

SCIENTIFIC AMERICAN
MIND

BEHAVIOR • BRAIN SCIENCE • INSIGHTS

May/June 2016

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ON YOU!**
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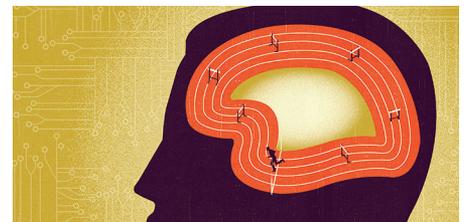
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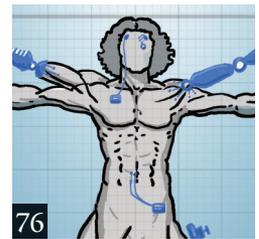
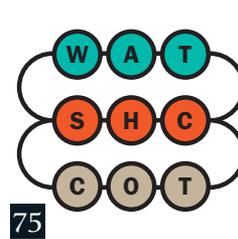
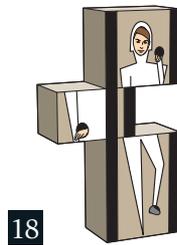


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Foes and Friends

We have all seen the horrors. The wreckage of a Paris concert hall where extremists turned a carefree Friday night into a bloodbath. “Jihadi John” mercilessly beheading a hostage. New York City’s fallen towers. Carnage left by suicide bombers. The perpetrators must be insane, we tell ourselves. Yet how could that be true? ISIS alone has tens of thousands of fighters. They cannot all be sadists and maniacs. No more so than were all 8.5 million members of the Nazi party in 1945 Germany.

So how are we to understand the psychology of terrorists, whether they are Islamic extremists, white supremacists or something else? For answers, we called on five experts for a three-part special report. In “Fueling Extremes” (*page 34*), social psychologists Stephen D. Reicher and S. Alexander Haslam, both members of this magazine’s board of advisers, use research on group dynamics to show how ordinary individuals become radicalized. This is not a passive process of surrendering to the spell of charismatic leaders. Extremist groups, they write, actively exploit existing rifts and feelings of marginalization to construct an us-versus-them appeal. Nor is their message primarily based on hate: Research shows that only 5 percent of ISIS’s recruitment imagery is violent. Most of it stresses the “nobility” of the cause.

No wonder fresh recruits continue to join the jihad. Dounia Bouzar heads an organization in France that attempts to open their eyes and bring them back. In “Escaping Radicalism” (*page 40*), she describes her work with more than 500 families to free loved ones from radicalization. In a third article, “Extinguishing the Threat” (*page 44*), social psychologists Kevin Dutton and Dominic Abrams draw on seven key studies for concrete suggestions on how to confront extremism.

One lesson of our report is that we in the West abet the schisms that fuel extremism. Donald Trump’s remarks about banning all Muslims from entering the U.S., Reicher and Haslam note, has become a sound bite in extremist propaganda.

Other stories in this issue explore contrasting aspects of human social behavior. In “For Shame” (*page 66*), Diana Kwon reports on how psychologists and criminologists are rethinking the impact of shaming offenders. There are “many shades of shame,” she writes, some destructive and some that spur contrition and reform.

And for a look at our most salutary form of social engagement, turn to page 50, where journalist Lydia Denworth dives into new research about the power—and evolutionary origins—of friendship. The propensity to affiliate is deeply rooted in our species—for worse and for better.

Claudia Wallis
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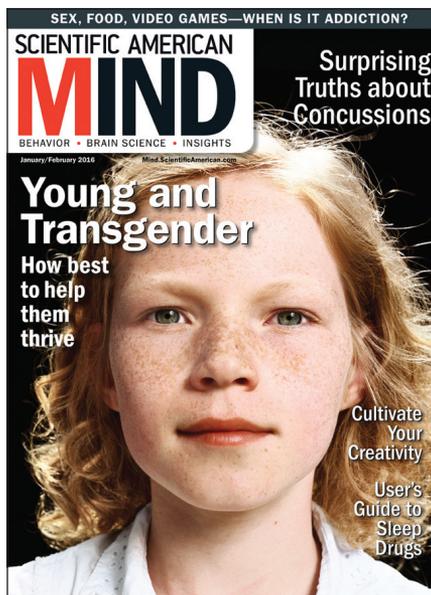
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HELP FOR TRANS YOUTH

As a therapist who has specialized in helping transgender people for 23 years and who is fully aware of the ever growing need to address the issue of transgender children, I was gratified that you chose to make this topic the cover story ["Transgender Kids," by Francine Russo]. Although in general I thought the article was very well written, I want to point out a couple of flaws. Most important, it is not the international Endocrine Society that is the primary source for the Standards of Care. Both historically and currently, it is the World Professional Association for Transgender Health (WPATH), formerly known as the Harry Benjamin International Gender Dysphoria Association.

In addition, readers should know that the University of Michigan Health System has one of the nation's longest-existing programs of its kind in the Comprehensive Gender Services Program. It has had a focus on helping transgender adults with a broad array of psychological, medical and surgical services since the early 1990s, before intervening with children was considered acceptable practice. Mention of the role of this major health system would have provided important historical context.

Sandra L. Samons
Ann Arbor, Mich.

THE EDITORS REPLY: Thank you for clarifying that WPATH's Standards of Care are separate guidelines from those of the Endocrine Society. Both documents build on the research described in this story and are widely used in the field. We apologize for the omission and have made a correction in the online version of this story.

I just had the pleasure of reading "Transgender Kids." As the president of the Southern Comfort Conference, an annual gathering of the trans community, I found the article very informative. It pointed out many of the issues that our community faces on a daily basis. The fact that these issues are finally being taken seriously will help many of the trans youths who have been closeted to get the help and support that they need to lead a better life in their chosen gender.

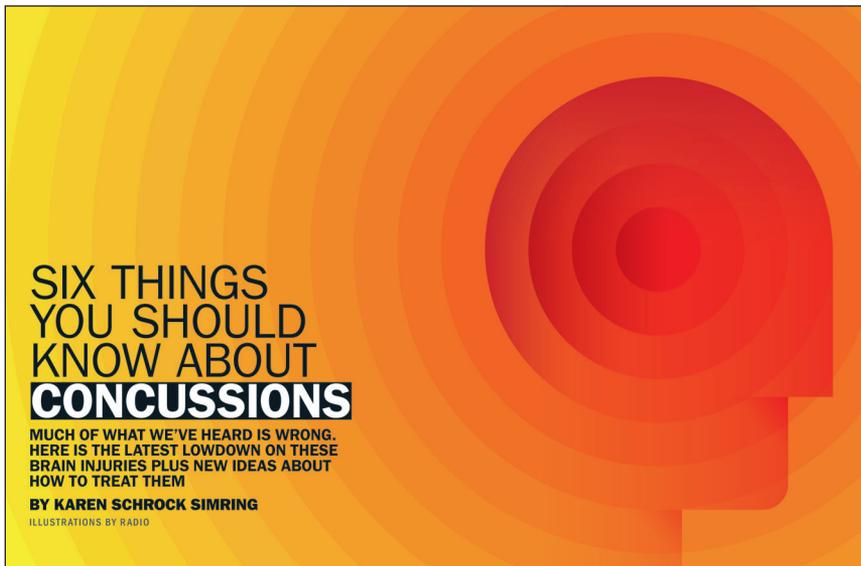
Alexis Dee
Fort Lauderdale, Fla.

SLEEP AFTER CONCUSSION

Thank you for "Six Things You Should Know about Concussions," Karen Schrock Simring's insightful article. I'm pleased that you are giving this problem the recognition it deserves and adding to the growing knowledge that traumatic brain injury is treatable. I have been effectively treating brain injury, particularly concussions, for more than 30 years in my practice as an osteopath. I want to clarify what the article recommends regarding the critical need for rest.

My concern is the directive to gradually return to your regular routine after a couple of days of rest. After a concussion, people do need lots of rest, but that doesn't mean suffering in a dark room, bored and frustrated. The majority of the body's and brain's repair and maintenance occurs during rest and sleep. I tell my patients to sleep as much as the body calls for, which is often 10 to 14 hours a day. It is important that people allow themselves time for naps if their body indicates the need.

After ensuring sleep and rest needs are met, move about gently, go for walks, do tai chi; the body does need to move to help flush debris out of the



brain. But shortchanging the body on rest is a critical mistake and can increase the insult to the brain. Listen to your body; it will tell you what it needs.

Maud Nerman
via e-mail

SEXUAL TRAUMA AND BOYS

In “*Breaking the Cycle*,” Sushma Subramanian examines the phenomenon of female victims of sexual trauma in childhood becoming victims in adulthood. She states, “Whether the pattern holds true for men is unclear because of a dearth of studies.”

Studies do exist that demonstrate that abuse in childhood establishes a pattern for men, in some ways similar to and in some ways different from the pattern for women. Prominent among analyses is the 1989 study “The Compulsion to Repeat the Trauma,” by Bessel A. van der Kolk, then at Harvard Medical School. Van der Kolk writes that trauma creates its own psychology, a baffling aspect of which is the tendency for traumatized people to “expose themselves, seemingly compulsively, to situations reminiscent of the original trauma.” He brings the findings of his cited 147 studies to bear on his thesis regarding the effect of childhood sexual abuse on men and women.

In these compulsive trauma reenactments, the abused may play the role of victim or victimizer—but generally

women tend to be victims, men victimizers. A recent study by Lorraine E. Cuadra, then at the University of Nebraska–Lincoln, found that criminal outcomes for adults abused as children are “frequent.”

There seems to be something particularly insidious about childhood sexual abuse and how it plagues the child-become-adult. The social, if not personal, consequences of these reenactments tend to be worse for men than for women. Abused girls who become victimized women present a sympathetic tableau. Abused boys who become victimizing men elicit no one’s sympathy. Moreover, the abuse itself has come to be seen by some courts as a marker to identify the criminally inclined.

We have a plenitude of studies that speak to, if not analyze, the effects of trauma on men. We don’t know conclusively why the effects are as they are, but we know *what* they are. The bigger question is why, in recognizing these effects and what such abuse does to women and to men, society vindicates the women but incarcerates the men.

Robert E. Byron
Hartford, Conn.

THE MALLEABLE BRAIN

I question the validity of the following statement in “Neuron Transplants May One Day Restore Vision,” by Jessica

Schmerler [Head Lines, November/December 2015]. Schmerler writes, “By adulthood, however, the brain has lost much of its plasticity and can no longer readily recover lost function after, say, a stroke.” This sounds to me exactly the opposite of what we now know. Surely plasticity remains deep into old age!

Lechesa Tsenoli
Mangaung, South Africa

THE EDITORS REPLY: Experts used to think the adult brain had almost no plasticity at all. Now we know that is untrue—the brain indeed remains somewhat malleable throughout life—but the capacity of the brain to grow, change and heal in adulthood is significantly less than it is in childhood.

LASTING TEEN FRIENDSHIPS

I want to know why lead researcher Brett Laursen, whose work is reported in “Why Preteen Friendships Are Fleeting,” by Meredith Knight [Head Lines], appears to assume that U.S. friendship patterns are universal. The U.K. doesn’t have middle school, and friendships here often last until children are parted at grade 11. Our secondary school timetables are less individualized, and kids are likely to be with the same people for five years. As for friendship across genders: the U.S.’s encouragement of preteens to pretend-date is not ubiquitous elsewhere.

I also couldn’t help noticing that Laursen assumes racial sorting. That’s not a preteen norm. That’s racism. Perhaps she would like to try to recapitulate her findings in multicultural North London, where groups of kids of all races hang out together in parks, playgrounds and streets.

Farah Mendlesohn
London

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Head Lines

A USER'S GUIDE TO THE BRAIN



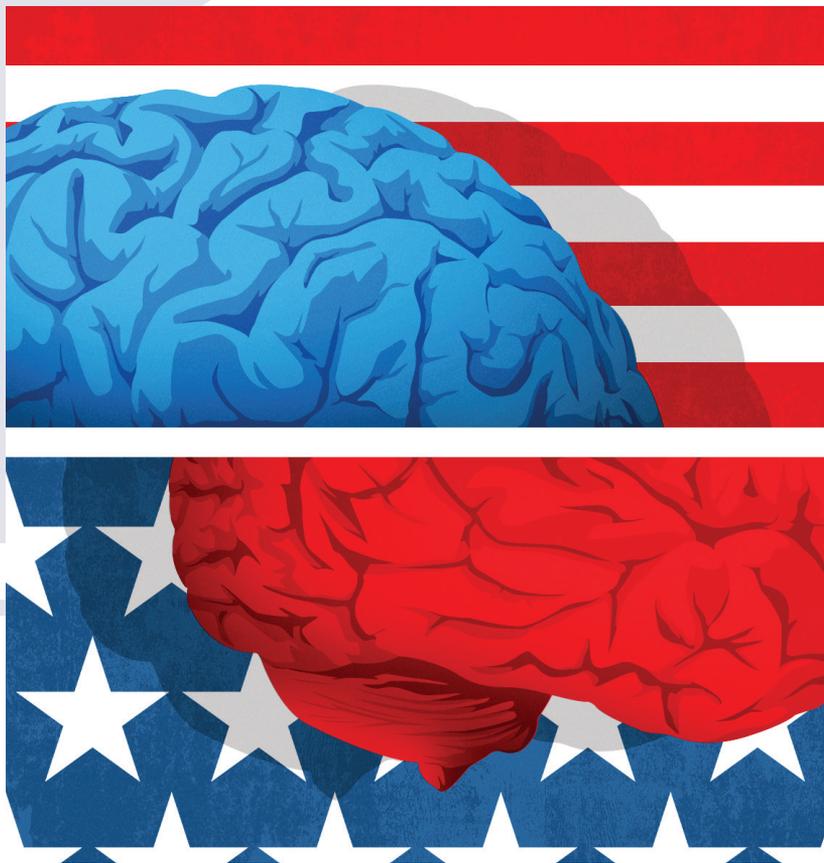
Politics in
Our Neurons



THE SCIENCE OF HOW WE VOTE

At the ballot box, we feel like we are in charge of our decisions. Yet recent research reveals that many unseen factors sway our political beliefs, from our cultural cognitive style to the genes that code for neurotransmitter receptors.

ILLUSTRATIONS BY TAYLOR CALLERY



Liberals Are from Mars, Conservatives Are from Venus

Political attitudes reflect cognitive styles that are rooted in differing cultures

When you debate a friend on the opposite end of the political spectrum, do you sometimes feel like you are talking to someone from a different planet? That might not be far from the truth: a 2015 study in *Personality and Social Psychology Bulletin* suggests liberals and conservatives think as though they come if not from different planets, at least from radically different cultures.

Previous research has shown that

people from cultures that are Western, educated, industrialized, rich and democratic (“WEIRD,” in psychological parlance) tend to think analytically, using logical rules, whereas those that are non-WEIRD process information more intuitively. They even perform differently on problem-solving tasks: Americans, who are more analytical, remember individual components of a complex visual scene better than East Asians, who are

more holistic. Only about 15 percent of the world’s population is from a WEIRD culture, yet most psychological studies use such participants.

Some researchers think culture actually shapes thought: cultures that emphasize individuality foster analytical thinking, whereas those that emphasize connectedness promote holistic thinking.

The current study applied this framework to the realm of politics. Scientists measured 218 participants’ political identification on a seven-point scale, from “very liberal” to “very conservative.” The subjects then completed tests such as the triad task, in which they saw pictures of three items—say, a panda, a banana and a monkey—and indicated which two they thought were more closely related.

Liberals acted more like Westerners, pairing items that belonged to the same abstract category (for instance, two animals), whereas con-

Twitter Language Reveals Political Beliefs

Democrats talk about themselves a lot and swear like sailors; Republicans say negative things and like bringing up religion. At least according to Twitter. Scientists at Queen Mary University of London analyzed the tweets of more than 10,000 users, sorting them by political party based on which American politicians’ Twitter feeds they followed. They found that the frequency of certain words was highly correlated with a user’s political orientation. Here are some of the more revealing findings:

Words That Predict a Person Is
DEMOCRAT

- “I,” “me” and “mine”
- Frequent use of curse words (e.g., the f-word)
- “Feel” (one of Dems’ most oft-used words)
- Positive sentiment (e.g., “love” and “like”)

Words That Predict a Person Is
REPUBLICAN

- “We,” “our” and “us”
- “God” and “psalm”
- “Great”
- Negative sentiment (e.g., “not” and addressing adversaries, e.g., “Obama”)

servatives tended to pair items that were functionally related (monkey and banana), as non-Westerners do. One other classic test of holistic thinking also suggested that liberals tended to use a more typically WEIRD cognitive style.

The finding that conservatives think more like those from collectivistic cultures might sound counterintuitive. Aren't liberals, who favor safety-net programs for the needy, the collectivist ones? Thomas Talhelm, now a professor of behavior science at the University of Chicago and lead author of the study, explains that true collectivism "doesn't mean general sharing with other people. It's about social ties and responsibilities to those within your group." Antipoverty programs usually serve to help individuals get a leg up rather than strengthening groups—thus aligning with

WEIRD cultures' focus on individuality.

Teasing apart the origins of these effects is not easy. Michael Varnum, a cultural psychologist at Arizona State University who was not involved in the study, believes "these group differences have their roots in people's environments." Liberals tend to live in cities, where research suggests people think in individualistic ways, he says, whereas conservatives are often found in more rural areas, where people are more collectivist. The surrounding culture influences both cognitive style and political beliefs.

The researchers found evidence that cognitive style might directly influence political beliefs, however. In a follow-up study, participants completed the triad task with a tweak: some were told to pair items by category, and some were told to pair by relationship. Next they were

asked to read an article about two contrasting welfare programs—a generous, liberal one and a stricter, conservative one—and "vote" for a plan. Those in the categorical group chose the liberal plan significantly more often than those in the relational group, suggesting that changing thought style can alter political views.

Talhelm cautions that the question is still open as to how much the thinking style of a culture shapes political beliefs in the real world. "Our political attitudes are influenced by so many things," he explains. "This is one factor among many."

Still, the findings have important implications. Talhelm suggests a politician making a speech to promote a liberal policy might want to "slow down and get people in an analytical mind-set," limiting emotional appeals and sticking to the facts. —Jennifer Richler

Powerful political speeches sync up listeners' brains—the more rousing, the greater the number of regions that activate similarly from one person to the next.

The Genes of Left and Right

Our political attitudes may be written in our DNA

Scientists and laypeople alike have historically attributed political beliefs to upbringing and surroundings, yet recent research shows that our political inclinations have a large genetic component.

The largest recent study of political beliefs, published in 2014 in *Behavior Genetics*, looked at a sample of more than 12,000 twin pairs from five countries, including the U.S. Some were identical and some fraternal; all were raised together. The study reveals that the development of political attitudes depends, on average, about 60 percent on the environment in which we grow up and live and 40 percent on our genes.

"We inherit some part of how we process information, how we see the world and how we perceive threats—and these are expressed in a modern society as political attitudes," explains Peter Hatemi, who is a genetic epidemiologist at the

Continued on next page



Continued from preceding page

University of Sydney and lead author of the study.

