self-help. Numerous books, CDs and DVDs teach people how to detect and surmount fear-escalating thought patterns and to use imagery and relaxation techniques to overcome their fear of flying. Some programs offer professional support. One of them, called Seminars on Aeroanxiety Relief (SOAR), consists of 10 DVDs that teach users about the psychology of flight anxiety, airline safety, and methods to control their anxiety. It also includes two hours of counseling with SOAR founder Tom Bunn, a retired United Airlines captain who is also a licensed therapist.

Virtual therapy. Aviophobes not ready to get on a real airplane can benefit from virtual exposure therapy using three-dimensional computer simulations of flight. A 2006 study led by psychologist Barbara Rothbaum of Emory University suggests a success rate of more than 70 percent for virtual therapy [see "Fantasy Therapy," by Nikolas Westerhoff; SCIENTIFIC AMERICAN MIND, October/November 2007].

At least one study suggests, however, that virtual therapy will not work in people whose fear of flying is a manifestation of another disorder, such as acrophobia (fear of heights) or panic disorder; in such cases, a patient may require real exposure therapy.

Hypnosis. Studies have shown that hypnotherapy can help some individuals tolerate a flight with greater equanimity. This strategy often involves coaxing a person to relive the circumstances under which he or she first developed the fear to gain a better understanding of the origins of his or her own terror.

Cognitive-behavior therapy. Offered by institutes, therapists and occasionally airlines, such therapy should include information about aircraft safety, relaxation techniques and exposure therapy, in which patients confront their fear by taking a short flight. A lack of positive experiences typically intensifies a phobia.

Medication. In certain cases, a doctor might prescribe drugs such as tranquilizers or antidepressants to help control the fear of flying. Many people self-medicate with alcohol, but experts warn against overindulging when you fly because you can become intoxicated more readily in the reduced oxygen level of an airplane cabin. Neither alcohol nor drugs are a long-term solution for a fear of flying, however, and therapy is usually required to help patients control their anxiety. —*R.R.*

pit, and he lets her remain there during takeoff.

Kramarczik, Stefan and Sven sit down in the cabin, their faces betraying tension as they discuss what they learned the day before. As the plane begins to taxi, they pause to identify the noises and movements of the aircraft. The turbines accelerate; the nose of the plane lifts off. Everyone is pressed softly against the backrest, and in a few minutes they are at cruising altitude.

They all drink a toast and then are allowed to visit the cockpit. When Lauda asks Kramarczik why he is afraid of flying, he admits that his lifelong displeasure with being in an airplane turned to fear after a very turbulent flight. The pilot reassures him that turbulence has never caused an airplane to break up or otherwise malfunction. Turbulence is mostly uncomfortable for the passengers, he says, like driving on a bumpy road.

Lauda and his co-pilot seem completely calm and in control, and Kramarczik is starting to relax, too. He blanches slightly during landing but is otherwise feeling fine. Seeing the flight from a pilot's perspective has helped him give up control and unwind onboard.

After the flight of 90 minutes, all the class participants disembark much less anxious about flying. "Waiting in the airport was much worse than the flight itself," Melanie says. "I was so tense. Now I'm feeling much better. My family will be proud of me!" Stefan remarks: "Now I know that there was no reason for my extreme reaction. When the thrust stopped after takeoff, I thought, uh-oh, we're going down! But nothing happened."

Trautmann is also pleased with the progress of his charges. "You now have the hardest step behind you," he says, "but don't forget: you have to fly back!" M

(Further Reading)

- **Flying without Fear.** Duane Brown. New Harbinger Publications, 1996.
- **Overcome the Fear of Flying.** Glenn Harold. Diviniti Publishing, 2002.
- **For Fear of Flying, Therapy Takes to the Skies.** Tim Murphy in *New York Times;* July 24, 2007.
- Seminars on Aeroanxiety Relief (SOAR) offers a course to help people overcome their fear of flying: **www.fearofflying.com**
- Wings of Light and the National Air Disaster Alliance represent people affected by aircraft accidents: **www.wingsoflight.org** and **www.planesafe.org**

Uncovering "Brainscams"

In which the authors debunk myths concerning the three-pound organ inside our head

BY SCOTT O. LILIENFELD AND HAL ARKOWITZ

MOST OF US take our brain for granted. As poet Robert Frost wrote, "The brain is a wonderful organ. It starts working the moment you get up in the morning and does not stop until you get into the office." Weighing in at a mere three pounds and possessing the consistency of a lump of Jell-O, our brain looks surprisingly unimpressive in the flesh. Yet it is capable of soaring intellectual feats.