The genes involved in such complex traits are difficult to pinpoint because they tend to be involved in a huge number of bodily and cognitive processes that each play a minuscule role in shaping our political attitudes. Yet a study published in 2015 in the *Proceedings of the Royal Society B* managed to do just that, showing that genes encoding certain receptors for the neurotransmitter dopamine are associated with where we fall on the liberal-conservative axis. Among women who were highly liberal, 62 percent were carriers of certain receptor genotypes that have previously been associated with such traits as extroversion and novelty seeking. Meanwhile, among highly conservative women, the proportion was only 37.5 percent.

“Perhaps high-novelty seekers are more willing to entertain the idea of change, including in the political sphere,” says the study’s lead author, Richard Ebstein, a molecular geneticist at the National University of Singapore. He admits, however, that the dopamine genes are undoubtedly just a small part of the story of how we inherit political attitudes, with hundreds of other genes equally involved.

These genetic findings are in line with the many psychological studies that have suggested that political attitudes are related to personality traits. Openness to experience, for example, predicts a liberal ideology; conscientiousness often goes with a conservative stance. Yet the evidence suggests that political attitudes are not entirely explained by personality; the two are more likely independently rooted in what Hatemi calls a “common psychological architecture.” Hatemi and his colleague Brad Verhulst, a political scientist at Pennsylvania State University, published a study in 2015 in *PLOS ONE* showing that changes in personality over a 10-year period do not predict changes in political attitudes.

Ultimately these early genetic results lend weight to the hypothesis that political beliefs may depend heavily on very basic processes in the brain—our ancient instincts to avoid danger and filth, which we experience as fear and disgust. Psychologists at the University of Warwick in England recently proposed a theory along these lines in a January paper published in *Topics in Cognitive Science*.

Using a computer simulation, they showed that when our ancestors met groups of strangers, they had to make choices among potential opportunities, such as new mates and trade, and risks, such as exposure to new pathogens. In areas with high levels of infections, their model showed that the driving force of evolution was fear of outsiders, conformity and ethnocentrism—things that in modern times we would call social conservatism.

—Marta Zaraska



Like Mother, Like Daughter

Brain structure in emotion-regulation areas—and possibly the risk of mood disorders—is inherited down the female line

We often attribute our key characteristics to one of our parents: “I get my perfectionism from my dad and my impatience from my mom.” In most such cases, though, we do not really know what combination of nature and nurture led to the family resemblance. Now a study has found that the structure of emotion-regulating regions in the brain may be passed down from mother to daughter, which could have implications for mood-disorder risk.

A growing body of research suggests that heredity plays a role in mood disorders—including depression, which afflicts an estimated 15.7 million adults in the U.S. alone. In the new study, published in January in the *Journal of Neuroscience*, researchers took MRI brain scans of each member of 35 families, all of whom had a clean bill of mental health. They measured the volume of areas in the brain’s corticolimbic system, responsible for the regulation of emotion. The results revealed that the relation between gray matter volume in the amygdala, anterior cingulate cortex, ventromedial prefrontal cortex and hippocampus was much more similar in mother-daughter pairings than in mothers and sons or in fathers and children of either sex.

“We joke about inheriting stubbornness or organization—but we’ve never actually seen that in human brain networks before,” says lead author Fumiko Hoefft, an associate professor of psychiatry at the University of California, San Francisco. The finding suggests a significant female-specific maternal transmission pattern in emotional responses. This could include mood disorders such as depression, although confirming that would mean extending the research to encompass families with a history of such disorders, notes Geneviève Piché, a psychology professor at the University of Quebec at Outaouais who was not involved in the study.

Past evidence from animal research and clinical studies on depression also suggests an element of maternal heritability. Hoefft’s study adds new evidence, but she cautions that one cannot yet say whether the mother-daughter similarities are the result of genetic, prenatal or postnatal effects, or some combination of the three. All of these factors may be essential to whether someone develops depression—but locating risk in the female family line may help doctors identify and treat patients early.

—Jordana Cepelewicz

City Parks May Mend the Mind

Urban green spaces may boost cognition in schoolchildren and reduce the health effects of inequality in people of all ages

Exposure to natural settings has been linked with a vast array of human health benefits, from reduced rates of depression to increased immune functioning. Two recent studies found evidence suggesting that urban green spaces, such as parks and gardens, may also improve cognitive development and buffer against the effects of health inequality.

In research reported last year in the *Proceedings of the National Academy of Sciences USA*, investigators in Spain, Norway and the U.S. explored the cognitive development of 2,593 children between the ages of seven and 10 from 36 primary schools in Barcelona. At regular intervals over a period of 12 months, they tracked changes in memory and attentiveness using cognitive tests, and they used high-resolution satellite data to assess the children's proximity to green space at home and school and during their commute. After factoring out socioeconomic status and other potential confounders, they determined that children who were closer to parkland had better memory development and less inattentiveness than other children.

The study authors suggest that green spaces may have a positive effect both directly and indirectly. "Green spaces provide children with opportunities to develop mental skills such as discovery and creativity," says co-author Payam Dadvand, a physician and researcher at the Center for Research in Environmental Epidemiology in Barcelona. More indirectly, green spaces may help by reducing exposure to air pollution and noise, increasing physical activity, and enriching microbial input from the environment, all of which have been associated with improved mental development, he says. When the researchers measured and factored in traffic-related air pollution, which is higher in places with fewer plants and trees, they found that it accounted for 20 to 65 percent of the observed association between greenness and cognitive development. Air pollution has been shown to have neurotoxic effects, Dadvand says.

Natural settings may also help reduce the mental health burden that comes with socioeconomic inequality, according to a paper by researchers at the University of Glasgow and the



University of Edinburgh. A cross-sectional observational study published last year in the *American Journal of Preventive Medicine* sought to determine which neighborhood characteristics might be "equigenic," or capable of disrupting the relation between socioeconomic disparities and health inequality. Using data from 21,294 adults living in urban areas in 34 European countries, the scientists examined associations between participants' level of financial stress and psychological well-being. Then they explored interactions between those variables and five neighborhood characteristics or services, including access to green spaces, banking and postal services, public transportation and cultural facilities. Results show that the difference in well-being scores among people experiencing the most and least financial difficulty diminished with greater access to green spaces, such that the health gap was 40 percent smaller among those with better access. No such benefits were found with any of the other variables studied.

Approximately half of the world's current population lives in urban areas, and that number is expected to increase, Dadvand says. Findings such as these could influence policy makers to increase access to green spaces, in the hopes that doing so might boost mental health in nearby residents and improve academic achievement in children. "That could have long-term consequences for individuals, families and society as a whole," Dadvand says. —Tori Rodriguez



(PHARMA WATCH)

The Hidden Harms of Antidepressants

Data about the true risks of suicide and aggression for children and teens taking these drugs have been suppressed

More than one in 10 Americans older than 12 takes antidepressants, according to a 2011 report by the National Center for Health Statistics. A significant but unknown number of children younger than 12 take them, too. Although most such drugs are not approved for young children, doctors have prescribed them off-label for years because they have been thought to have relatively mild side effects. Yet recent reports have revealed that important data about the safety of these drugs—especially their risks for children and adolescents—have been withheld from the medical community and the public.

In the latest and most comprehensive analysis, published in January in the *BMJ*, researchers at the Nordic Cochrane Center in Copenhagen showed that pharmaceutical companies have not been revealing the full extent of serious harm in clinical study reports, which are detailed documents sent to regulatory authorities such as the U.S. Food and Drug Administration and the European Medicines Agency (EMA) when applying for approval of a new drug. The researchers examined reports from 70 double-blind, placebo-controlled trials of two common categories of antidepressants—selective serotonin reuptake inhibitors (SSRIs) and serotonin and norepinephrine reuptake inhibitors (SNRIs)—and found that the occurrence of suicidal thoughts and aggressive behavior doubled in children and adolescents who used these drugs.

The investigators discovered that some of the most revealing information was buried in appendices where individual patient outcomes are listed. For example, they found clear instances of suicidal thinking that had been passed off as “emotional lability” or “worsen-

ing depression” in the report itself. This information, however, was available for only 32 out of the 70 trials. “We found that a lot of the appendices were often only available on request to the authorities, and the authorities had never requested them,” says Tarang Sharma, a Ph.D. student at Cochrane and lead author of the study. “I’m actually kind of scared about how bad the actual situation would be if we had the complete data.”

This study “confirms that the full degree of harm of antidepressants is not reported,” says Joanna Moncrieff, a psychiatrist and researcher at University College London who was not involved in the study. “[These harms] are not reported in the published literature—we know that—and it appears that they are not properly reported in clinical study reports that go to the regulators and form the basis of decisions about licensing.”

The researchers struggled for many

years to get access to the clinical trial reports, which are often withheld under the guise of commercial confidentiality. “All this secrecy actually costs human lives,” says Peter Gøtzsche, a clinician researcher at Cochrane and a co-author of the recent study. Eventually the EMA provided access after being publicly accused of mismanagement, but in the U.S. these documents remain inaccessible. “It’s deeply unethical when patients volunteer to benefit science, and then we let drug companies decide that we cannot get access to the raw data,” Gøtzsche says. “The testing of drugs should be a public enterprise.”

The fact that antidepressants may cause suicidal ideation has been shown before, and in 2004 the FDA gave these drugs a black box warning—a label reserved for the most serious hazards. The EMA has issued similar alerts. There are no labels about risks for aggression, however. Although hints about hostile behavior existed in case studies, the *BMJ* study was the first large-scale work to demonstrate an increase in aggressive behavior in children and adolescents. “This is obviously important in the debate about school shootings in the [U.S.] and in other places where the perpetrators are frequently taking antidepressants,” Moncrieff says.

Taken together with other research—including studies that suggest antidepressants are only marginally better than placebos—some experts say it is time to reevaluate the widespread use of these drugs. “My view is that we really don’t have good enough evidence that antidepressants are effective, and we have increasing evidence that they can be harmful,” Moncrieff says. “So we need to stop this increasing trend of prescribing them.”

—Diana Kwon



How Dancing Leads to Bonding

Both exertion and synchrony play a role in the social effects of dance

There is perhaps nothing more universal than the drive to move our bodies in sync with music. Studies show that dancing at parties and in groups encourages social bonding, whether it is a traditional stomp, a tango or even the hokeypokey. Many researchers have argued that people experience a blurring of the self into their groups thanks to the synchronization that occurs while dancing. Yet it is also possible that the exertion inherent to dancing releases hormones—like any other form of physical exercise—and these molecules are behind the bonding effect. A new study suggests both views may be correct.



University of Oxford psychologist (and dancer) Bronwyn Tarr and her colleagues asked teenagers from Brazilian high schools to dance to fast, 130-beat-per-minute electronic music in groups of three. The students were instructed to dance either in or out of sync with one another and with either high or low levels of physical exertion.

Participants said they felt closer to their dance partners than to others in their classes after dancing the same steps at the same time than they did when doing different moves, no matter the level of exertion. Those who exerted themselves more also felt closer to their group, regardless of whether they had danced in sync.

Synchrony and exertion each raised the dancers'

pain tolerance, as measured by a tight blood pressure cuff. Pain tolerance was the highest when the students both were in sync and had high energy, according to the study, published in October 2015 in the journal *Biology Letters*. (The finding on pain tolerance may come as no surprise to dancers; one study found that more than 80 percent of professional dancers put off seeking medical treatment after becoming injured.)

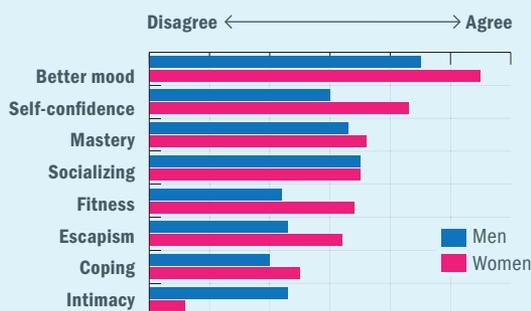
Tarr thinks that the two separate effects might both be driven by the release of endorphins, hormones responsible for the “runner’s high” and involved in other pleasures, such as sex and eating. “More endorphins in your system mean higher pain tolerance,” she says. “This study suggests that endorphins are activated when we groove with others and that they may be underpinning social-bonding effects.”

Paul Reddish, a social psychologist at the Victoria University of Wellington in New Zealand who was not involved with the study, agrees “there is something special about matching the same behaviors at the same time.” But he says that the jury is still out regarding the role of endorphins in social bonding.

Still, it seems clear that mirroring others—whether in dance, in sports or even in conversation—helps to foster friendships. “We should all dance more,” Tarr says. —*Jason G. Goldman*

Why We Fox-trot

In a study exploring why salsa and ballroom enthusiasts choose to dance, men and women had differing motivations. For both genders, however, the social aspect was key.



DANCE THERAPY Dancing may help people recover from psychological trauma or physical injury, according to preliminary evidence. Studies show, perhaps unsurprisingly, that dancing can improve fitness and reduce stress, as well as boost mood and self-esteem. In Parkinson’s disease patients, learning to dance has been shown to reduce depression and improve movement and balance. The new findings (above) suggest that the social element of dance may also be playing a therapeutic role—regular, positive social interactions are well known to improve health and stave off cognitive decline.

—*Victoria Stern*

ALAMY (corga [line]); SOURCE: “WHY DO YOU DANCE? DEVELOPMENT OF THE DANCE MOTIVATION INVENTORY (DMI).” BY ANIKO MARAZ ET AL., IN PLOS ONE, VOL. 10, NO. 3, ARTICLE NO. E0122866; MARCH 24, 2015 (graph)

MULTITASKING BY BRAIN WAVE

How we take in new information while tapping prior knowledge

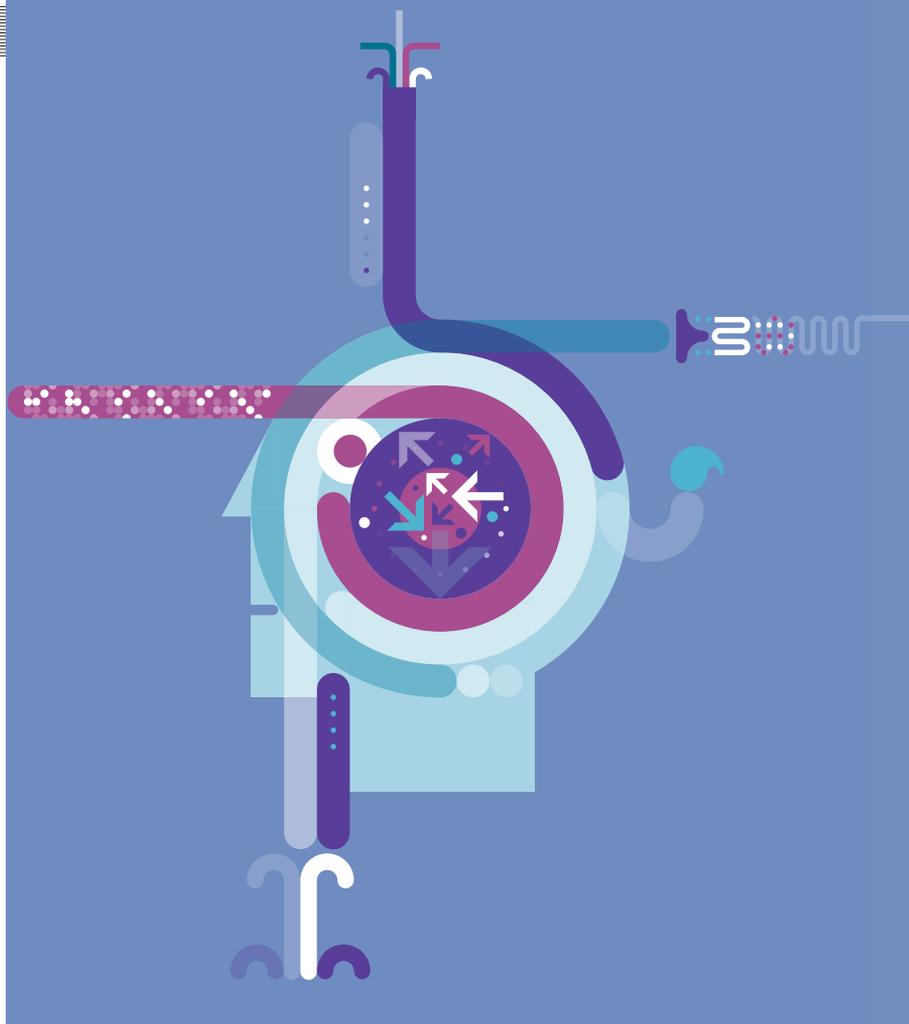
As we experience the world, our brain manages to continually absorb new information even as it calls up memories and thoughts from within. The two processes seem to happen simultaneously. Thus, we are able to drive to the grocery store, recalling a familiar route, while processing fresh input about road conditions and that pedestrian who suddenly darted across the street. Now a team at the University of Texas at Austin has found evidence that in the brain's spatial system, this balancing act is accomplished via distinct electrical frequencies. The results also offer hints about how the brain compresses memories—that is, how we can recall an hours-long event in mere seconds.

The group, led by neuroscientist Laura Colgin, studied rats as the animals navigated a maze, recording electrical activity in the hippocampus, an area crucial for memory formation. The experiment focused on a type of hippocampal cell called place cells, which correspond to specific locations in space. In a rat, researchers can tell by which place cells are firing where the rat is in the maze—or what part of the maze the rat is thinking of.

As with all the brain's neurons, place cells produce electrical signals that oscillate in waves. In particular, past research suggests that when place cells encode spatial memories they produce theta waves, which operate on a relatively slow, long-wave frequency. Yet these theta oscillations do not work alone. They also contain shorter and more frequent gamma rhythms nested within them like folded accordion bellows. As each wave of electrical activity pops up at the gamma frequency, it conveys information nuggets to the interacting theta wave, effectively presenting a highlights reel relative to the longer theta wave.

In a 2009 study, Colgin and her colleagues described an additional level of theta-gamma complexity in the rat hippocampus. When the hippocampus communicated with a brain area relaying as-it-happens sensory information, the team saw theta signals supported by “fast” (60- to 100-hertz) gamma frequencies. A second, previously unappreciated set of “slow” (25- to 55-hertz) gamma rhythms seemed to be interacting with theta waves when the hippocampus swapped messages with brain areas that may replay memories or plan future movements.

In their current analysis, Colgin and her team found further evidence that fast gamma waves code new information and slow gamma waves retrieve memories. The researchers recorded place cell activity in seven rats as they negotiated a short track



during three 10-minute sessions daily for several days. They found fast gamma signals when place cell activity matched the rats' actual location. Slow gamma activity showed up when place cell activity aligned with locations ahead of the rats' current position—perhaps reflecting the animals' memory and anticipation of the upcoming route.

The team also noticed that the length of track represented by place cells during each millisecond seemed to skyrocket when slow gamma rhythms took over, prompting speculation that another level of memory compression may exist within the theta-gamma code. This could explain how the brain is able to replay long events over mere seconds.

Not all experts are convinced by this interpretation. Brandeis University researcher John Lisman, an expert on the theta-gamma code, explains that such compression would require cells to fire faster than current biophysical estimates allow—although he praised Colgin's team for uncovering distinct functional roles for slow and fast gamma frequencies in the hippocampus.

Other scientists think the brain might indeed be capable of faster and more complex signaling than many models predict. Loren Frank, a neuroscience researcher at the University of California, San Francisco, is in this camp. He says the new finding reveals that “things associated with memory may be going on very, very quickly.”
—Andrea Anderson



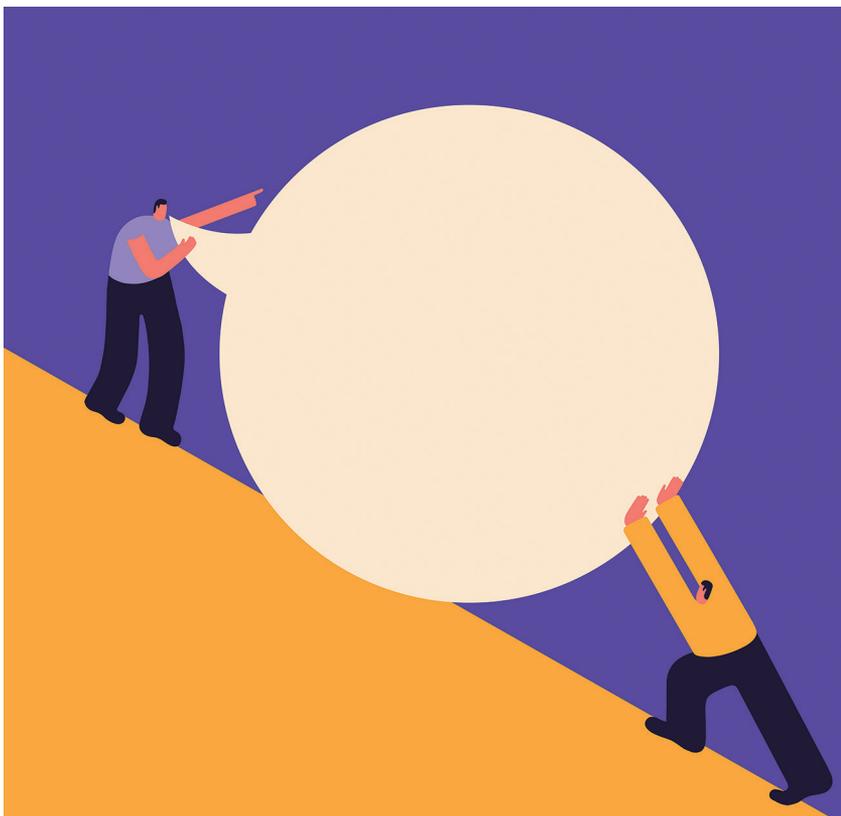
How to Be a Better

arguer

My family is what you might call politically diverse, with members ranging from real pinko-commie hippies to paranoid right-wing conspiracy theorists—and we’re all connected on Facebook. This election year, things among us had gotten pretty acrimonious until my brother, Colin, did something ingenious: he made a pledge to stop talking politics on Facebook. Most of my other family members and I quickly followed suit, and as a result, I not only like my family more, I honestly feel more open to their opinions and ideas. If you’re anything like me, you argue because you want to win people over to your side, to be right, to show them the light. But think about it: Does it ever really work? Not for me. Thankfully, research says there’s a better way.

#1 Open your mind. A few years ago philosophy scholars Hugo Mercier and Dan Sperber wrote a widely disseminated paper on human reasoning and argumentative theory. The gist (*italics added below*), which we see demonstrated every time candidates debate: “People who have an opinion to defend don’t really evaluate [others’] arguments *in a search for genuine information* but rather consider them from the start as counterarguments to be rebutted.” In other words, if you’re too busy trying to push your own POV, you’re apt to ignore even the most reasonable evidence and arguments your opponent makes. On the other hand, the researchers write, “in group reasoning experiments where participants share an interest in discovering the right answer, it has been shown that *truth wins*.” Truth. Yeah, I could go for that.

#2 Have hope. In the middle of a heated argument, it’s tough to picture everything working out well in the end with your opponent. Yet remaining hopeful may actually help that happen, says Susan Krauss Whitbourne, a personality researcher and professor of psychology at the University of Massachusetts Amherst. She points to studies of international conflict resolution in embattled plac-



es such as Northern Ireland and the Middle East, which have found that when leaders believe peace is possible, that outlook engenders compromise, a willingness to forgive and less retaliation. In short, a sense of hope allows you to think more clearly and to think outside the box, Krauss Whitbourne says. You may not win the dispute, but you might be able to bring it to a fair conclusion.

#3 Change it up. Some arguments may be more about knee-jerk reactions than actual, real disagreement, Krauss Whitbourne says. There are patterns of actions and reactions in relationship “systems” that tend to play out over and over again. “In systems theory, the system tries to maintain dynamic balance,” she notes—so to resolve these kinds of well-worn arguments, we need to break out of the system by thinking and acting in ways we usually would not. Doing or saying the unexpected may feel strange or even fake at first, she says, but “behaving in a way that’s counter to what’s usual throws

the other person off the pattern and thereby allows reframing.”

#4 Try smiling. Defensiveness can derail an argument, sending it into a spiral of pure negative emotion. But a genuine laugh or smile can completely diffuse a tense situation and help turn it around, Krauss Whitbourne says. It has worked for me: I remember a spat I got into with my husband a couple of years ago, where, in the middle of exchanging irritated jabs, I started laughing and just blurted out, smiling but truthful: “I’m just tired of your face! It’s always in my face! Gah!” He cracked up, too, and we both realized that we weren’t really arguing about anything and just needed some alone time.

It’s clear to me now that no matter how strongly I feel about something, the goal of arguing shouldn’t be to win at all costs, with intimidation, fact rattling, loud talking, even *smack* talking. A better, more satisfying end game of any argument is to find some common ground. Then, somehow, everybody wins. —Sunny Sea Gold



Are You Sure That's the Guy?

Asking eyewitnesses about their level of certainty improves the efficacy of police lineups

DNA tests have made it clear that many innocent people have been sent to prison after a witness picked them out of a lineup. Between 1989 and 2016, more than 70 percent of the 337 wrongful convictions identified in the U.S. had been influenced by misidentification from eyewitnesses, according to the Innocence Project. Researchers recently reported, however, that a simple procedure could help reduce the risk of misidentification: ask the eyewitnesses about their confidence level when they pick someone from a lineup.

The new work, published online last December in *PNAS*, also investigated a long-standing debate over how to perform a lineup. Numerous studies during the past few decades have examined how to minimize the possibility that witnesses will finger an innocent person, and they have settled on showing people the photographs one by one, instead of all together. About 30 percent of the police departments in the U.S. have adopted this sequential method.

Yet some of the studies used to support that approach overlooked the important question of how sure a witness felt about his or her selection. In the current study, the researchers examined real lineups administered by the Robbery Division of the Houston Police Department to see how the different procedures compared when witness confidence was taken into account. The lineups, of which 187 were simultaneous and 161 sequential, were cases in which the suspect was a stranger to the witness, and they were administered by people who themselves were unaware of the suspect's identity. Witnesses rated their confidence as low, medium or high.

In a third of the cases, the witnesses did not identify anyone.

In another third, they identified the suspect, and in the remaining cases, they chose someone who was not suspected, or a "filler." Confidence turned out to be key: most high-confidence identifications were of the suspect, whereas most low-confidence IDs were of fillers. "Ignoring low confidence in the beginning is a grave error," says lead researcher John Wixted of the University of California, San Diego. "The witness is telling you that there's a good chance they're making a mistake."

Comparing the results of the two different lineup techniques, the researchers found that the simultaneous method produced more confident identifications, leading to the conclusion that it may be more useful than the sequential approach.

The difference between the two methods, however, is statistically very slight, notes Gary Wells, a professor of psychology at Iowa State University who studies eyewitness memory: "The more important part of this article is that witness confidence did a good job of helping sort between accurate and mistaken witnesses."

What matters most for police departments is that they ask the witness about their confidence on the spot and ensure the lineup is double-blind, meaning neither the witness nor the administrator of the lineup has been tipped off as to who is the suspect. Fewer than half of U.S. police departments use a double-blind procedure, Wells says.

The idea that initial confidence is the best measure, rather than the oft-used level of confidence at trial, has not yet made it beyond the realm of research. Wixted hopes his findings will influence how lineups are handled by the police, but, he says, "the word has not gotten out."
—Veronique Greenwood

Conjuring Equivocations

Magicians hijack our brain's limited ability to deal with perceptual ambiguity

The renowned Slydini holds up an empty box for all to see. It is not really a box—just four connected cloth-covered cardboard walls, forming a floppy parallelogram with no bottom or top. Yet when the magician sets it down on a table, it looks like an ordinary container.

Now he begins to roll large yellow sheets of tissue paper into balls. He claps his hands—SMACK!—as he crumples each new ball in a fist and then straightens his arm, wordlessly compelling the audience to gaze after his closed hand. He opens it, and ... the ball is still there. Nothing happened. Huh.

Slydini's hand closes once more around the tissue, and it starts snaking



BY STEPHEN L. MACKNIK AND
SUSANA MARTINEZ-CONDE



Stephen L. Macknik and Susana Martinez-Conde are professors of ophthalmology at SUNY Downstate Medical Center in Brooklyn, N.Y. They are authors of the Prisma Prize-winning *Sleights of Mind*, with Sandra Blakeslee (<http://sleightsofmind.com>), and magician members of

the Academy of Magical Arts (aka the Magic Castle) in Hollywood, Calif., and the Magic Circle in London.



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around, slowly and gracefully, like a belly dancer's. The performance is mesmerizing. With his free hand, he grabs an imaginary pinch of pixie dust from the box to sprinkle on top of the other hand. This time he opens his hand to reveal that the tissue is gone! Four balls disappear in this fashion. Then, for the finale, Slydini tips the box forward and shows the impossible: all four balls have mysteriously reappeared inside.

Slydini famously performed this act on *The Dick Cavett Show* in 1978. It was one of his iconic tricks. Despite the prestidigitator's incredible showmanship, though, the sleight only works because your brain cannot multitask.

SPOILER ALERT: The next page reveals magic secrets! Stop reading unless you truly want to know more.

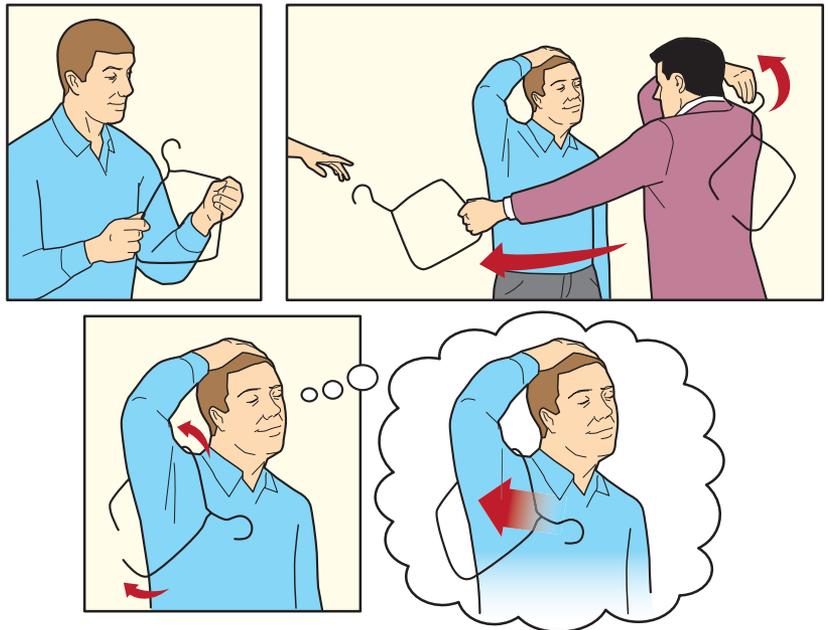
Slydini's trick relies on creating ambiguity and fooling you into resolving it incorrectly. When he reached into the box for "pixie dust," he used the same hand movement to drop each ball inside (having previously transferred it between hands). The pixie dust ploy justified what would have otherwise seemed like an unnatural action—a tactic we explained more fully in an article co-authored with magicians Teller, Apollo Robbins, James Randi, Mac King and Johnny Thompson. Teller refers to this kind of action as "a motion with a purpose."

The misdirection works because our brain automatically categorizes people's motions by interpreting their intentions. We see somebody push her glasses up the bridge of her nose and assume that the glasses had slipped. But a magician might use the same motion to hide something in her mouth. The motion is fundamentally ambiguous, although the action seems clear. It turns out your brain cannot conceive of an action having two simultaneous aims. So all Slydini needed to do was bias your perception to favor one interpretation (the hand is grabbing pixie dust) over the other (the hand is dropping a ball). Therein lies the magic. **M**

THE POWERS OF DARKNESS

Magician Paul Daniels has taken magical ambiguities to the sense of touch with his famous trick called The Powers of Darkness. Here a volunteer tests a regular wire coat hanger (upper row, left), and then an assistant secretly swaps in a trick hanger that has a gap in it (upper row, right). With the volunteer's eyes shut, the magician seems to pass the hanger through various parts of the volunteer's body (lower row)—although the audience can openly see that it is an illusion.

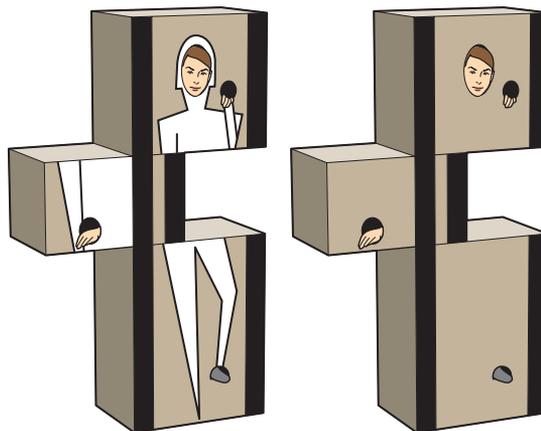
The trick works only because, having inspected the original hanger, the volunteer does not know it has been swapped for a gimmick and concludes that the solid hanger must have passed through his body magically. He closes the hanger's physical gap in his mind: a practical application of the good-continuation principle [see "The Zig Zag Girl" below] in the tactile domain.



THE ZIG ZAG GIRL

Magician Anthony Barnhart ("Magic Tony") is also a cognitive scientist at Carthage College. He has postulated that some magic acts rely on ambiguous illusions that take advantage of the so-called Gestalt laws of vision. In particular, the Gestalt principle of good continuation asserts that the visual system preferentially organizes aligned segments into continuous objects.

Barnhart has suggested that a popular magic trick, the Zig Zag Girl illusion, relies on such ambiguous visual cues. In the standard trick (left), an image on the side of the box shows how the woman inside the box must be magically segmented. Without the woman's painted silhouette (right), the illusion becomes less magical because other bodily contortions seem plausible.



MORE TO EXPLORE

- **Attention and Awareness in Stage Magic: Turning Tricks into Research.** S. L. Macknik, M. King, J. Randi, A. Robbins, Teller, J. Thompson and S. Martinez-Conde in *Nature Reviews Neuroscience*, Vol. 9, No. 11, pages 871–879; November 2008.
- **The Exploitation of Gestalt Principles by Magicians.** Anthony S. Barnhart in *Perception*, Vol. 39, No. 9, pages 1286–1289; September 2010.
- **The Put-and-Fetch Ambiguity: How Magicians Exploit the Principle of Exclusive Allocation of Movements to Intentions.** S. Van de Cruys, J. Wagemans and V. Ekroll in *i-Perception*, Vol. 6, pages 86–90; April 2015.

LANGUAGE

The Surprising Benefits of Sarcasm

Although snarky comments can cause conflict, a little verbal irony also stimulates new ideas

By Francesca Gino

“**Sarcasm** is the lowest form of wit but the highest form of intelligence,” that connoisseur of witticisms, Oscar Wilde, is said to have remarked. But not everyone shares his view. Communication experts and marriage counselors alike typically advise us to stay away from this particular form of expression. The reason is simple: sarcasm carries the poisonous sting of contempt, which can hurt others and harm relationships. By its very nature, it invites conflict.

Sarcasm involves constructing or exposing contradictions between intended meanings. It is the most common form of verbal irony—that is, allowing people to say exactly what they do not mean. Often we use it to humorously convey disapproval or scorn. “Pat, don’t work so hard!” a boss might say, for example, on

FRANCESCA GINO is a behavioral scientist and professor at Harvard Business School. She is author of *Sidetracked: Why Our Decisions Get Derailed, and How We Can Stick to the Plan* (Harvard Business Review Press, 2013). Follow her on Twitter @francescagino



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catching his assistant surfing the Web.

And yet behavioral scientists Li Huang of INSEAD business school, Adam D. Galinsky of Columbia University and I have found that sarcasm may also offer an unexpected psychological payoff: greater creativity. The use of sarcasm, in fact, appears to promote creativity for those on both the giving and receiving end of the exchange. Instead of avoiding snarky remarks completely, our research suggests that, used with care and in moderation, clever quips can trigger creative sparks.

Saying What You Don’t Mean

Early research into how people interpret sarcastic statements revealed, as one might expect, that most perceive such comments as critical compared with more direct utterances. In one study, published in 1997, 32 participants read scenarios in which, for instance, one person did something that could be viewed negatively, such as smoking, and

a second person commented on the behavior to the first person, either literally (“I see you don’t have a healthy concern for your lungs”) or sarcastically (“I see you have a healthy concern for your lungs”). Consistently, participants rated sarcasm to be more condemning than literal statements.

In 2000 University of Western Ontario researchers encouraged 66 students to read a scenario while imagining the perspective of a certain person in the story, such as the viewpoint of someone making a critical comment or the person receiving that comment. Although there was some disagreement on how these comments might affect the relationship between a speaker and listener, perspective taking did not alter anyone’s understanding of the speaker’s intentions, such as mockery or a desire to provoke anger.

And sarcasm can be easily misinterpreted, particularly when it is communicated electronically, according to a 2005 study by Jason Parker and Zhi-Wen Ng,

both then psychologists at the University of Illinois at Urbana-Champaign, and their colleagues. They gave 30 pairs of university students a list of statements, half of which were sarcastic and half serious. Some students relayed messages via e-mail and others via voice recordings. Participants who received the voice messages accurately gleaned the sarcasm (or lack thereof) 73 percent of the time, but those who received the statements via e-mail did so only 56 percent of the time, hardly better than chance.

The e-mailers had anticipated that 78 percent of the participants would pick up on the sarcasm inherent in their messages. That is, they badly overesti-

questionnaire about their perceived sense of conflict during the conversation.