Although our brain underpins virtually every aspect of our thinking, personality and identity, it is the focus of a host of misconceptions. Without question, the world's expert on "neuromythology"—the study of myths regarding brain structure and function—was Simon Fraser University psychology professor Barry L. Beyerstein, who died last June at the age of 60. Barry coined the term "brainscams" in a 1990 article to draw attention to popular efforts to capitalize on the public's misunderstanding of the brain.

Barry was a friend of one of us (Lilienfeld) and a contributor to both *Scientific American* and *Scientific American Mind*. We thought it would be apropos to honor Barry's memory and contribution to neuromythology by dedicating this column to him and by examining three widespread brainscams that he helped to expose.

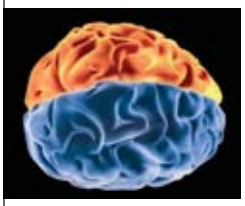
1. We use only 10 percent of our brain's capacity. This misconception, about which Barry wrote on multiple occasions (including for an Ask the Experts column in the June 2004 issue of *Scientific American*), is among the most deeply entrenched in all of popular psychology. Its seductive appeal is understandable, as we would love to believe that our brain harbors an enormous reservoir of untapped potential. The 10 percent myth has contributed to a plethora of self-help books and self-improvement gadgets, including commercially available devices that supposedly enable us to harness our unrealized capacities.

Yet the scientific evidence against this myth is overwhelming. Functional brain-imaging studies have consistently failed to turn up any region of the brain that is perpetually inactive. Moreover, research on brain-damaged individuals reveals that a lesion to almost any brain area will produce at least some psychological deficits.

As Barry had noted, the 10 percent myth probably stemmed in part from a misinterpretation of the writings of William James, one of the founders of American psychology. In his musings around the turn of the 20th century, James wrote that most of us actualize only a small portion of our intellectual potential, an assertion that may well possess some merit. But several popular authors—including Lowell Thomas, who penned the foreword to Dale Carnegie's 1936 best-seller, *How to Win Friends and Influence People*—took liberties with James's writings by proposing that we use only about 10 percent of our brain. Further contributing to this notion's cachet were early studies suggesting that a substantial majority of the cerebral cortex is "silent." Yet because of advances in the measurement of brain

COURTESY OF SCOTT O. LILIENFELD (*top*); COURTESY OF HAL ARKOWITZ (*bottom*); PASIEKA SPL/*Photo Researchers, Inc.* (*brain images*)

activity, we now know that these areas are far from silent; they make up what neuroscientists term the brain's "association cortex," which plays a vital function in connecting perceptions, thoughts and emotions across diverse brain areas.



2. Some people are left-brained; others are right-brained. Supposedly, left-brained people are analytical, logical and verbal, whereas right-brained people are creative, holistic and spatial. Scores of popular books have seized on this purported dichotomy. In his 1972 best-seller, *The Psychology of Consciousness,* Stanford University psychologist Robert Ornstein argued that Western society places too great an emphasis on rational, left-brain thinking and not enough on intuitive, right-brain thinking. In 1979 artist and psychologist Betty Edwards's still popular book, *Drawing on the Right Side of the Brain,* similarly touted the benefits of more creative, right-brained forms of artistic expression.

Yet as Barry and University of Auckland psychologist Michael Corballis noted, the left-brained-versus-right-brained dichotomy is grossly oversimplified. For one thing, this distinction implies that people who are verbally gifted are not likely to be artistically talented, but research suggests otherwise. Moreover, neuroscience studies suggest that the brain's two hemispheres work in a highly coordinated fashion.

Like many brain myths, this one contains a kernel of truth. For several decades, beginning in the 1960s, neuroscientist Roger Sperry of the California Institute of Technology, psychologist Michael S. Gazzaniga of the University of California, Santa Barbara, and their colleagues studied patients who underwent surgery to sever the corpus callosum (the large band of neural fibers connecting the two hemispheres) in an effort to halt intractable epilepsy. The research showed that the left and right hemispheres are indeed different. In most of us, the left hemisphere is specialized for most aspects of language, whereas the right hemisphere is specialized for most visuospatial skills. Yet even these differences are only relative; for example, the right hemisphere tends to play a larger role than the left does in interpreting the vocal tone of spoken language. Moreover, because practically all of us have an intact corpus callosum, our hemispheres are continually interacting.