Not surprisingly, the participants exposed to sarcasm reported more interpersonal conflict than those in other groups. More interestingly, those pairs who had engaged in a sarcastic conversation fared better on the creativity tasks. This effect emerged for both the deliverer and recipient in the simulated conversation but only when the recipient had picked up on the sarcasm in the script.

Why might verbal irony enhance creativity? Sarcasm's challenge is that the message sounds serious but should not be taken literally. One way to overcome this is through tone—as when exagger-

abstract or concrete action (for example, “voting” could pair with the concrete “marking a ballot” or the abstract “influencing the outcome of an election”). We found that generating or deciphering sarcastic statements occurred more readily when people were thinking abstractly, a state that also promotes creative thinking.

None of our findings negates the fact that sarcasm can damage relationships. So how do we harness its creative benefits without stirring up conflict? It comes down to trust. Our 2015 studies also showed that, given the same tone and content, sarcasm expressed toward or received from someone we trust is less provocative than sarcasm from someone we distrust. Of course, if we were to vary the tone and content, it would make a difference, too. Even trust may not be enough to protect a friendship from an extremely harsh tone and cutting content.

Given the risks, your best bet is to keep conversational zingers limited to those you know well, lest you cause offense. But on occasions when you do enjoy such repartee, you may also boost your creative thinking. To borrow another quote from Wilde, “It is the critical spirit that creates.” **M**

GENERATING OR DECIPHERING SARCASTIC STATEMENTS OCCURRED MORE READILY WHEN PEOPLE WERE THINKING ABSTRACTLY, A STATE THAT ALSO PROMOTES CREATIVITY.

mated their ability to communicate the tenor of these statements via e-mail. And the recipients of the sarcastic e-mails were even more overconfident. They guessed they would correctly interpret the tone of the e-mail messages about 90 percent of the time. They were much better at gauging their ability to interpret voice messages.

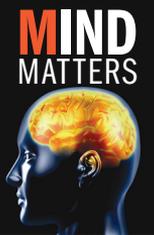
Oh, the Irony!

In 2015 my colleagues and I discovered an upside to this otherwise negative picture of sarcasm. In one study, we asked 56 participants to choose a script that was sarcastic, sincere or neutral and then engage in simulated conversation with another subject, who was unaware of the script.

Immediately after our participants enacted the dialogue, we presented them with tasks testing their creativity. For instance, they had to think of a word that was logically linked to a set of three provided words (for example, “manners,” “round” and “tennis” linked to “table”). We also presented them with a short

ated speech indicates the facetiousness of a message. We need to think outside the box to generate and decipher ironic comments. That means sarcasm may lead to clearer, more creative thinking.

Abstract thinking also helps. In a variant of the previous experiment, we asked 114 students to take on a similar set of roles and tasks (either to listen to or to make sarcastic comments, then take on a creative challenge). But this time we also assessed the students' thinking through a test in which they had to associate a word with either an



Each week in Mind Matters, www.ScientificAmerican.com/mind-matters, researchers explain their disciplines' most notable recent findings. Mind Matters is edited by Gareth Cook, a Pulitzer Prize-winning journalist and contributing writer to the New York Times Magazine.

MORE TO EXPLORE

- **Why Not Say It Directly? The Social Functions of Irony.** Shelly Dews et al. in *Discourse Processes*, Vol. 19, No. 3, pages 347–367; 1995.
 - **When Sarcasm Stings.** Andrea Bowes and Albert Katz in *Discourse Processes*, Vol. 48, No. 4, pages 215–236; 2011.
 - **Ironic Expression Can Simultaneously Enhance and Dilute Perception of Criticism.** James Boylan and Albert N. Katz in *Discourse Processes*, Vol. 50, No. 3, pages 187–209; 2013.
 - **The Highest Form of Intelligence: Sarcasm Increases Creativity for Both Expressers and Recipients.** Li Huang et al. in *Organizational Behavior and Human Decision Processes*, Vol. 131, pages 162–177; November 2015.
- From Our Archives*
- **A Sense of Irony.** Wray Herbert; *We're Only Human*, October/November 2008.

CONSCIOUSNESS

Constructing the Modern Mind

From Aristotle to Watson, views on mind, brain and soul have evolved. A brilliant new book adds perspective

Unlike any other empirical object in Nature, the mind's presence is immediately apparent to itself, but opaque to all external observers.

—George Makari,
Soul Machine, 2015

My life, as well as this column, is dedicated to understanding the conscious mind and how it relates to the brain. This presupposes that you, the reader, and I have a precise sense of what is referred to by such seemingly innocent terms as “consciousness” and “mind.” And lest it be forgotten, the allied concept of “soul” (or spirit), banned from scientific discourse, continues to remain profoundly meaningful to vast throngs of humankind here and abroad.

But there's the rub! Unlike such material objects as “egg,” “dog” or “brain,” this triptych of intangible concepts is a historical construct, endowed with a universe of religious, metaphysical, cul-

tural and scientific meaning, as well as an array of underlying assumptions, some clearly articulated, others wholly ignored. These meanings adapt over time as society changes in response to wars and revolutions, catastrophes, trade and treaties, invention and discovery. Psychiatrist and historian George Makari tries to illuminate this historical evolution in his *Soul Machine: The Invention of the Modern Mind*, published last November by W. W. Norton. His intellectual history masterfully describes how consciousness, mind and soul are shape-shifters that philosophers, theologians, scholars, scientists and physicians seek to tame, by conceptualizing, defining, reifying, denying and redefining these terms through the ages to come to grips with the mystery that is our inner life.

A Brief History of the Soul

The systematic search for answers goes back to Aristotle (384–322 B.C.), foremost of all biologists, taxonomists, embryologists and evolutionists. His *De Anima* (literally *On the Soul*) classifies the nature of living things and discusses his notion of the soul (*psyche*), which for him means the essence of a thing. The soul defines an organism. All living things have souls with distinct faculties. The *vegetative* soul embodies the life force that distinguishes living matter, be it plants, animals or people, from inanimate matter, such as a rock. It supports nutrition, growth and reproduction. The *sensitive* soul enables sense perception, pain and pleasure, memory, imagination and motion. It is common to animals and to humans. Both the vegetative and the sensitive souls are corporeal and, therefore, mortal. It is the *rational* soul, unique to people, that is responsible for intellect, thought and reason. The rational soul constitutes the quiddity of what it is to be a human. For Aristotle, although the rational soul is immaterial, it cannot exist independent of the body. Famously, of course, Socrates

and Plato differed with Aristotle, arguing for the immortality of the soul on the death of the body.

Dominican friar and Scholastic philosopher Thomas Aquinas (1225–1274) casts these classical Greek ideas into a form that meshed with Christian ones and would remain an important influence through the Middle Ages. A trivium of three souls makes up every living human—a *nutrient* soul common to all organisms, a *sensitive* (or *appetitive*) soul characteristic of animals and people, and a *rational* soul that is immortal, a repository of humanity's godhood, lifting people above the natural, material world. The rational soul could not become sick, because it was immaterial, but it could be possessed by the Devil or some of his demonic servants. Doctors could not help those so afflicted, but ecclesiastical authority could and did—saving their immortal souls one way or another as attested to by the fiery death of tens of thousands of both female and male witches.

For close to four centuries, this Thomist philosophy was the dominant intellectual narrative for Christians, noblemen and peasants alike. It offered solace to the weary and the dying, and it justified the divine right and the absolute power of kings and queens. Yet decades of bloody religious warfare among Christians for the “one true faith” during the first half of the 17th century led to widespread questioning of these received truths.

This is the chronological starting point for *Soul Machine*—it follows the philosophers, savants, doctors, writers and revolutionaries of the English, Scottish, French and German Enlightenment as they transmogrified the rational soul over two centuries into a mechanized, naturalized and desacralized thing. This process gave birth to psychology, neurology and psychiatry and the knowledge that we, children of the 21st century, are evolved from apes.

All of this starts with the reclusive



BY CHRISTOF KOCH

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



Frenchman René Descartes (1596–1650) and the radical and outspoken Englishman Thomas Hobbes (1588–1679). The former is one of the fathers of modern science (he linked algebra to geometry, thereby giving us the Cartesian coordinate system). Descartes replaced the moth-eaten final causes and forms of the Scholastics—wood burns because it possesses an inherent form that seeks to burn—by mechanistic ones. In particular, he argued that the movements and actions of animals and humans are

caused by particles of various shapes that jostle one another and move about. Nothing more and nothing less.

Descartes postulated that everything under the sun is made out of one of two substances. The stuff that can be touched and that has spatial extension is *res extensa*; it includes the bodies and brains of animals and people. The stuff that cannot be seen, that does not have extension, is thinking stuff, *res cogitans*. It alone enables humans to reason, to speak and to freely decide. Descartes's

dualism divided the world into two magisteria: a mechanistic one that was to be the playground of experimental philosophers, the precursors of modern scientists and clinicians, and a theological one, the dominion of the immaterial and immortal soul. Descartes thereby safeguarded Christian dogma and ecclesiastical authority.

This dichotomy won Descartes the enmity of Hobbes, who published his celebrated *Leviathan*, a bold materialistic manifesto, considered the foundation

for Western political philosophy. For Hobbes, everything was made out of matter. There was no necessity for any special thinking substance. Matter could think. Even though the bulk of *Leviathan* was a book-length argument for absolute monarchy (rather than religious authority) to prevent the kind of religiously motivated bloodshed of the European Wars of Religion (circa 1524–1648), Hobbes was considered blasphemous, and his books were burned.

English doctor John Locke (1632–1704) further naturalized the rational soul in his *Essay Concerning Human*

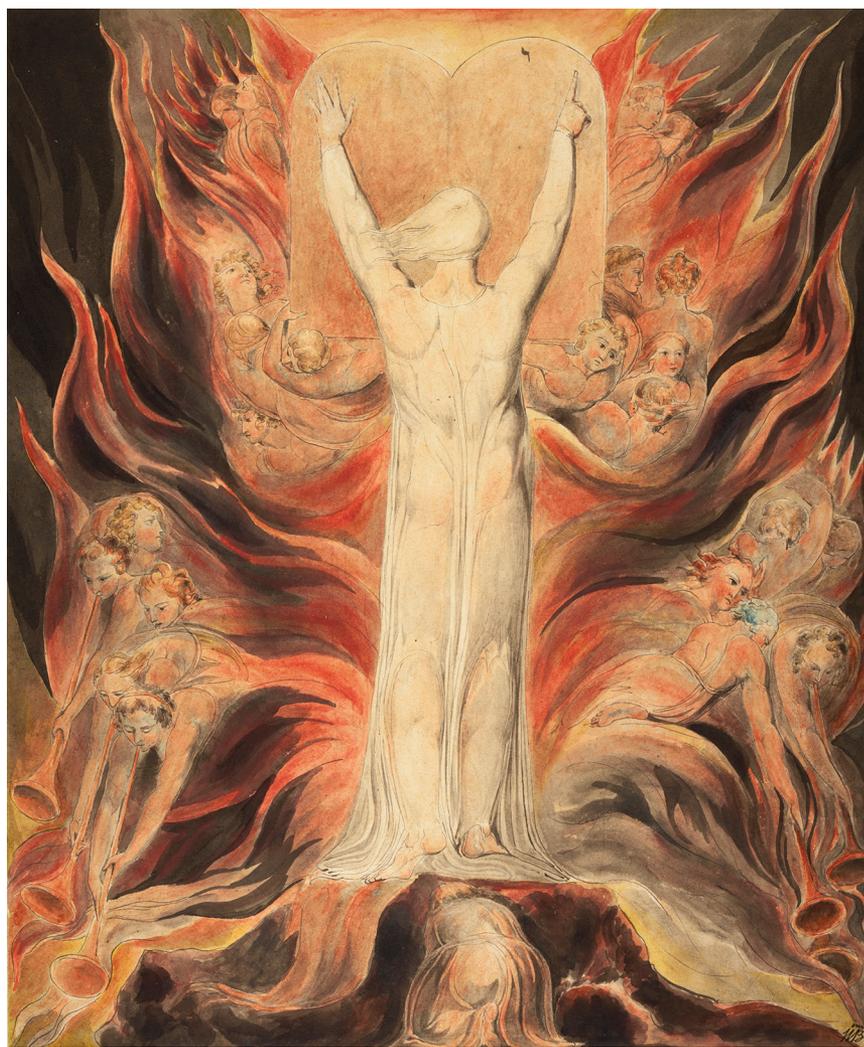
Understanding, written while in exile in Holland and first published in an abridged French edition. Locke's work helped to turn the soul into something closer to the modern mind (from the Old English *mynde*), the theater of our subjective experience. The mind is populated by ideas that ultimately derive from the outside, from sensations, for the mind at birth is an empty slate, a *tabula rasa*. The ideas of God, justice, mathematics and the self, as well as everyday objects, whether implements, machines, animals or people, are not innate. Rather they are learned by experience, by re-

flection and by association. How the mind could carry out these tasks was a mystery for Locke as it was for Descartes, Hobbes and everybody else. For how mere brain matter could think, reason or speak was inexplicable given the mechanics and chemistry of the day. Thus, Locke postulated that God had super-added active forces to brain matter.

Common to Descartes, Hobbes, Locke, Baruch Spinoza and other radical thinkers was a disdain for superstition. Makari cites an entry from Locke's journal: "The three great things that govern mankind are reason, passion, and superstition. The first governs a few, the two last share the bulk of mankind and possess them in their turns. But superstition most powerfully produces the greatest mischief." Two centuries hence, Fyodor Dostoyevsky's *Grand Inquisitor* understood this mind-set well: "the only three forces that are able to conquer and hold captive forever the conscience of these weak rebels for their own happiness ... are miracle, mystery and authority." Today, another two centuries onward, humanity continues to battle these forces.

As the mind of the closing years of the 17th century had lost many of its heavenly attributes and had become a part of nature, it could now suffer the corruptions all matter is prey to; it could become dysfunctional, sick or afflicted with melancholia (a widespread ailment). Or it could be fallible and form misassociations that led to cognitive errors, explaining the rising tide of religious fanatics, enthusiasts and prophets: the Anabaptists, Methodists, Seekers, Quakers, and other self-avowed divine messengers who wandered the world, preaching their own interpretation of God and the Bible. Perhaps God was not speaking through them, but rather they were simply deluded. Likewise, perhaps witches were not truly possessed. Maybe they were simply ill, sick to their souls or crazy, and they should not be burned.

If people had unbalanced minds, could these be righted? Could they be



Superstition—as exemplified in William Blake's *The Witch of Endor*—received withering critiques from Enlightenment philosophers, including René Descartes, Thomas Hobbes and John Locke.

The odd behaviors of King George III entranced all his subjects. The 1994 film *The Madness of King George* rendered an account of this period.

cured? How so? By confining them to madhouses? What kind of therapies would work best? How can one tell a mad person from an eccentric? These questions captivated the United Kingdom in response to the bizarre behavior of King George III, the sovereign who lost the American colonies and triggered a political crisis concerning his sanity and whether and how it could be restored. Echoes of these controversies can be heard even today in the ongoing dispute concerning who to blame for mass shootings—deranged individuals or gun ownership and cultural factors.

Ever so slowly, with countless setbacks, as the decades turned into a century and then two, religious explanations of idiosyncratic behaviors turned into clinical ones, with attendant mental asylums and specialist doctors to treat the afflicted, now considered neither evil nor touched by God but patients in need of help.

Makari rightfully spends many pages on Prussian astronomer and philosopher Immanuel Kant (1724–1804), who did more than anybody else to delimit and plumb what the mind can know and what reason can deduce about the world. With rapierlike precision, Kant argued that our mind can never penetrate to the true nature of things.

Of Spirits and the Profane

The book does an outstanding job of relating changing epistemological narratives to the politics of the day. Possessions and exorcisms provided visible proof of the reality of the spiritual world. If these were now profane matters, subject to medicine and reason, where did this leave the divine justifications for the absolute rights of monarchs?

Soul Machine ends in the mid-19th century, with a portrayal of German



physicians Franz Joseph Gall (1758–1828) and his assistant Johann Spurzheim (1776–1832). Based on systematic dissection of human and animal brains, Gall formulated a thoroughly materialistic, empirically based account of the brain as the sole organ of the mind, one that is not homogeneous but an aggregate of distinct parts and, as a consequence, distinct “functions.” Gall argued for 27 functions, each one assigned to different and distinct regions of the brain. Every individual inherits a separate set of organs, some smaller, some larger, thus explaining individual differences. These views of the brain as a machine for producing thought and memory clashed with religious sentiments and public morality to such an extent that Gall had to leave Vienna and settle in postrevolutionary Paris.

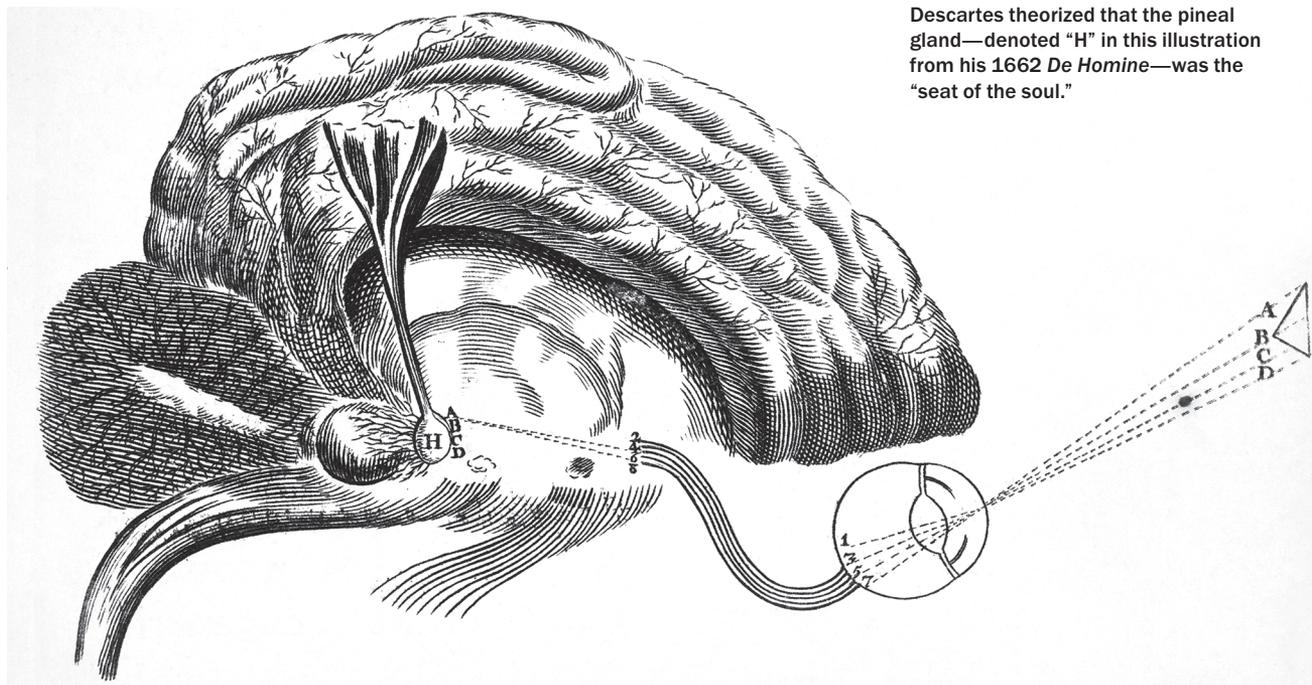
Using the detailed curvature, shape and extent of the skull, Gall and Spurzheim claimed to be able to infer the size and import of the organ underneath the cranium and thereby diagnose the mental character of the individual examined. Their phrenological method proved immensely popular, as it appealed to the growing middle class as scientific, sophisticated and modern. Phrenology was used to classify crimi-

nals, lunatics, the eminent and the (in)famous. It eventually lost favor as a reputable scientific method but lingered on until the early 20th century.