3. We can achieve a deeper sense of consciousness and relaxation by boosting our alpha waves. Purveyors of "alpha consciousness" have encouraged people to undergo brain-wave biofeedback—in some cases using commercially available devices—to increase their production of alpha waves, brain waves that occur at a frequency of about eight to 13 cycles per second. Yet research shows alpha-wave output is largely or entirely unrelated to long-term personality traits and short-term states of contentment.

As Barry observed, the myth of alpha consciousness reflects a confusion between "correlation" and "causation." It is true that people tend to display a heightened proportion of alpha waves while meditating or relaxing deeply. But this fact does not mean that an increased production of alpha waves *causes* heightened relaxation. Moreover, research shows that elevated levels of alpha waves are found in some children with attention-deficit hyperactivity disorder, who are anything but relaxed.

These three myths barely scratch the surface of the sprawling field of neuromythology, but they give us a flavor of Barry's valuable role in combating the public's misconceptions about brain function. Fortunately, as readers of *Scientific American Mind* know, the facts about brain function are often far more interesting and surprising than the fictions. By helping laypersons better distinguish brain myths from brain realities, Barry Beyerstein was a pioneer in the ongoing effort to increase the public's scientific literacy. We will miss him. M

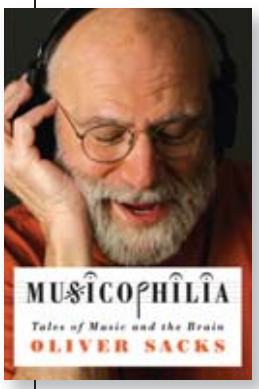
> The facts about brain function are often **far more interesting** and surprising than the fictions.

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)

- **Enhancing Human Performance: Issues, Theories, and Techniques.** Edited by D. Druckman and J. Swets. National Academy Press, 1988.
- **Brainscams: Neuromythologies of the New Age.** B. L. Beyerstein in *International Journal of Mental Health,* Vol. 19, No. 3, pages 27–36; 1990.
- **Mind Myths: Exploring Popular Assumptions about the Mind and Brain.** Edited by S. Della Salla. John Wiley & Sons, 1999.
- **Tall Tales about the Mind and Brain: Separating Fact from Fiction.** Edited by S. Della Salla. Oxford University Press, 2007.

PASIEKA SPL/Photo Researchers, Inc.



THE NEUROLOGIST SINGS

Musicophilia: Tales of Music and the Brain

by Oliver Sacks. Knopf, 2007 ($26)

Music provides a fascinating window into the mind. In my research at the University of California, San Diego, I have found that music and language are deeply intertwined and that listening to music can involve striking illusions and perceptual disagreements. Now Oliver Sacks, world-renowned neurologist and author, has combined his lifelong passions for neurology and music to produce a masterly overview of music and the brain. In *Musicophilia,* Sacks focuses on individual case studies, which he presents vividly and with care. In so doing, he convinces readers that these cases illustrate—albeit in extreme fashion—aspects of musical processing that relate to everyone's brain.

Sacks describes people who are so plagued with tunes stuck in their head that they urgently seek medical advice. He writes about patients who hallucinate music—sometimes unrelenting, loud music that interferes with their sleep and ability to function in everyday life. Many musical hallucinations are remarkably detailed, demonstrating that we must possess extraordinarily accurate and precise musical memories that are normally inaccessible to us.

Other cases involve patients afflicted with severe amnesia, aphasia (difficulty with speech) or dementia who have miraculously preserved sophisticated musical capacities. Sacks also encounters patients with Parkinson's disease who, though usually paralyzed, will rise up and dance to music, as well as people suffering from Tourette's syndrome who are relieved of their habitual ticks when playing in ensembles. Sacks goes on to consider, among other topics, people who develop insatiable desires for music following brain trauma and unusual musical phenomena such as absolute pitch.

Although the book is deeply personal in tone, Sacks expertly reviews perceptual and behavioral laboratory studies. He provides illuminating discussions of modularity in musical processing—currently a hot debate topic. His case studies strongly suggest that rather than a single music-processing center in the brain, there must be separate neural bases for the perception of rhythm, melody and timbre and for the integration of musical elements into coherent wholes.

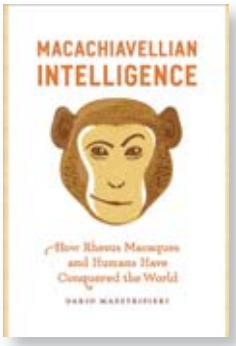
Musicophilia is a landmark book—thoughtful, compelling and engrossing. —*Diana Deutsch*

Mind Reviews

PRIMATE POLITICS

Macachiavellian Intelligence: How Rhesus Macaques and Humans Have Conquered the World

by Dario Maestripieri. University of Chicago Press, 2007 ($25)



In 1513 Niccolò Machiavelli advised politicians that being feared was more important than being loved if they were to preserve a stable and healthy state.

About 2.5 million years earlier rhesus macaques, dusty-brown monkeys that are ubiquitous in mainland Asia, already used strong kin-based alliances and rigid dominance hierarchies to maintain order. Evolutionary biologist Dario Maestripieri of the University of Chicago, who has studied rhesus behavior for more than 20 years, attributes this species' overwhelming success largely to a special set of cognitive adaptations, which they share with humans.

In *Macachiavellian Intelligence,* Maestripieri suggests that in response to the complexities of cooperation and competition that arose from life in large social groups, people and rhesus macaques "evolved a sophisticated and opportunistic form of social intelligence." Stemming from these adaptations, he argues persuasively, are some of the most fundamental (and least commendable) human traits, including aggression, nepotism and xenophobia.

Many social scientists believe widespread variation in lifestyle and behavior implies that there is no typical "human nature." Maestripieri questions this view, suggesting that stripped of their cultural clothes, human societies are fairly similar to one another—and to those of rhesus macaques. The strict dominance hierarchies and social alliances in the military and in prisons, he says, may be the most truthful manifestations of many of our psychological and behavioral predispositions.

Maestripieri's informative narrative on the lives of the macaques—peppered with amusing anecdotes and witty observations—leaves no doubt he is the right person to tell their story. But he sometimes takes too far the idea that human interactions can be reduced to the daily risk-reward calculations that underlie rhesus behavior (should I fight? should I grant sex?), ignoring evidence that culture shapes our brains and actions. The result is his occasional use of improbable and even offensive stereotypes, such as the notion that all women use sex (or should, if they do not) to exploit men's power.

Nevertheless, *Macachiavellian Intelligence* is an intriguing departure from the currently vogue studies of animal benevolence—chimps are our moral progenitors, capuchins are exemplars of fairness, and empathetic rats show the roots of human compassion. Maestripieri convinces us that rhesus macaques, on the other hand, help to explain some of the darker qualities underlying the human success story. —*Rachel Dvoskin*

Blogs on the Brain

Scientific American Mind offers up a hearty helping of science, but for the most voracious brain buffs six issues a year may not be enough. Fortunately, plenty of extra crumbs of brain candy can be picked up online in the blogosphere.

Any well-stocked bookmark folder has to include **Cognitive Daily**, the brainchild of cognitive psychologist Greta Munger and her writer husband, Dave. In a lyrical tone, the Mungers dutifully break down two to three pieces of peer-reviewed research per week on topics relating to everyday life, such as whether using red ink to grade papers impairs learning or how adopted children acquire new languages. On "Casual Fridays," the pair conduct mini studies, quizzing readers on everything from whether they have perfect pitch to who makes the messes in their home.

Most neuroblogs serve as filters for brain science news, mining content from journals, newspapers, magazines and more. The most earnest of these curators, **Mind Hacks**, is a multiauthor U.K. outfit born out of a 2004 book with the same name. The blog culls articles that in some way help readers better understand their own mind. **PsyBlog** occupies similar territory but also offers fun special features—for example, a recent post heralded 10 brilliant social psychology studies, including Philip Zimbardo's disturbing Stanford Prison Experiment in which students posing as "guards" quickly developed abusive behavior toward "prisoners."

For a blog with more personality, try **The Neurocritic**, which is always sardonic (and occasionally scathing). According to his bio, the anonymous author has led a hard-knock life, and he works out his hostility by excoriating scientists and journalists who dare to sensationalize findings. In November he jumped on the authors of a *New York Times* op-ed over the dubious results of their fMRI study regarding people's perceptions of the 2008 presidential candidates.