Although there is no discernible relation between the morphology of the external skull and the size and function of the underlying neural tissue, Gall’s insistence on localization for specific cognitive functions in the cerebral cortex found validation in 1848 through the work of Parisian neurologist Paul Broca. The physician presented the landmark case of a patient unable to speak except for the single word “tan.” His brain proved to have suffered damage to its left frontal lobe. Thus, Broca concluded that meaningful speech was closely related to this region. An analysis of a second patient fortified his conclusion that a circumscribed region in the frontal cortex—the left inferior frontal gyrus, named Broca’s area—was responsible for productive speech, that most human of all behaviors.

Overall, *Soul Machine* is a monumental work, replete with reproductions of contemporary engravings, that describes in sometimes overwhelming detail the work of a large cast of individuals—and their influences on one another—over the course of several centuries.

Descartes theorized that the pineal gland—denoted “H” in this illustration from his 1662 *De Homine*—was the “seat of the soul.”



It seems strange that Makari stops short of describing Charles Darwin’s influence on the conception of the human mind as an evolutionary refinement, an extension of the minds of apes, monkeys and other animals, shaped by natural selection to fit a particular socioecological niche. That is, we have the cognitive apparatus that we have precisely because it enabled our proximal and distal ancestors to better survive the struggle for existence. Our genetic endowment profoundly shapes the way we apprehend the world. This inborn bias to see the world in a particular way—for example, for most of us in a combination of three colors—also irredeemably shapes our perception and ultimately our knowledge about the world. This echoes Kant’s celebrated argument for the existence of knowledge that cannot be logically derived yet is prior to our experience (synthetic a priori proposition).

My far bigger complaint with *Soul Machine* is the book’s complete neglect of the dominant strand of modern thinking about the mind—the information-pro-

cessing paradigm. In this narrative (dominant in academic psychology and neuroscience), the brain transforms incoming sensory information to yield an internal representation of the external world. In conjunction with emotional and cognitive states and both conscious and unconscious memories, the mind generates—or

that prevails, one as familiar to us all as mother’s milk.

Descartes’s ideas were rooted in his inability to conceive of procedures and mechanisms to explain intelligence, reasoning and language. In the 17th century nobody could envision how the mind-less application of innumerable,

WHAT WOULD ARISTOTLE, AQUINAS AND DESCARTES HAVE MADE OF A ROOMBA, WHICH CLEVERLY CLEANS FLOORS, OR OF IBM’S WATSON, WHICH BESTED HUMANS IN JEOPARDY?

computes, as the cognoscenti would have it—an appropriate response and generates the associated motor behaviors. Think of the human body as a robot, with its brain as a neuromorphic computer. Thanks to Steve Jobs, Bill Gates, Paul Allen and the other visionary entrepreneurs who gifted us with personal computers, this is the view of the mind

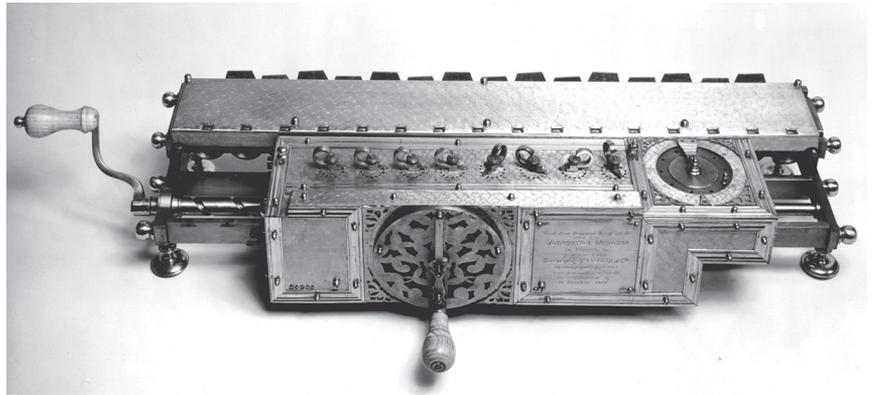
meticulously detailed, step-by-step instructions, what we today refer to as algorithms, could get a computing machine to play chess or Go, recognize faces, label photographs and translate Web pages. Descartes had to appeal to a mysterious, ethereal substance that, in some nebulous manner, did the thinking and reasoning.

A mere couple of decades later the seed of the computational paradigm was laid down by German rationalist philosopher, scientist and polymath Gottfried Wilhelm Leibniz (1646–1716), who developed the binary number system and, in fierce competition with Isaac Newton, invented calculus. He was on a lifelong quest to develop a universal calculus, what he termed a “calculus ratiocinator,” in conjunction with a universal conceptual language. If he had been capable at the time of creating such a thing, it would have resembled either a proto-computer program (software) or a description of a powerful calculating machine (hardware). Leibniz was looking for ways to cast any dispute into a rigorous mathematical form that could then be evaluated for its truth. As he wrote:

The only way to rectify our reasonings is to make them as tangible as those of the Mathematicians, so that we can find our error at a glance, and when there are disputes among persons, we can simply say: Let us calculate, without further ado, to see who is right.

Leibniz was no mere theoretician but an all-around talent who designed and built an early general digital calculator. His dream of a calculus ratiocinator motivated logicians of the late 19th and early 20th centuries, culminating in the 1930s with work by Kurt Gödel, Alonzo Church and Alan Turing that gave us two things. First, their labors placed absolute and formal limits on what can be proved by mathematics, bringing to an end its ancient, aspirational dream of formalizing truth, of constructing a universal alethiometer, that is, a truth meter. Second, it gave birth to the universal Turing machine, a dynamic model of how any mathematical procedure can be implemented and evaluated on a very simple machine.

These conceptual breakthroughs fed two related but distinct streams of inqui-



Polymath Gottfried Wilhelm Leibniz invented an early digital calculator at the end of the 17th century, a manual processing unit capable of performing the basic arithmetical operations of addition, subtraction, multiplication and division.

ry, with profound implications for our contemporary view of the mind. One strand ushered in neural networks and computational neuroscience, demonstrating how large networks of interconnected nodes can learn to recognize letters, faces or objects, navigate a complex environment, speak and reason. The second strand completely upended society and our way of life because it gave rise to digital computers, first in the shape of a few large university- or government-operated centers, then on millions of desks in offices, and now living in the pockets and hands of billions of people.

Even more critical, computers gave rise to the idea and later the practice of artificial intelligence, the design of machine minds whose performance is narrowly defined but increasingly able to match and exceed what the human mind is capable of. What would Aristotle, Aquinas and Descartes have made of a Roomba, a popular disk-shaped household robot for cleaning floors, or of IBM’s Watson, the computer program that understands and speaks English and that bested humans in the quiz show *Jeopardy?* Judged purely by their behaviors, one would have to accord these technologies as possessing both sensitive and rational souls capable of achieving *res cogitans*. Yet the extent to which digital computers can experience

anything and can be conscious in the way that people are remains controversial, with at least one popular theory of consciousness denying it. (To go still further and achieve a naturalized immortality, some of the more enthusiastic technologists postulate a heaven in the appropriately located Cloud, to which our digital simulacrum will eventually be uploaded, provided we practice the right brain-freezing technique.)

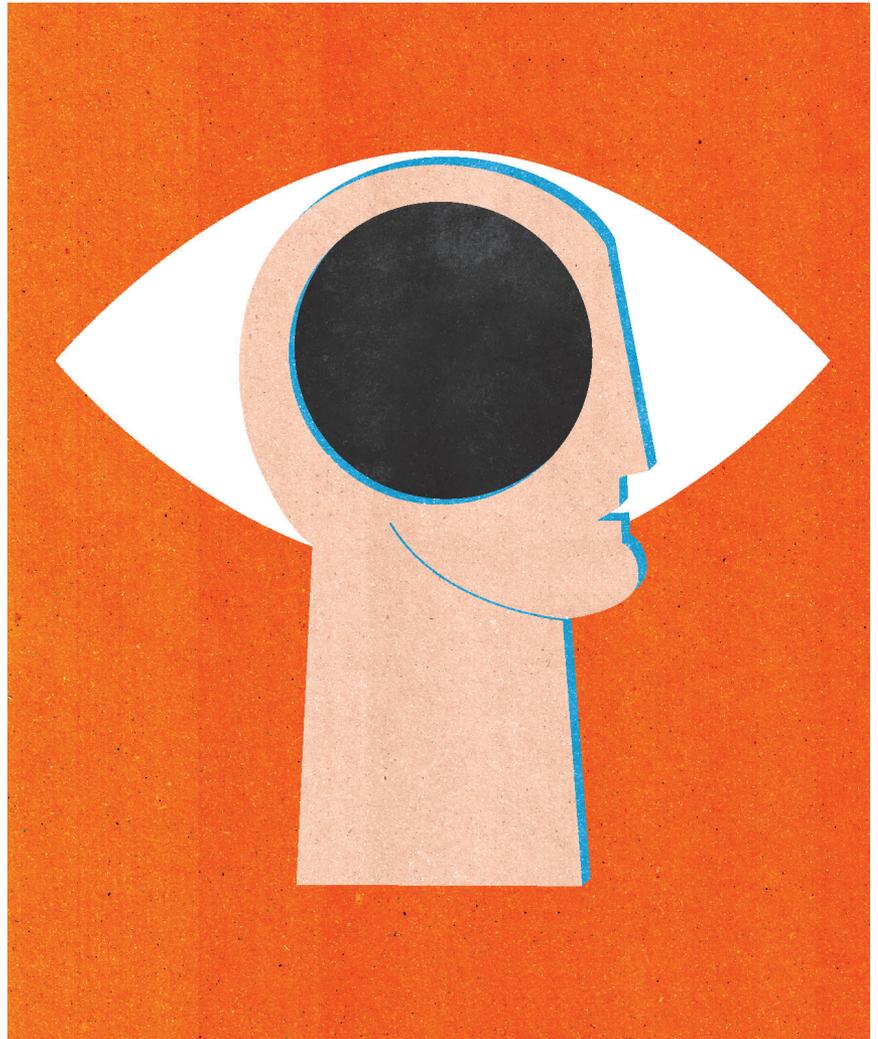
Supernatural meaning has been leached from the modern conception of the computational mind by the acid bath of the Enlightenment. No brain, never mind! Yet by no means has our understanding of the interbraided leitmotifs of *Soul Machine*—consciousness, mind and soul—reached its final apogee. It will continue to evolve as scientists, clinicians and philosophers, newly joined by engineers, seek an ever more precise carving of nature at its joints, to use a beautiful Platonic idiom.

Soul Machine is an eminently readable account of how these concepts are shaped and determined by historical and cultural contingency in ways that science usually chooses to ignore. **M**

MORE TO EXPLORE

■ **Soul Machine: The Invention of the Modern Mind.** George Makari. W. W. Norton, 2015.

“You don’t understand, doctor,” he said pleadingly. “It’s driving me crazy. When I try to study, that spot blacks out whatever I’m reading or looking at. When I’m using my iPhone, I can hardly focus because the spot is there. I feel like ripping my hair out.”



ILLUSTRATIONS BY KOTRYNA ZUKAUSKAITE

The Black Spot

By Carol W. Berman

Eric* had consulted three ophthalmologists before he came to see me. This third-year medical student, dressed in jeans and an oxford, button-down blue shirt, looked typical in every way except for his spiky blond hair. Usually medical students don’t get into extreme fashion in hair or dress. But what distin-

guished Eric the most, besides his hair, was the look of distress on his pale face. We sat across from each other in my small office on Manhattan’s Upper West Side. “My parents are so angry at me because I’m flunking out! And I’ll tell you why. Right now, as I’m looking at you, I see a large, black spot over your

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Send suggestions for column topics to MindEditors@sciam.com

*Not his real name.

OCD: DIAGNOSTIC CRITERIA*

Presence of obsessions or compulsions, or both, that cannot be attributed to drug use or another medical condition.

Spending more than an hour a day on obsessions and compulsions, such that they interfere with some aspects of daily life.

Obsessions are intrusive, recurrent thoughts that cause anxiety and that one struggles to suppress.

Compulsions are repetitive behaviors one feels driven to do to relieve distress.

**Adapted from the DSM-5.*

face,” he said, squinting a little.

“Is it a floater?” I asked. I happened to have one of those annoying specks in my own eye. I was looking at him through mine, a new problem that had just developed. What synchronicity.

“Yes, but it’s not an ordinary one,” he insisted. “It’s gigantic and obscuring the vision in my left eye!” I told him I was sorry to hear about this problem and asked him what the doctors had advised. I thought visiting three ophthalmologists as he had done was a little much (one long, unpleasant exam had been more than enough for me), but I reserved judgment about Eric until I heard his full story.

The doctors, it turned out, had told him to wait it out. “I heard

that they usually disappear on their own, especially at your age,” I said, hoping that would be the case with mine, too.

“You don’t understand, doctor,” he said pleadingly, “It’s driving me crazy. When I try to study, that spot blacks out whatever I’m reading or looking at. When I’m using my iPhone, I can hardly focus because the spot is there. I feel like ripping my hair out,” he said, touching his head. Now I understood the spiky locks—it wasn’t just a fashion statement. I began to wonder if he had trichotillomania, an obsessive-compulsive condition in which patients pull out their hair.

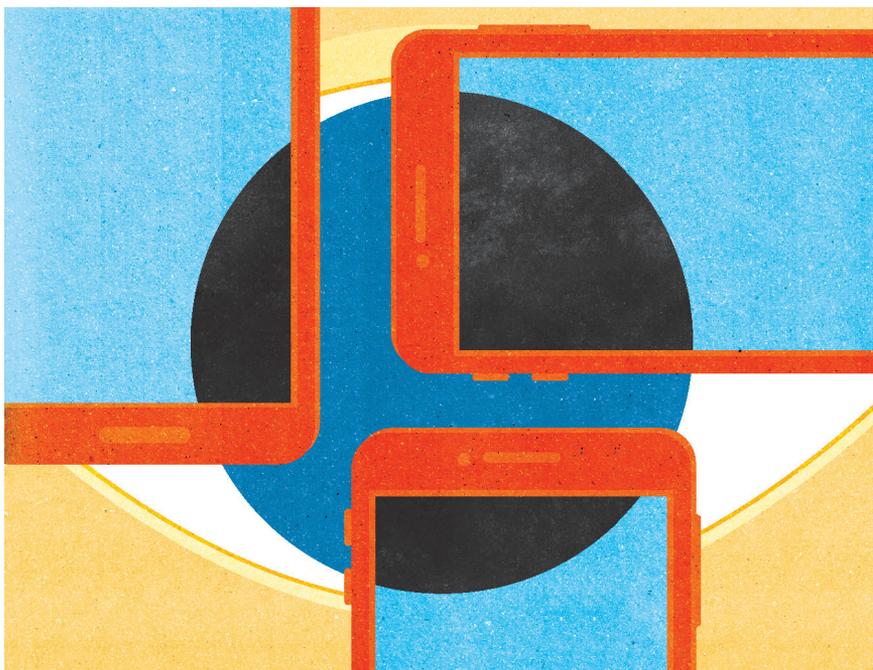
As we continued to talk, it became clear that Eric’s problem had begun well before the floater appeared. He admitted to being “obsessed” with the black spot, but before that he had been firmly fixated on his cell phone. “I used to look at my phone all the time—now I have to look at that stupid spot. You must understand.

It’s separating me from my phone.”

This caught my attention. Many people, perhaps most of us, are obsessed with our electronic devices these days, but for this poor man, the preoccupation had apparently crossed over into the realm of pathology.

Surveys in both the U.S. and the U.K. have shown that about 70 percent of young adults feel so attached to their phone that they admit to feeling anxiety or even panic when they are separated from it. They seem to view the device as an extension of themselves. Wikipedia even has a new term called “nomophobia,” which means fear of being out of cell-phone contact.

A number of articles have been published in the popular press about smartphone obsession, although the phenomenon is only just beginning to draw the attention of researchers. One study conducted at the University of Missouri and



published last year in the *Journal of Computer-Mediated Communication* involved 41 young people solving word puzzles with and without their smartphone by their side. It found that when the subjects were separated from their phone, their heart rate and blood pressure rose significantly, along with feelings of anxiety. They also did a poorer

job solving the puzzles when parted from their precious phones. And it was taking a serious toll. “I failed my last biochemistry test because I couldn’t concentrate with that black spot in front of me,” he told me. The dean had warned him that if he failed one more exam, he would have to drop out or repeat that year of medical school. “I know the floater is just a chunk of vitreous matter that broke off

ERIC’S OBSESSION WITH HIS CELL PHONE WAS ALMOST NORMAL BEHAVIOR FOR HIS GENERATION—A SOCIAL TREND THAT HAD ESSENTIALLY MASKED HIS OCD.

from my eyeball,” he lamented, “but I can’t stand it! It’s ruining my life!”

Given his misery and the threat to his academic standing, we needed to act quickly. Cognitive-behavioral therapy and other psychotherapies have been found to be effective for OCD, but as a psychopharmacologist, I knew I could relieve Eric of his obsessions and compulsions quickly and effectively with medication. I immediately suggested treatment with sertraline, a selective serotonin reuptake inhibitor that is perhaps better known by its brand name, Zoloft. I have treated dozens of OCD patients with this medication, with generally good results.

I explained to Eric that we believe that OCD involves a dysregulation of the neurotransmitter serotonin and that sertraline increases serotonin in brain cell synapses, relieving the symptoms. I told him that we would start at 25 milligrams daily and gradually increase to a fairly high amount—because OCD usually remits only with dosages above 200 mg. It would take about four weeks to kick in.

Eric had all the symptoms to make a diagnosis of obsessive-compulsive disorder (OCD), according to the *DSM-5*—the *Diagnostic and Statistical Manual of Mental Disorders* [see box on opposite page]. The fact that his obsession with his cell phone was almost typical behavior for his generation had essentially masked his disorder.

While he might have been able to rationalize a cell-phone fixation, he knew his obsession with the black spot was ri-

diculous. And it was taking a serious toll. “I failed my last biochemistry test because I couldn’t concentrate with that black spot in front of me,” he told me. The dean had warned him that if he failed one more exam, he would have to drop out or repeat that year of medical school. “I know the floater is just a chunk of vitreous matter that broke off

Eric agreed to the treatment but expressed concern about side effects—especially on sexual function. “My friend took sertraline, and he couldn’t have an orgasm,” he noted. “Will that happen to me? My girlfriend will freak out. I don’t want that problem, too.”