> "Did we really need fMRI to tell us that Mrs. Clinton should try to soften the negative responses of swing voters?"

Nearing the highbrow end of this spectrum is **The Frontal Cortex**, the literary brain blog of Jonah Lehrer, twentysomething author of *Proust Was a Neuroscientist* (Houghton Mifflin, 2007). Like the book, which presents instances of art as a harbinger of scientific insights, Lehrer's blog covers neuroscience as part of a broader cultural milieu.

But because this is the Web, there are also plenty of opportunities to give your reading comprehension skills a rest. For example, try **Channel N**, a repository of brain science videos where you can sample, among other things, *Mind* columnist Vilayanur S. Ramachandran's lectures on neurological oddities. And, speaking of our own, don't forget to drop by the **Mind Matters** blog at SciAmMind.com, where David Dobbs serves up a weekly morsel of brain food straight from the research lab. *—Nikhil Swaminathan*

- Cognitive Daily: **www.scienceblogs.com/cognitivedaily**
- Mind Hacks: **www.mindhacks.com**
- PsyBlog: **www.spring.org.uk**
- The Neurocritic: **www.neurocritic.blogspot.com**
- The Frontal Cortex: **www.scienceblogs.com/cortex**
- Channel N: **www.channeln.blogspot.com**
- Mind Matters: **www.SciAmMind.com**

SURGERY OF THE SOUL

The Lobotomist

Buy the DVD or watch for free online at www.pbs.org/wgbh/amex/lobotomist

Lobotomy, a gruesome brain operation purported to treat intractable mental illness, has emerged as one of the ghastliest failures of modern medicine. That this operation achieved such prominence even among reputable physicians during the 1940s remains a perplexing social mystery.

Grappling with this baffling saga, directors Barak Goodman and John Maggio have produced a fascinating documentary that explores with compassion and a critical eye the unfolding of this tragic tale of human agony, experimentation, hope and failure. Based on a book of the same title by journalist Jack El-Hai (Wiley, 2005), Goodman and Maggio's *The Lobotomist* presents an impressively evenhanded interpretation of the legacy of Walter J. Freeman, the physician who popularized the procedure in the U.S.

In the early 20th century intractably ill mental patients faced a lifetime in filthy, dingy asylums as their hopeless families and physicians searched desperately for some way—any way—to lessen their agonies. Freeman, an ambitious neurologist from a prominent medical family, became convinced that operating on the brain to sever connections between the "rational" frontal lobe and the "primitive" thalamus would stop unmanageable emotions from disturbing patients' reasoning faculties. His initial experiments in the late 1930s produced controversial results, relieving some patients of violence or fear yet rendering them docile and childlike. Demand swelled until the early 1950s, when long-term studies revealed the procedure's severe side effects and the advent of antipsychotic drugs rendered lobotomy—and its purveyor—obsolete.

A one-hour documentary cannot provide the same level of detail as a book can, but words on a page pale in comparison to the emotional impact of archival footage showing lobotomies performed on live patients with an ice pick and a common hammer. Goodman and Maggio restrain themselves from exploiting the story's grotesque nature, however; they portray accurately and empathetically the complexity of this American fiasco. In the end, the viewer feels appropriate sadness and confusion over the ironies surrounding Freeman, his patients, their families and mainstream medicine as they all struggled to understand the so-called miracle cure. *—Richard Lipkin*

askthe**Brains**

Why do some people sleepwalk?

—Carlos Navarro, via e-mail

Neurologist **Antonio Oliviero** of the National Hospital for Paraplegics in Toledo, Spain, explains:

SLEEP DISORDERS such as sleepwalking arise when normal physiological systems are active at inappropriate times. We do not yet understand why the brain issues commands to the muscles during certain phases of sleep, but we do know that these commands are usually suppressed by other neurological mechanisms. At times this suppression can be incomplete—because of genetic or environmental factors or physical immaturity—and actions that normally occur during wakefulness emerge in sleep.

People can perform a variety of activities while asleep, from simply sitting up in bed to more complex behavior such as housecleaning or driving a car. Individuals in this trancelike state are difficult to rouse, and if awoken they are often confused and unaware of the events that have taken place. Sleepwalking most often occurs during childhood, perhaps because children spend more time in the "deep sleep" phase of slumber. Physical activity only happens during the non–rapid eye movement (NREM) cycle of deep sleep, which precedes the dreaming state of REM sleep.

Recently my team proposed a possible physiological mechanism underlying sleepwalking. During normal sleep the chemical messenger gamma-aminobutyric acid (GABA) acts as an inhibitor that stifles the activity of the brain's motor system. In children the neurons that release this neurotransmitter are still developing and have not yet fully established a network of connections to keep motor activity under control. As a result, many kids have insufficient amounts of GABA, leaving their motor neurons capable of commanding the body to move even during sleep. In some, this inhibitory system may remain underdeveloped—or be rendered less effective by environmental factors—and sleepwalking can persist into adulthood.

Sleepwalking runs in families, indicating that there is a genetic component. The identical twin of a person who sleepwalks often, for example, typically shares this nocturnal habit. Studies have also shown that frequent sleepwalking is associated with sleep deprivation, fever, stress and intake of drugs, especially sedatives, hypnotics, antipsychotics, stimulants and antihistamines.

To clarify the many mysteries of sleepwalking, we need to find out more about the brain mechanisms that control sleep and arousal states. Future research will have to focus not only on what is happening while sleepwalkers are sleeping but also on the characteristics of their waking brains.

Why do we get "brain freeze" when we eat something cold?

—Christina Zuniga, via e-mail

Mark A. W. Andrews, professor of physiology and director of the Independent Study Pathway at the Lake Erie College of Osteopathic Medicine, replies:

THIS COMMONLY experienced pain, also known as an ice cream headache, results from quickly eating or drinking very cold substances. Officially termed sphenopalatine ganglioneuralgia (talk about a painful mouthful!), it is the direct result of the rapid cooling and rewarming of the blood vessels in the palate, or the roof of the mouth. A similar but painless blood vessel response causes the face to appear "flushed" after being outside on a cold day. In both instances, the cold temperature causes blood vessels to constrict and then experience extreme rebound dilation as they warm up again.

People can perform a variety of activities while asleep, from simply sitting up in bed to more complex behavior such as housecleaning or driving a car.

In the palate, this dilation is sensed by nearby pain receptors, which then send signals back to the brain via the trigeminal nerve, one of the major nerves of the facial area. This nerve also senses facial pain, so as the signals are conducted the brain interprets the pain as coming from the forehead—the same "referred pain" phenomenon seen in heart attacks. Brain-freeze pain may last from a few seconds to a few minutes, which is blissfully short as compared with the duration of its cousin, the migraine headache. Research suggests that the same vascular mechanism and nerve implicated in brain freeze cause the aura (sensory disturbance) and pulsatile (throbbing pain) phases of migraines. Interestingly, it is impossible to give yourself an ice cream headache in cold weather—only in a warm ambient temperature will it hurt to wolf down a banana split.

Fortunately, abstaining from ice cream is not necessary. Placing the tongue hard against the palate may help, as will eating cold foods more slowly or warming food in the front of your mouth before swallowing. M

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

JUAN CARLOS MONROY (*top*); COURTESY OF MARK A. W. ANDREWS (*bottom*)

Head Games

Match wits with the Mensa puzzlers

1 ESCALATORS

Fill in the blanks to make 15 four-letter words. Blanks in the same column represent the same letter.

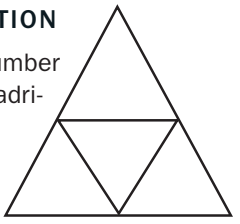
_ _ _ _	_ _ _ _	_ _ _ _
E _ _ _	L _ _ _	R _ _ _
_ E _ _	_ L _ _	_ R _ _
_ _ E _	_ _ L _	_ _ R _
_ _ _ E	_ _ _ L	_ _ _ R

2 TRANSMOGRIFIER

The Transmogrifier makes bizarre changes to those brave enough to enter it. Sam gave it a try, and he came out colored red (but otherwise the same). Then Don stepped in. The Transmogrifier took a while, but Don came out blue when he was finally done. Slim took his chances next and unfortunately came out as green ooze. Sid's resulting coloring was red, but only on one side. Justin turned into a blue woman, then Mal stepped out green—and her sex was changed, too. Tom is up next. What will the Transmogrifier do to Tom?

3 TRIANGULATION

What is the total number of triangles and quadrilaterals in this shape?