I told him we would deal with that issue if it occurred. We could, for instance, add another medicine to counteract the side effect. But sexual dysfunction was the least of his concerns now. I had to get him better quickly before he flunked out.

It took five weeks for the sertraline to work, and Eric called me every other day, complaining about side effects of nausea, diarrhea and some memory problems. This kind of relentless, fretful behavior is common in patients with obsessive-compulsive disorder.

Fortunately, he didn’t experience sexual dysfunction. We had to increase his dosage to 500 mg a day, a fairly large amount that his insurance company initially balked at. Thankfully, the sertraline worked, the side effects eased up, and Eric was able to concentrate and pass his exams.

Eric continues to be my patient to this day, but he only has to visit me for medication checkups a few times a year. As for the floater, it eventually disappeared. But in a sense, it had served Eric well: it was the black spot that brought his condition to light. **M**

MORE TO EXPLORE

■ **The Extended iSelf: The Impact of iPhone Separation on Cognition, Emotion, and Physiology.** Russell B. Clayton et al. in *Journal of Computer-Mediated Communication*, Vol. 20, No. 2, pages 119-135; March 2015.

From *Our Archives*

■ **Obsessions Revisited.** Melinda Wenner Moyer; May/June 2011.

BEYOND FEAR: THE PSYCHOLOGY OF TERRORISM

Since September 11, terrorism has been an ever present threat gnawing at our collective peace of mind. In recent years those fears—particularly of domestic attacks by Islamic extremists—have spiked. They are up by 38 percentage points since 2011 in France, 21 points in the U.K. and 17 points in the U.S., according to a survey released by the Pew Research Center last summer. And that was before Paris and San Bernardino.

But “fear itself,” as President Franklin D. Roosevelt so famously pointed out, is not very useful. To contend with a threat, it is better to understand the forces that shape it. That is where science enters in. What can psychology tell us about the mind of a suicide bomber? What makes someone a fanatic in the first place? How is it that during the past five years, extremist groups in Syria and Iraq have managed to recruit some 30,000 foreign fighters to their cause—a number that doubled between 2014 and 2015? Can we reclaim some of them before it is too late?

The experts writing in this special report share some valuable insights from recent studies, classical research and professional experience. Social psychologists Stephen D. Reicher and S. Alexander Haslam make the case that most terrorists are not psychopaths or sadists, much as we would like to believe. Instead the majority are ordinary people, shaped by

group dynamics to do harm in the name of a cause they find noble and just. Critically, those group dynamics involve all of us: our overreaction and fear, Reicher and Haslam explain, can beget greater extremism, thereby fueling a cycle other scholars have termed “co-radicalization.”

French anthropologist Dounia Bouzar describes what she has learned from deprogramming hundreds of young people caught up in this cycle. She notes that only the tug of emotion, not reason, can pull teens back from the call to jihad. Bouzar emphasizes that parents should talk to their children about the shadow world on the Internet—a major recruitment arena in both Western Europe and the U.S.

Last but not least, social psychologists Kevin Dutton and Dominic Abrams consider how we can all help break the cycle of co-radicalization, drawing on seven key studies for concrete suggestions. Among those ideas: bridging the toxic divide of mutual distrust by celebrating broader social identities—much as President Barack Obama did so powerfully in his address to Muslim Americans at a Baltimore mosque this past February. Instead of listening to “polemical pundits and belligerent blowhards,” Dutton and Abrams write, we all need a brain check: keep calm and “tune in to the quieter, more discerning notes emanating from some of our laboratories.” —*The Editors*

PHOTOILLUSTRATIONS BY AARON GOODMAN





FUELLING Extremes

The psychology of group dynamics goes a long way toward explaining what drives ordinary people toward radicalism

The steep and virulent rise of terrorism ranks among the more disturbing trends in the world today.

According to the 2015 Global Terrorism Index, terror-related deaths have increased nearly 10-fold since the start of the 21st century, surging from 3,329 in 2000 to 32,685 in 2014. Between 2013 and 2014 alone, they shot up 80 percent. For social psychologists, this escalation prompts a series of urgent questions, just as it does for society as a whole: How can extremist groups treat fellow human beings with such cruelty? Why do their barbaric brands of violence appeal to young people around the globe? Who are their recruits, and what are they thinking when they target innocent lives?

Many people jump to the conclusion that only psychopaths or sadists—individuals entirely different from us—could ever strap on a suicide vest or wield an executioner's sword. But sadly that assumption is flawed. Thanks to classic studies from the 1960s and 1970s, we know that even stable, well-adjusted individuals are capable of inflicting serious harm on human beings with whom they have no grievance whatsoever. Stanley Milgram's oft-cited "obedience to authority" research showed that study volunteers were willing to administer what they believed to be lethal electric shocks to others when asked to do so by a

■ **By Stephen D. Reicher and S. Alexander Haslam**

researcher in a lab coat. Fellow psychologist Philip Zimbardo's (in)famous Stanford Prison Experiment revealed that college students assigned to play the part of prison guards would humiliate and abuse other students who were prisoners.

These studies proved that virtually anyone, under the right—or rather the wrong—circumstances, could be led to perpetrate acts of extreme violence. And so it is for terrorists. From a psychological perspective, the majority of adherents to radical groups are not monsters—much as we would like to believe that—no more so than were the everyday Americans participating in Milgram's and

terrorists and the experiences that can prime them toward radicalization.

In particular, we are learning that radicalization does not happen in a vacuum but is driven in part by rifts among groups that extremists seek to create, exploit and exacerbate. If you can provoke enough non-Muslims to treat all Muslims with fear and hostility, then those Muslims who previously shunned conflict may begin to feel marginalized and heed the call of the more radical voices among them. Likewise, if you can provoke enough Muslims to treat all Westerners with hostility, then the majority in the West might also start to endorse more

tification. Specifically, for someone to follow a group—possibly to the point of violence—he or she must identify with its members and, at the same time, detach from people outside the group, ceasing to see them as his or her concern.

We confirmed these dynamics in our own work that has revisited Zimbardo's and Milgram's paradigms. Across a number of different studies, we have found consistently that, just as Tajfel and Turner proposed, participants are willing to act in oppressive ways only to the extent that they come to identify with the cause they are being asked to advance—and to disidentify with those they are harming.

Radicalization does not happen in a vacuum but is driven by rifts among groups that extremists seek to exploit and exacerbate.

Zimbardo's investigations. As anthropologist Scott Atran notes, drawing on his long experience of studying these killers, most are ordinary people. What turns someone into a fanatic, Atran explained in his 2010 book *Talking to the Enemy*, "is not some inherent personality defect but the person-changing dynamic of the group" to which he or she belongs.

For Milgram and Zimbardo, these group dynamics had to do with conformity—obeying a leader or subscribing to the majority view. During the past half a century, though, our understanding of how people behave both within and among groups has advanced. Recent findings challenge the notion that individuals become zombies in groups or that they can be easily brainwashed by charismatic zealots. These new insights are offering a fresh take on the psychology of would-be

confrontational leadership. Although we often think of Islamic extremists and Islamophobes as being diametrically opposed, the two are inextricably intertwined. And this realization means that solutions to the scourge of terror will lie as much with "us" as with "them."

Following the Leader

Milgram's and Zimbardo's findings showed that almost anyone *could* become abusive. If you look closely at their results, though, most participants did not. So what distinguished those who did? The pioneering work of social psychologists Henri Tajfel and John Turner in the 1980s, though unrelated, suggested part of the answer. They argued that a group's behavior and the ultimate influence of its leaders depended critically on two interrelated factors: identification and disiden-

The more worthwhile they believe the cause to be, the more they justify their acts as regrettable but necessary.

This understanding—that social identity and not pressure to conform governs how far someone will go—resonates with findings about what actually motivates terrorists. In his 2004 book *Understanding Terror Networks*, forensic psychiatrist Marc Sageman, a former CIA case officer, emphasized that terrorists are generally true believers who know exactly what they are doing. "The mujahedin were enthusiastic killers," he noted, "not robots simply responding to social pressures or group dynamics." Sageman did not dismiss the importance of compelling leaders—such as Osama bin Laden and ISIS's Abu Bakr al-Baghdadi—but he suggested that they serve more to provide inspiration than to direct operations, issue commands or pull strings.

Indeed, there is little evidence that masterminds orchestrate acts of terror, notwithstanding the language the media often use when reporting these events. Which brings us to a second recent shift in our thinking about group dynamics: we have observed that when people do come under the influence of authorities, malevolent or otherwise, they do not usually display slavish obedience but instead

FAST FACTS

UNDERSTANDING CO-RADICALIZATION

- 1 Although we may think of terrorists as sadists and psychopaths, social psychology suggests they are mostly ordinary people, driven by group dynamics to do harm for a cause they believe to be noble and just.
- 2 Terrorism reconfigures these group dynamics so that extreme leadership seems more appealing to everyone. Just as ISIS feeds off immoderate politicians in the West, for example, so do those immoderate politicians feed off ISIS to draw support for themselves.
- 3 Having others misperceive or deny a valued identity—an experience we describe as misrecognition—systematically provokes anger and cynicism toward authorities.

find unique, individual ways to further the group's agenda. After the Stanford Prison Experiment had concluded, for example, one of the most zealous guards asked one of the prisoners whom he had abused what he would have done in his position. The prisoner replied: "I don't believe I would have been as inventive as you. I don't believe I would have applied as much imagination to what I was do-

entific progress, so successful leaders need to sell the enterprise they envision for their group as honorable and noble.

Both al Qaeda and ISIS deploy this strategy. A large part of their appeal to sympathizers is that they promote terror for the sake of a better society—one that harks back to the peaceful community that surrounded the prophet Mohammed. Last year University of Arizona journal-

promote conflict and violence—depend not only on what they say and do but also on their opponents' behavior. Evidence for this fact emerged after a series of experiments by one of us (Haslam) and Ilka Gleibs of the London School of Economics that looked at how people choose leaders. One of the core findings was that people are more likely to support a bellicose leader if their group faces competition

with another group that is behaving belligerently. Republican candidate Donald Trump might have been wise to ponder this before he suggested that all Muslim immigrants are potential enemies who should be barred from entering the U.S. Far from weakening the radicals, such statements provide the grit that gives their cause greater traction. Indeed, after Trump made his declaration, an al Qaeda affiliate reaired it as part of its propaganda offensive.

The Gray Zone

Just as ISIS feeds off immoderate politicians in the West, so those immoderate politicians feed off ISIS to draw support for

themselves. This exchange is part of what religion scholar Douglas Pratt of the University of Waikato in New Zealand refers to as co-radicalization. And here lies the real power in terrorism: it can be used to provoke other groups to treat one's own group as dangerous—which helps to consolidate followers around those very leaders who preach greater enmity. Terrorism is not so much about spreading fear as it is about seeding retaliation and further conflict. Senior research fellow Shiraz Maher of the International Center for the Study of Radicalization and Political Violence at King's College London has pointed out how ISIS actively seeks to



Most Syrian refugees (left) do not view the West as their enemy, a fact that writers in the ISIS-run magazine *Dabiq* have bemoaned, calling for an end to the "gray zone" of constructive coexistence.

ing.... I don't think it would have been such a masterpiece." Individual terrorists, too, tend to be both autonomous and creative, and the lack of a hierarchical command structure is part of what makes terrorism so hard to counter.

How do terror leaders attract such engaged, innovative followers if they are not giving direct orders? Other discoveries from the past few decades (summarized in our 2011 book, co-authored with Michael J. Platow, *The New Psychology of Leadership*) highlight the role leaders play in building a sense of shared identity and purpose for a group, helping members to frame their experiences. They empower their followers by establishing a common cause and empower themselves by shaping it. Indeed, Milgram's and Zimbardo's experiments are object lessons in how to create a shared identity and then use it to mobilize people toward destructive ends. Just as they convinced the participants in their studies to inflict harm in the name of sci-

ism professor Shahira Fahmy carried out a systematic analysis of ISIS's propaganda and found that only about 5 percent depicts the kind of brutal violence typically seen on Western screens. The great majority features visions of an "idealistic caliphate," which would unify all Muslims harmoniously. Moreover, a significant element of ISIS's success—one that makes it more threatening than al Qaeda—lies in the very fact that its leaders lay claim to statehood. In the minds of its acolytes at least, it has the means to try to make this utopian caliphate a reality.

Crucially, however, the credibility and influence of leaders—especially those who

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incite Western countries to react in ways that make it harder for Muslims to feel that they belong in those communities.

In February 2015 the ISIS-run magazine *Dabiq* carried an editorial entitled “The Extinction of the Grayzone.” Its writers bemoaned the fact that many Muslims did not see the West as their enemy and that many refugees fleeing Syria and Afghanistan actually viewed Western countries as lands of opportunity. They called for an end of the “gray zone” of constructive coexistence and the creation of a world starkly divided between Muslim and non-Muslim, in which everyone either stands with ISIS or with the *kuffar* (nonbelievers). It also explained the attacks on the headquarters of the French magazine *Charlie Hebdo* in exactly these terms: “The time had come for another event—magnified by the presence of the Caliphate on the global stage—to further bring division to the world.”

In short, terrorism is all about polarization. It is about reconfiguring intergroup relationships so that extreme leadership appears to offer the most sensible way of engaging with an extreme world. From this vantage, terrorism is the very opposite of mindless destruction. It is a conscious—and effective—strategy for drawing followers into the ambit of confrontational leaders. Thus, when it comes to understanding why radical leaders continue to sponsor terrorism, we need to scrutinize both their actions *and* our reactions. As editor David Rothkopf wrote in *Foreign Policy* after the Paris massacres last November, “overreaction is precisely the wrong response to terrorism. And it’s exactly what terrorists want.... It does the work of the terrorists *for* the terrorists.”

Currently counterterrorism efforts in many countries give little consideration to how our responses may be upping the ante. These initiatives focus only on individuals and presume that radicalization starts when something happens to undermine someone’s sense of self and

purpose: discrimination, the loss of a parent, bullying, moving, or anything that leaves the person confused, uncertain or alone. Psychologist Erik Erikson noted that youths—still in the process of forming a secure identity—are particularly vulnerable to this kind of derailment [see “Escaping Radicalism,” by Dounia Bouzar, on page 40]. In this state, they become easy prey for radical groups, who claim to offer a supportive community in pursuit of a noble goal.

We have no doubt that this is an im-

port. They also supply narratives that resonate with their recruits and help them make sense of their experiences. And in that case, we need to seriously examine the ideas militant Muslim groups propagate—including the notion that the West is a long-standing enemy that hates all Muslims. Do our “majority” group reactions somehow lend credence to radicalizing voices in the minority Muslim community? Do police, teachers and other prominent figures make young Muslims in the West feel excluded and rejected—such that

Anti-Islam rallies, such as this one in Phoenix, Ariz., last spring, abet ISIS’s strategy to polarize Muslims and non-Muslims and draw followers into the ambit of confrontational leaders.



portant part of the process by which people are drawn into terrorist groups. Plenty of evidence points to the importance of small group ties, and, according to Atran and Sageman, Muslim terrorists are characteristically centered on clusters of close friends and kin. But these loyalties alone cannot adequately address what Sageman himself refers to as “the problem of specificity.” Many groups provide the bonds of fellowship around a shared cause: sporting groups, cultural groups, environmental groups. Even among religious factions—including Muslim groups—the great majority provide community and meaning without promoting violence. So why, specifically, are some people drawn to the few Muslim groups that do preach violent confrontation?

We argue that these groups are offering much more than consolation and sup-

port. They also supply narratives that resonate with their recruits and help them make sense of their experiences. And in that case, we need to seriously examine the ideas militant Muslim groups propagate—including the notion that the West is a long-standing enemy that hates all Muslims. Do our “majority” group reactions somehow lend credence to radicalizing voices in the minority Muslim community? Do police, teachers and other prominent figures make young Muslims in the West feel excluded and rejected—such that

they come to see the state less as their protector and more as their adversary? If so, how does this change their behavior? To begin to find out, one of us (Reicher), working with psychologists Leda Blackwood, now at the University of Bath in England, and Nicholas Hopkins of the University of Dundee in Scotland, conducted a series of individual and group interviews at Scottish airports in 2013. As national borders, airports send out clear signals about belonging and identity. We found that most Scots—Muslim and non-Muslim alike—had a clear sense of “coming home” after their travels abroad. Yet many Muslim Scots had the experience of being treated with suspicion at airport security. Why was I pulled aside? Why was I asked all those questions? Why was my bag searched? In the words of one 28-year-old youth

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worker: “For me to be singled out felt [like], ‘Where am I now?’ I consider Scotland my home. Why am I being stopped in my own house? Why am I being made to feel as the other in my own house?”

We gave the term “misrecognition” to this experience of having others misperceive or deny a valued identity. It systematically provoked anger and cynicism toward authorities. It led these individuals to distance themselves from outwardly British-looking people. After such an experience, one Muslim Scot said he felt that he would look ridiculous if he then continued to advocate trust in the agencies that had humiliated him. In other words, misrecognition can silence those who, having previously felt aligned with the West, might have been best placed to prevent further polarization. To be clear, misrecognition did not instantly turn otherwise moderate people into terrorists or even extremists. Nevertheless, it began to shift the balance of power away from leaders who say, “Work with the authorities; they are your friends,” toward those who might insist, “The authorities are your enemy.”

A Cautionary Tale

We can take this analysis of misrecognition and its consequences a step further. When we adapted Zimbardo’s prison study in our own research, we wanted to reexamine what happens when you mix two groups with unequal power. For one thing, we wanted to test some of the more recent theories about how social identity affects group dynamics. For instance, we reasoned that prisoners would identify with their group only if they had no prospect of leaving it. So we first told the volunteers assigned to be prisoners that they might be promoted to be guards if they showed the right qualities. Then, after a single round of promotions, we told them that there would be no more changes. They were stuck where they were.

We have discussed the effects of these manipulations in many publications, but

there is one finding we have not written about before—an observation that is especially relevant to our discussion of extremization. From the outset of the study, one particular prisoner had very clear ambitions to be a future guard. He saw himself as capable of uniting the guards and getting them to work as a team (something with which they were having problems). Other prisoners teased him; they talked of mutiny, which he ignored. Then, during the promotion process, the guards overlooked this prisoner and promoted someone he viewed as weaker and less effective. His claim to guard identity had been publicly rebuffed in a humiliating way.

Almost immediately his demeanor and behavior changed. Previously he was a model inmate who shunned his fellow prisoners, but now he identified strongly with them. He had discouraged the prisoners from undermining the guards’ authority, but now he joined in with great enthusiasm. And although he had supported the old order and helped maintain its existence, he began to emerge as a key instigator of a series of subversive acts that ultimately led to the overthrow and destruction of the guards’ regime.