CORRECTION In last issue's "Cubic Deduction," the top green square should read "J," and the top-right red square should read "T."

4 WORD CHESS

Go from PAWN to KING by changing one letter at a time and by obeying these rules:

From white to yellow, use a pawn's move.
From yellow to blue, use a knight's move.
From blue to red, use a bishop's move.
From red to green, use a rook's move.
From green to orange, use a queen's move.
From orange to purple, use a king's move.

RING	KING	KINK	WANT	WAND	WISE
SING	WING	KIND	RANT	WIND	BARN
SINK	RANK	RINK	SIDE	WINK	WICK
YARD	LAPS	RANK	RANG	SICK	FAIR
SIRE	PANG	DARE	SANG	RIND	TANG
SIDE	DARN	YARN	LAIR	YAWS	RAIN
SINE	WINE	PAIR	PANS	LAWS	SANE
DAWN	FAWN	LAWN	YAWN	PAIN	PAWS
PAWN					

5 LOGICAL LIES

A group of four logicians agree to make three statements each. One logician will always tell the truth. Another will always lie. One will tell the truth twice and then lie on the third statement. And finally, one logician will lie twice and then tell the truth. The four logicians are named Anna, Bob, Carl and Donna. Here are their statements:

Anna:
1) Bob always lies.
2) Carl speaks more truth than lies.
3) Donna always speaks truth.

Carl:
1) Donna always lies.
2) Anna speaks more truth than lies.
3) Bob always speaks truth.

Bob:
1) Carl always lies.
2) Donna speaks more truth than lies.
3) Anna always speaks truth.

Donna:
1) Anna tells more lies than truth.
2) Bob tells more truth than lies.
3) Carl tells more lies than truth.

Which logician has which pattern?

Answers

1. TONS GOAD TEAM
EONS LOAD REAM
TENS GLAD TRAM
TOES GOLD TERM
TONE GOAL TEAR

2. The Transmogrifier changes colors in a repeating pattern of red, blue, then green. It also adds the letter "E" to the end of a person's name. Thus, Sam → Same, Don → Done, Slim → Slime, Sid → Side, Justin → Justine, and Mal → Male. Tom, therefore, will turn into a red book: Tom → Tome.

3. 11.

4. PAWN, PAWS, PANS, PANG, SANG, SING, KING.

5. Anna tells lies twice, and then she speaks the truth. Bob tells the truth twice, and then he lies. Carl always lies, and Donna always tells the truth. Remember, if someone "speaks more truth than lies," that may mean she tells no lies at all.

Coming Next Issue

SCIENTIFIC AMERICAN
MIND
BEHAVIOR • BRAIN SCIENCE • INSIGHTS

Available in April 2008

ONLY AT WWW.SCIAMMIND.COM

Weekly Mind Matters seminar blog

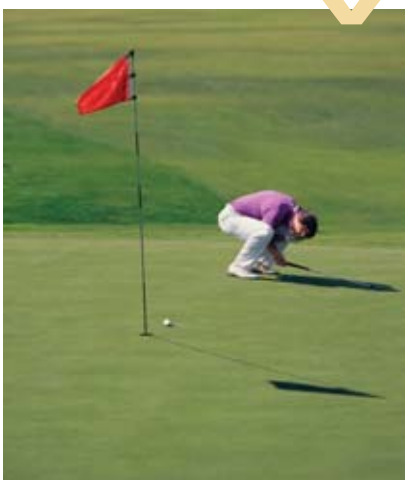
Two features highlighted from every print issue

Neuroscience news

E-mail alerts for new issues

Why People Choke

A clash of self-identity and negative stereotypes may explain why talented people sometimes fail under pressure.



A Schizophrenia Virus?

Mental illnesses, from autism to bipolar disorder, may be caused by infections, mounting evidence suggests.

Into Thin Air

Mountaineering can kill brain cells—even in climbers who show no signs of altitude sickness.

Sixth Sense

Sometimes the brain sees things that you do not—as in the case of one blind man with better than normal vision.

PLUS:

Ask the Brains Why does our sleep schedule change as we age?
Illusions Play tricks on your brain—and gain insights about mental functions.
Head Games Brainteasers and puzzles.

LAGUNA DESIGN *SPL/Photo Researchers, Inc. (left);*
DAVID MADISON *Getty Images (right)*