His dramatic conversion came after a series of psychological steps that are occurring regularly in our communities today: aspiration to belong, misrecognition, disengagement and disidentification. Outside of our prison experiment,

the story goes something like this: Radical minority leaders use violence and hate to provoke majority authorities to institute a culture of surveillance against minority group members. This culture stokes misrecognition, which drives up disidentification and disengagement from the mainstream. And this distancing can make the arguments of the radicals harder to dismiss. Our point is that radical minority voices are not enough to radicalize someone, nor are the individual’s own experiences. What is potent, though, is the mix of the two and their ability to reinforce and amplify each other.

The analysis of terrorism we present here is, of course, provisional as we continue to collect evidence. We do not deny that some individual terrorists may indeed have pathological personalities. But terrorism brings together many people who would not ordinarily be inclined to shoot a gun or plant a bomb. And so there can be no question that understanding it calls for a group-level examination—not just of radicals but of the intergroup dynamic that propels their behavior. This context is something we are all a part of, something that we all help to shape. Do we treat minority groups in our communities with suspicion? Do those who represent us question their claims to citizenship? Do we react to terror with calls for counter-terror? The good news is that just as our analysis sees us as part of the problem, it also makes us part of the solution. **M**

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ESCAPING Radicalism

Memories and emotions—not reason—hold the key to reclaiming young fanatics, according to an expert team in France

In 2013 Mériam's husband kidnapped their daughter and left to join the jihad in Syria.

Once there he began sending chilling text messages back home, expressing his wish to die as a martyr alongside their child. By the time our disindoctrination team got to Mériam, she was distraught. We advised her to keep communicating with her husband and to follow one basic rule: Do not confront him about his ideology or his plan. Instead focus on his memories. Remind him about the day you met, the birth of your child, the places you visited together.

For 10 months, nothing. Then one day, for no apparent reason, there was a change. He had remembered a romantic evening at a restaurant, a moment of peace. This was good news. His emotions were not yet dead. Eventually he agreed to meet Mériam at a hotel on the Turkish border. There she reclaimed her child, her husband was arrested and they all returned to France.

Mériam's case illustrates a fundamental truth we have discovered in our work with more than 500 families in France who had a loved one caught up in Islamic extremism: There is no room for reason. You must reach out to radical recruits using emotion—which is easier said than done. As soon as Mériam received her husband's reply, all she wanted to do was tell him that his plan was crazy and that he urgently needed to come home. We convinced her to stay calm, to continue to revive his past memories and to remember that her husband had lost touch with a great part of his humanity.

How did he become so lost in the first place? How did he become a pawn in the radicalization machine?

Recruiting Steps

In our experience, many kinds of people are vulnerable—from teenagers who are flunking out to those who are first in their class. Radical Islam not only lures Muslims, it attracts Christians and even Jews, who make up about 3 percent of our caseload. Most had been uninvolved in religion. Some 50 percent are not recent immigrants; they are from families living in France for many generations. Also, only 30 percent of the families who ask us for help come from working-class backgrounds. Perhaps they are more fearful of authorities than middle-class families, who usually have more confidence in publicly funded institutions and contact us sooner.

Despite this diversity, extremists enlist everyone using the same four steps. First, they isolate the recruit—most often a teenager or young adult—from his or her social environment. Ideological recruitment rhetoric, often on the Internet, convinces them that they live in

a world in which adults and society lie—about food safety, medicine and vaccinations, history and politics. The recruiters mix verifiable facts with unverifiable elements so that susceptible young people snared in their web start to doubt everything. They tell them that “secret societies”—a Zionist conspiracy, the Illuminati, the Freemasons—are “buying up the planet.”

Against this backdrop, a young recruit soon finds himself—the target is often a male—in a peculiar situation. In the familiar and secure atmosphere of his room, he goes from YouTube link to YouTube link, feeling drawn into precisely the world he wants to reject. Recruiting Web sites cleverly reference films such as *The Matrix*, in which the protagonist, Neo, wonders if he should take a pill that will wake him up and show him the truth about reality or if he should go on sleeping, blissfully oblivious.

At this stage, the recruit abruptly stops seeing his friends, deeming them blind to reality. He abandons his hobbies because they prevent him from participating in the “revolution.” He also stops going to school, believing his teachers are paid to make him docile and prevent him from exposing the ubiquitous lies. Eventually he shuns his family. If his parents do not agree with him, they, too, must be blind, asleep or, worse, sell-outs to the system.

During the second phase of recruitment, handlers tell the isolated teen that only true Islam can renew and reawaken him. He gets a clear message that he is among the chosen people, who are more discerning than the rest. To be integrated into that group, he will adopt clothing that erases his individual look. He will disappear into the common group identity. This transformation begins to dissolve his memories of his past. From that point on, the group thinks for him. His family, if they are in touch, finds it impossible to have a discussion. He answers only with words from the Prophet, out of context, which he keeps repeating, as if some other entity is thinking for him.

In the third step, a now fully indoctrinated teenager will adhere completely to the radical group’s ideology. He is convinced that he is chosen and accepted into a community possessing the truth. The supposed purity and importance of the group are very powerful concepts at work in his mind. He believes that he must not associate with or be contaminated by anyone who does not think as it does.

The fourth and last stage of recruitment is dehumanization. Initially other people are dehumanized: all those who do not follow the recruit’s same path of “awakening” are considered not really human; killing them is not a crime and is even a duty. Then dehumanization applies to the recruit, too, as the ideas

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Recruitment 2.0

How terror networks are evolving to attract girls

During the past few years ISIS’s recruitment techniques have advanced. They now deliberately adapt how they pitch their radical ideology to the cognitive and emotional needs of the teens they target. Recruiters get adolescents to express themselves online to understand their motivations. Then each teen receives a personalized offer according to his or her psychological “profile” (below). To a young altruist, recruiters pitch a humanitarian mission: save the children who are victims of Syrian president Bashar al-Assad. Those who want to run away? Come be with people who share your values. The depressed? Fight in a great battle that will lead to the end of the world. In our experience, the following individualized approaches are particularly effective in recruiting girls.

“Abused” Profile

To a young girl who has been abused, recruiters will promise marriage to a bearded prince, armed with a Kalashnikov, and life forever covered with a *niqab* (a guarantee that she will never have to approach another man besides this warrior). We estimate that up to 70 percent of the girls recruited in this way are untreated rape victims.

“Guilty” Profile

In a typical scenario, a teen girl opens up online to a “friend”—a recruiter who discovers that she saw her 14-year-old brother die when she was little. Ever since then, she has believed that she will not live past 14, because she is the one who should have died on that day. The recruiter promises her an explosives belt. It will be strapped to her body, and she will die and be guaranteed to join her brother in paradise within the hour.

“Humanitarian” Profile

A third victim wants to sign up as a nurse in Burkina Faso and says so on her Facebook profile. For several weeks her page is flooded with pictures of dying children in Syria. These pictures come with a structured discourse that twists her intentions into planning terrorist attacks instead.

and emotions of the group supplant his own. Within the group itself, emotional ties among individuals exist only through the group. For example, we tried to “rehumanize” one woman by reviving her ties with her husband. But this approach failed miserably because, as the team later realized, she had an emotional connection to him only because he was also radicalized and planned to die for “the cause.” The barbaric acts of cruelty that radical groups engage in, such as suicide bombings and decapitations, further destroy a recruit’s sense of humanity.

Breaking the Spell

Once victims have been fully radicalized via these four phases, what are the chances of getting them to reconnect with their past and future? Recovery always begins by rekindling an emotional connection with family members. The problem is that by the time the family contacts us for help, the break is often complete: the teen no longer considers his parents his

parents. We must then work patiently and deftly to rebuild these attachments.

Fortunately, the human brain always preserves traces of past feelings, which can surface at unexpected moments. Parents need to think of pivotal events in their child's life and recall their interactions. This process is exceptionally difficult on parents. Some young people destroy images in the house forbidden by radical rhetoric, break the televisions (seen as vectors of the Illuminati ideology) or refuse to eat (for fear of pork gelatin in the food). The only way to tap their emotions is by recalling remnants of their former life—perhaps a childhood photograph, enlarged and left around the house, or a souvenir from a family trip. Such tactics can have surprising results. As long as parents remain extremely patient (for months, they

“One day I told myself that my recruiters were terrorists, bloody executioners who played football with severed heads, and I was wondering how they could call what they were doing a religious activity. An hour later I was sure that those who wanted to disindoctrinate me were working for the Zionists and that we needed to kill them.”

must not attempt to address the problem with rational arguments), this method eventually bears fruit.

“Resensitized,” a teenager may then, using one excuse or another, reluctantly consent to go to a support-group meeting. At this point, our team jumps into action. For instance, we assisted one family whose son, in the course of being radicalized, was focused on rejecting alcohol. His own jihad was to destroy any trace of alcohol in the house: deodorants, perfumes, food products—all had to go. For several months his parents had worked toward an emotional reactivation, little by little. And then, for Mother's Day, the teen gave his mother a bottle of perfume. She called us in tears. We told her we would be there in two hours.

We brought former recruits with us—as we always do—so that they could talk about their experiences. In these interactions, we have these volunteers answer our questions so that it appears as if they, too, are seeking our perspective. They talk about the huge discrepancy they encountered between their expectations and the reality of the radical group they had joined. We select former recruits whose experiences match the victim's [see box on opposite page]. Hearing testimonies that mirror their own story, teenagers will often wise up to the formulaic recruitment they underwent. The veterans are adamant: The radical groups are not what you think they are. The recruit's dream is actually a nightmare. The shock of such revelations is brutal.

Restoring Reason

At that precise moment, the teenager starts to think for himself again. He begins his own analysis, reflecting and dissecting. Confronted at last with reality, he typically breaks down after about three hours in conversation with us and the other recruits—and runs into the arms of his parents. A complete emotional and cognitive reversal takes place at that point. The teenager enters a new phase that could be called remission. He typically reveals entire recruitment networks—information that we share with authorities.

We may think the game is now won, but it is not. Two weeks later the young recruit will typically call us back, accusing us of trying to “put him to sleep.” Meanwhile, to his support group, he will usually express astonishing ambivalence. For example, one teen explained: “One day I told myself that my recruiters were terrorists, bloody executioners who played football with severed heads, and I was wondering how they could call what they were doing a religious activity. An hour later I was sure that those who wanted to disindoctrinate me were working for the Zionists and that we needed to kill them.”

It is essential for the teen to continue to question who is telling the truth and whom to trust. This process helps to nurture a healthy state of doubt. The use of former recruits is central to our success because they introduce doubt, little by little, one personal account at a time. The survivor support groups last for six months.

Sometimes new recruits have their own doubts from the start. One woman we helped had joined the jihad in hopes of entering a world in which everyone would be like her and would love her. She believed she was embracing values of solidarity and brotherhood while stepping away from material possessions. So no wonder she was very surprised to discover her comrades in the Middle East passing around watches and ISIS T-shirts, strutting around with their Kalashnikovs and driving luxury cars. She felt intense suspicion that was difficult to explore at first, but as her doubts accumulated, her reason returned.

Today the recruiting machine is operating at full speed: five families call us every week. They represent just the tip of the iceberg. Public authorities have gone as far as they can in monitoring jihadist Web sites. Families and teachers must also confront the problem head-on and teach young people about this shadow world that exists online and how it is being used to mislead them. Too many adults have no idea of what is out there or its psychological impact. Many have no idea of what is happening with their own children until one day they wake up in hell. **M**

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TERRORISM

EXTINGUISH

■ By Kevin Dutton and Dominic Abrams DRAWINGS BY HARRY MALT

Terrorism is as old as history and almost certainly older. In 68 B.C., for instance, the Roman city of Ostia, a vital port for one of the world's earliest superpowers, was set on fire by a band of thugs. They destroyed the consular war fleet and, rather embarrassingly, kidnapped two leading senators. Panic ensued—the same panic that has now been recapitulated down the centuries, courtesy of such terror groups as the Irish Republican Army, the Palestine Liberation Organization, the African National Congress, the Liberation Tigers of Tamil Eelam, al Qaeda and, most recently, ISIS. At the time of

writing this article, the world had witnessed three major terrorist attacks within a period of 20 days—Beirut, Paris, San Bernardino—which were quickly followed by additional atrocities in Istanbul, Kabul, Dikwa, Nigeria, and elsewhere, each committed by Islamic extremists. And just as 19th-century German historian Theodor Mommsen described the culprits at Ostia as “the ruined men of all nations” forming “a piratical state with a peculiar esprit de corps,” political leaders today typically resort to describing terrorists as insane, deranged or purely evil.

So what have psychologists had to

say about the problem? Quite a lot. But their cool-headed observations seem to have been drowned out by the all-too-familiar chorus of senators, celebrities and others waging their own rhetorical jihad against Islam. As we continue to grapple with the challenge of violent extremism, perhaps we should all take a brain check. Instead of lip-synching to the shrill braying of polemical pundits and belligerent blowhards, maybe we should tune in to the quieter, more discerning notes emanating from some of our laboratories.

Or rather maybe our policy makers should.





SHINING

The Threat

Seven enlightening studies from social psychology hold vital lessons for policy makers—and the rest of us

Granted, science and politics have often made uncomfortable bedfellows. History attests to a regrettable roll call of impromptu trysts between the two spawning inhumane ideologies. Consider the brutal abduction of mainstream evolutionary theory by genocidal Aryan supremacists and its grotesque rebranding—through the medium of social Darwinism—as Nazi doctrine. In the face of a rising tide of violent extremism, though, it would seem remiss if we scientists simply sat back and did nothing.

So in this article, we step up to the challenge of placing social psychology center

stage in the war on terror. We will not pretend it was easy: over the years the field has generated a considerable body of empirically laundered wisdom. But after lively discussions with an international group of experts, we have homed in on seven exemplary studies across an eclectic array of research areas—from social cognition to conflict resolution. We believe each has direct implications not just for policy decisions but for all of us as individuals in a fast-changing world.

1 Are You with Me?

STUDY: The “False Consensus” Effect: An Egocentric Bias in Social Perception and Attribution Processes. Lee Ross, David Greene and Pamela House (1977)

RESEARCH AREA: Social cognition

OVERVIEW: “Always remember that you are absolutely unique,” quipped cultural anthropologist Margaret Mead. “Just like everyone else.” She was spot on. Don’t we all assume that we’re “normal”? This classic study examined how susceptible we are to the delusion that our choices, judgments, feelings and beliefs reflect what others think as well.

METHODOLOGY: The investigators presented college students with real and hypothetical tasks (would they, for example, be prepared to wear a sandwich board around campus as part of a study on attitude change?) and asked them to indicate their responses. They also asked them to estimate the percentage of other students who they thought would respond in the same way.

FINDINGS: The participants were consistently of the opinion that their own personal judgments broadly represented their fellow students’ views. This now well-established effect has become



known as the false consensus bias.

IMPLICATIONS: This experiment provided incontrovertible evidence that when it comes to “being ourselves,” we humans like to have our cake and eat it, too. We revel in the idea of being our own person, but our brain is hardwired for group living. So natural selection came up with a nifty little app that affords us the illusion of being just like everyone else. It tells us that our behavioral choices are rational and appropriate while offering us the sociocognitive autonomy we crave. Most of the time, it

works just fine: Ever wonder why politicians often display such bizarre, unfounded optimism in the run-up to elections? But occasionally, when a little militant conviction metastasizes into a malignant ideological tumor, the illusion of consensus can prove deadly. It is especially dangerous within groups; in the absence of any challenge from other points of view, the tumor can quickly turn aggressive.

Politicians and the public must be willing to question their assumptions—about terrorism, about immigration, about religion—lest they fall into a trap of false consensus.

We need strategies to reduce “us-them” distinctions—focusing on individuals or the “super us” of all humans.

FAST FACTS

TURNING TO THE EVIDENCE

- 1 Social psychology has generated a wealth of empirically tested wisdom that can help policy makers and the public address the threat of terrorism.
- 2 By understanding our propensities, among others, to “swarm and norm” in forming beliefs or take cues from others in the face of emergencies, we can develop more effective strategies and responses.
- 3 Additional studies offer insight about how we form social identity, why people resort to terror and how we might diffuse longstanding historical grievances.

2 See Something, Say Something

STUDY: Group Inhibition of Bystander Intervention in Emergencies. Bibb Latané and John M. Darley (1968)

RESEARCH AREA: Group decision making

OVERVIEW: Why do people sometimes do nothing in the face of danger? This hall-of-famer study from the annals of social psychology investigates the powerful and surprising effect that the presence of others has on decision making in emergencies. To take action, an individual must first notice an event, interpret it as an emergency and take personal responsibility to intervene. The study shows how group dynamics can break the links in that chain.

METHODOLOGY: Male undergraduates assigned to complete a questionnaire find themselves in a room that begins to fill with smoke. They are alone, in groups of three, or accompanied by two others



who are in on the experiment and do not react. Will someone leave the room to report the smoke?

FINDINGS: About 75 percent of the participants left alone reported the smoke, compared with only 38 percent of those in groups of three. What about the subjects accompanied by blasé study accomplices? A mere 10 percent of these eye-rubbing, smoke-waving stoics raised the alarm.

IMPLICATIONS: This study demonstrates that we reference others for any kind of behavior that may depend on unfamiliar

Swarm and Norm

STUDY: *Knowing What to Think by Knowing Who You Are: Self-Categorization and the Nature of Norm Formation, Conformity and Group Polarization.* Dominic Abrams et al. (1990)

RESEARCH AREA: Belief formation

OVERVIEW: Sometimes we want a second opinion, but it turns out that we are selective about whom we trust to give it. This bias is so powerful that it even affects our perceptions of physical reality. The experiments in this paper showed how we mistakenly assume that people with whom we identify have a clearer window on reality than those we class as “different.”

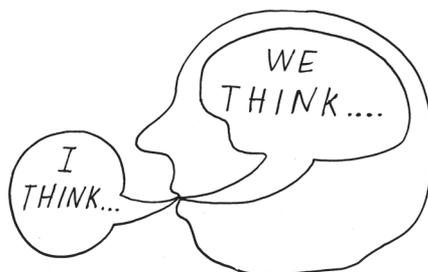
METHODOLOGY: The investigators presented a classic optical illusion, the autokinetic effect, to a group of six participants in a pitch-dark room. In this illusion, a stationary point of light appears to move around in different directions for about 15 seconds. Over a series of trials, the participants had

actions or decisions. Unfortunately, emergencies often begin as ambiguous, potentially innocuous situations. And because most of us are enthusiastic proponents of embarrassment evasion, we look to the actions of others to inform our own. If *they* don't act, we don't act.

So a key challenge for policy makers is to facilitate the cultural transmission of what psychologists refer to as interpersonal empowerment: the sense that we are all responsible for outcomes that affect other people's well-being, in addition to our own. Simple interventions include poster campaigns on public transportation showing, perhaps, a suspicious bag and the warning: “Don't leave it up to others. It's YOUR call!”

We would all benefit from regular reminders so that our lemminglike tendencies did not stand in the way of foiling a terror attack. Similarly, within an extremist group, the same inhibition may be at work, stopping members from questioning outrageous acts, which then become the norm as time goes by.

to estimate out loud the farthest distance they thought the spotlight reached from its starting point. But there was a catch. Half of the group were secret agents, briefed by the researchers to extend the judgments of a real participant by five centimeters. In addition, the experimenters subtly manipulated



the social identity of some of these secret agents so that they more or less resembled those of the genuine participants. Would group “belongingness” cause the participants to increase their estimates to match those of the infiltrators?

FINDINGS: Absolutely! The greater the obvious differences between the participants and the secret agents—how much they ap-

peared to belong to different social groups—the greater the disparity in their estimates.

IMPLICATIONS: There are two take-home messages here. The first is that we follow the examples of those we identify with and disregard everyone else. Thus, policy framing around social differences is crucial. It is all very well for moderate, middle-aged imams to denounce fanatical, young fundamentalists, but since when has youth ever identified with establishment? Second—and community and religious leaders take note—when we are not sure what to make of a given situation, we rely on those in our own social groups to decide what constitutes an appropriate response. In a healthy cultural melting pot, this is fine. But when groups start becoming isolated from conventional society, this innate propensity to “swarm and norm” can form a springboard for cliques, cults and other kinds of extremists.

Two things follow: First, our leaders must actively seek evidence and advice from experts outside their own groups. Second, they should try to find ways to stop the isolation of groups drifting toward extremist ideology.

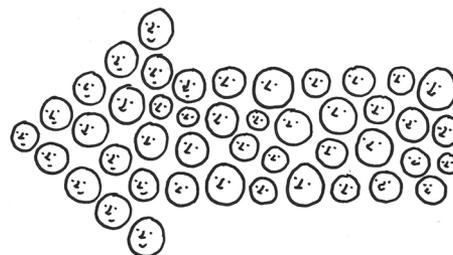
Tribal Ties

STUDY: *Social Categorization and Intergroup Behaviour.* Henri Tajfel et al. (1971)

RESEARCH AREA: Group dynamics

OVERVIEW: As mentioned earlier, we humans are hardwired to be part of a group. But just how fastidiously natural selection managed to install our tribal circuitry, and how easily its switches are flipped, was not at all apparent until this classic paper fiendishly put the Klees among the Kandinskys.

METHODOLOGY: Volunteers evaluated unfamiliar, uncredited artwork and were then divided into two groups on a completely trumped-up, arbitrary basis: half were told the paintings they preferred were by artist Paul Klee; the others heard they preferred the work of Wassily Kandinsky. In truth, the assignments were completely random. Once placed in these meaningless, zero-calorie groups and without knowing who else was in them, each participant was given an entirely unrelated task: allocate points—which translated into money—to two fellow study subjects. These compatriots remained anonymous except for the following identity tags: of the Klee group or of the Kandinsky group. Would the simple fact that the participants were members of one group as opposed to another influence their allocation of points?



FINDINGS: The participants liberally doled out points—and the prospect of financial reward—to members of their own group and steadfastly withheld points from those in the other group. Equanimity went out of the window. It was “my lot versus the other lot.” Period.

IMPLICATIONS: It is not difficult to appreciate the power of in-group bias. All you have to do is turn up at a football game or log on to Facebook. But what is not so amenable to common sense, and what this paper demonstrates so elegantly, is that such loyalty can be harvested without a lifetime’s allegiance to the Broncos, the Giants or the Eagles—or Islam, Christianity or Judaism, for that matter. Categorizing people into what are known as minimal groups—those lacking any distinguishing features apart from a name—is sufficient to awaken an immediate, perhaps ancestral desire for positive in-group distinctiveness. The mind-set of us versus them—the psychological ground zero for all discrimination and prejudice.

The challenge for policy makers is to harness this built-in motivation to be part of the “dream team” to the benefit of society. We need strategies that reduce the psychological fit of the us-them distinction. Research has given us plenty of ammunition: focus on everyone as unique individuals; focus on the super us, a category that binds everyone into a single group (humans, for example); or zoom in on the panoply of us categories that intersect the them categories (gender, age and nationality, for instance, even a passion for basketball). All these approaches can help eradicate the tendency people have to bet their entire psychological savings on that one single hand of existential poker.

Know Thyself

STUDY: Exposure to Out-Group Members Criticizing Their Own Group Facilitates Inter-group Openness. Tamar Saguy and Eran Halperin (2014)

RESEARCH AREA: Conflict resolution

OVERVIEW: Perhaps unsurprisingly, we do not like it when members of our own in-group criticize our posse’s attitudes, beliefs or behaviors. But how would we react if we were members of an out-group? This research shows that when a competitor of ours takes one of its own to task, it can significantly boost our sympathy for that group’s cause.

METHODOLOGY: The researchers presented Israeli participants with a variety of fictitious United Nations reports on the Israeli-Palestinian conflict. The summaries differed in three important ways—whether they included any criticism of Palestinian conduct toward the Israelis; whether that criticism was voiced by a Palestinian official or an “out-

Extreme Identities

STUDY: Dying and Killing for One’s Group: Identity Fusion Moderates Responses to Intergroup Versions of the Trolley Problem. William B. Swann et al. (2010)

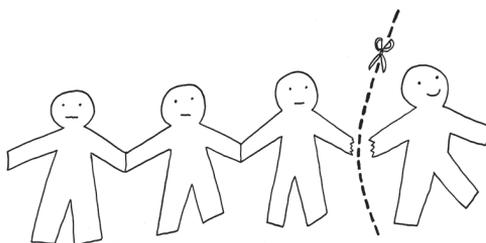
RESEARCH AREA: Social identity

OVERVIEW: Many people are highly committed to causes that “matter,” but few go so far as to give their lives for them. What distinguishes these ideological extremists? According to this paper, the boundaries between their individual and group identities have become blurred.

METHODOLOGY: The researchers compared two types of Spaniards: those whose personal identities were or were not “fused” with their national identities. The volunteers faced three versions of a self-sacrificial form of the classic trolley problem: Five Spaniards, five fellow Europeans or five Americans are about to be killed by a runaway trolley. If you jump off a bridge into the trolley’s path and die, though,

the five will be spared. In a fourth study, they were asked: Would you allow a fellow Spaniard to jump to his or her death to kill five terrorists, or would you elbow the person aside and jump yourself?

FINDINGS: The participants with fused identities were far more likely to sacrifice themselves to save their countrymen, compared with those with nonfused identities. This



“moral imperative” informed the fused participants’ decisions to preserve the lives of Europeans, too—members of an extended in-group for them—and to sacrifice themselves in place of a compatriot to eliminate

five terrorists. When it came to averting American, or out-group, fatalities, however, their moral conviction evaporated.

IMPLICATIONS: Horrifying suicide attacks are becoming increasingly common. But claims that those who commit such acts are either hole-in-one psychopaths or brainwashed dissidents miss the fundamental psychological element that leads them to mass murder. This research shed a powerful light on the matter. For some people, the usual process of identifying with a group devolves into a kind of transcendent state—one in which their individual sense of cognitive, emotional and moral agency becomes totally immersed with the prevailing imperatives of the collective. They become depersonalized to the point that they see suicide as an act of self-salvation of their fused-group self.

The central message for policy makers and other professionals is that identifying such personalities and developing intervention programs—through schools and counselors and within our organizational and institutional structures—designed to unfuse self-identities or prevent fusion in the first place could significantly reduce the risk of political or religious martyrdom.

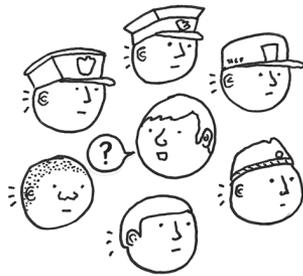
THE AUTHORS

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side” source from Europe or China; and whether the criticism was about the conflict or not. Would critiques of Palestinian policy from Palestinians themselves attenuate hard-boiled Israeli attitudes toward them?

FINDINGS: The answer was a qualified yes. Participants who read Palestinian self-criticism—regardless of whether that criticism was conflict-related or not—came to see the Palestinians as being more open-minded than those who read statements of disapproval from Chinese or European sources or those who saw no criticism at all. They became more understanding of the Palestinian perspective on the situation, more hopeful of finding a peaceful resolution and more willing to explore the possibility of compromise.

IMPLICATIONS: Within the current climate of



cultural polarization, the results of this study are as significant as they are surprising. In-group censure may well come at a price for the renegade turncoat. But as a means of opening doors—of offering a psychological olive branch to a wary out-group and of breaching the fortifications of militant, entrenched beliefs—it should not be underestimated. Islamic leaders, listen up! Your public criticism of terrorist atrocities committed by Islamist fundamentalists can positively impact Western public opinion of mainstream Islam, challenging prejudicial stereotypes. Likewise the more transparent U.S. and European authorities are when publicly debating the wisdom of their foreign policy, the more sympathy they will engender among Muslims who harbor festering suspicions about Western imperialist motives.

Paradoxical Priming

STUDY: *Paradoxical Thinking as a New Avenue of Intervention to Promote Peace.* Boaz Hameiri et al. (2014)

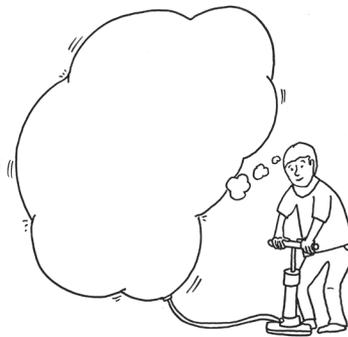
RESEARCH AREA: Persuasion and attitude change

OVERVIEW: How can we get past historical grievances between groups? This unique longitudinal field study revealed how an unorthodox intervention could help break down the inflexible socio-psychological barriers inherent to the Israeli-Palestinian conflict.

METHODOLOGY: A control group of pro-Israeli supporters watched a neutral Israeli tourism video. Another group was primed to think “paradoxically” about the Palestinian conflict: specifically, they watched videos that endorsed a perspective consistent with their own but taken to an extreme. For instance, the videos espoused ideas such as “We need the conflict to have the strongest army in the world.” Would such irrational hyperbole prompt them to reconsider their original position?

FINDINGS: This so-called paradoxical intervention, conducted in the run-up to the 2013 Israeli general elections, softened participants’ attitudes toward the Palestinian problem. It even influenced how they intended to vote, increasing the chance they would support parties interested in making peace.

IMPLICATIONS: In some circumstances, an effective antidote to extremist philosophies might be to “see” proponents’ attitudinal stances and then “raise” them. For instance, to counter extreme fundamentalism, more moderate religious leaders might debate individual extremists on the argument that “women should never be allowed to leave their homes.” These kinds of ideologically consistent but practically absurd extensions of faulty principles could help force people to reappraise their thinking.



In the Final Analysis

The insights generated from each of the studies we have described are either supported by or have, in turn, precipitated a wealth of well-tested theories and additional evidence. As such, they offer policy makers a powerful perspective on how to contend with the threat of terrorism. Of course, scientific theories are sometimes derailed. But social psychology offers some of the best tools we have for understanding human behavior. It is a remarkable indictment against the edicts of common sense that when seeking to divine the best way forward, many politicians and policy makers still put their faith in the garbled outpourings of soothsaying pollsters and op-ed oracles over scientific analysis. **M**

MORE TO EXPLORE

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WITH A LITTLE HELP FROM OUR

Researchers delving into genetics, social networks and animal behavior are discovering how friendship affects our health and well-being—and how it played a part in our evolutionary story **By Lydia Denworth**

FRIENDS

Picture two female chimpanzees hanging out under a tree. One grooms the other, systematically working long fingers through fur, picking out bugs and bits of leaves. The recipient sprawls sleepily on the ground, looking as relaxed as someone enjoying a spa day. A subsequent surreptitious measurement of her levels of oxytocin, a hormone associated with bonding and pleasure, would confirm that she is pretty happy.

And why not? Grooming appears to be a pleasurable way to spend time. Many species of apes and monkeys devote long chunks of the day to it. Among other things, grooming can curry favor and strengthen alliances, so it is likely that of these two chimps, the female being primped is of equal or greater rank in the troop than the one doing the work.

There is another level of social complexity to this scene that researchers have only recently discovered. If any old troop mate is doing the grooming, hormone levels do not change much. But if it is an individual with whom the recipient has a close bond—including but not limited to kin—oxytocin levels will rise considerably. What matters most, in other words, is whether the chimpanzees are friends.

To most of us, the pleasures of friendship are familiar. Like

Female gelada monkeys huddle in a group. Scientists have observed friendship not only in primates but also elephants, horses, hyenas, dolphins and whales.



this pair of chimps, we are more likely to relax and enjoy ourselves at dinner with people we know well than with people we have just met. Philosophers have celebrated the joys of social connection since the time of Plato, who wrote a dialogue on the subject, and there has been evidence for decades that social relationships are good for us. But it is only now that friendship is getting serious scientific respect. Researchers from disciplines as diverse as neurobiology, economics and animal behavior are recognizing parallels between the interactions of animals and the habits of people at dinner parties and are asking far more rigorous questions about the motivations behind social behavior.

The early answers, though preliminary, are spurring a reappraisal of the importance of friendship as a biological and societal force. First, there is the apparent universality of friendship. “As we think more deeply about what friendships are, we’re starting to find them in other species,” says Lauren J. N. Brent, a behavioral ecologist at the University of Exeter in England who studies sociality in rhesus macaques and killer whales. “That means there’s a story there that goes beyond humans and human society.”

There also appears to be a genetic basis to both our instincts toward sociability and our actual relationships that goes beyond family. And there is strong evidence that the absence of friendship can be toxic for our health, whereas those with tighter social bonds live longer and enjoy more reproductive success. All of which means friendship has evolutionary origins, says Robert M. Seyfarth, a psychologist at the University of Pennsylvania who studies social relationships in baboons. “It suggests a basic propensity for the need for sociality in mammals.” Friendship, then, is not a luxury; it is an infrastructural necessity.

Mapping Connections

Just what constitutes friendship? If you think we are friends, but I think we are acquaintances, which are we? The variety of possible answers is one reason friendship went unexamined for so long. Scientists gravitated to the study of individuals because it meant fewer statistical headaches and more available data. Furthermore, if one is interested in evolution, it is also true that natural selection occurs when con-

Friendship by the Numbers

Most people believe they are more popular than their colleagues—but in fact, they have fewer friends than their friends have. This mathematically proved “friendship paradox,” noted by sociologist Scott L. Feld in 1991, is just one of many findings that gives new meaning to the idea of “friends you can count on.”



ditions favor *individuals* carrying particular traits. The beak size of Charles Darwin’s finches, to take a famous example, changed bird by bird. It is harder to develop an evolutionary argument about connections between people, which are so much less tangible.

When researchers did look at bonds between pairs, or dyads in scientific terms, they studied mates or relatives such as mothers and infants. To consider relationships between individuals who are not related and do not have sex requires agreement on how to measure the properties of those bonds. The current working definition of friendship—a persistent positive relationship that involves cooperation over time—developed only recently and is based on the quality and patterning of interactions.

Most critically, friendship is sustained. You might have a pleasant interaction with someone on the subway but would not call that person your friend. But the neighbor with whom you regularly exercise and occasionally dine? That is a friend.

Although researchers cannot ask a monkey to name his or her closest friends, they can observe, in natural environments, how and with whom the animal spends time. By following individual animals closely over years and painstakingly recording every instance of vocalizing, grooming, cooperative forag-

FAST FACTS

THE PERKS OF FRIENDSHIP

- 1 Researchers mapping social networks have found that not only our friends but also their friends can influence our health and habits, such as smoking or voting behaviors.
- 2 Across species, friendship appears to reduce stress levels and increase both reproductive success and longevity, making it evolutionarily advantageous.
- 3 Genetic evidence suggests that the degree to which our friends socialize with one another and an individual’s social standing may be somewhat heritable.

Several major studies have shown that the strength of our social network powerfully predicts mortality. Maintaining strong ties may be as beneficial to our health as quitting smoking.

ing, and so on, behavioral ecologists have amassed volumes of data on social activity in certain populations.

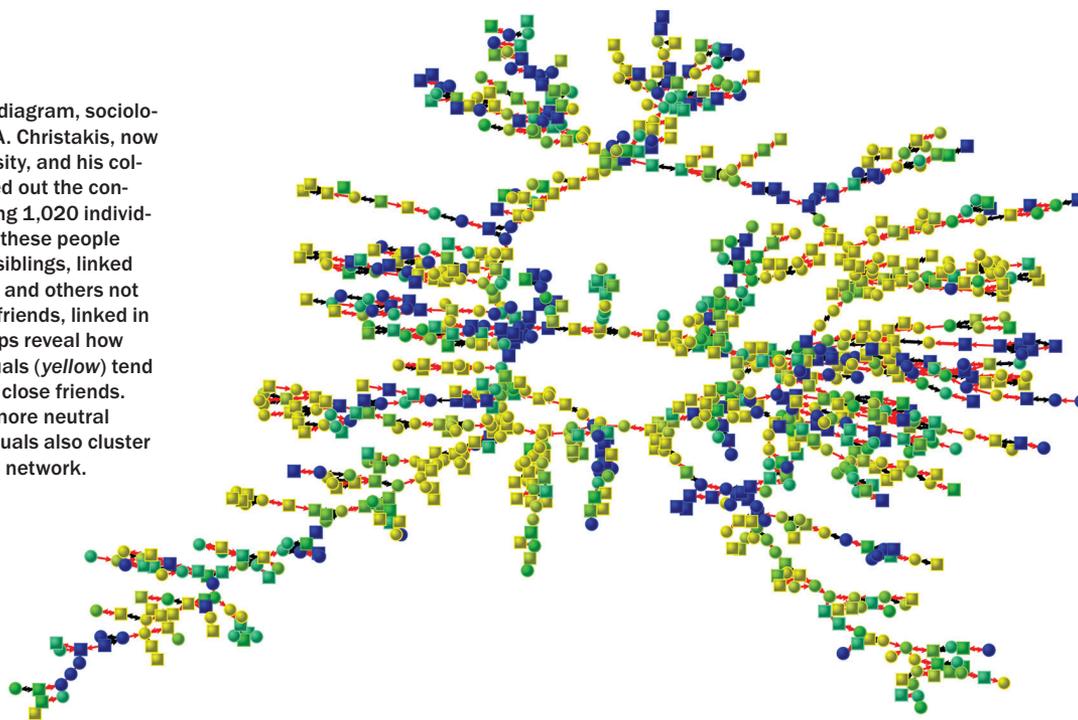
In people, researchers prod subjects to list names of friends and identify social relationships. The top two “name-generating” questions concern free time and discussing important matters: Whom do you invite to the movies? And whom do you call when you are sick, breaking up or changing jobs? There may well be more than one person on the list, and the names may change over time, but a 2014 study of phone calls made by college students over a year and a half showed that the number of close friends you have remains surprisingly constant. Based at the Aalto University School of Science in Finland, the researchers monitored 24 students as they transitioned from high school to college, a period when these young men and women met many new people. They found that specific friendships changed during this period, but at any given time most individuals still leaned on roughly the same number of core companions—and the specific number was unique to each person.

Your entire social circle is relevant to the new friendship research. In his early career as a physician, Nicholas A. Christakis, now a sociologist at Yale University, became interested in the way one person’s illness might take a toll on another, especially a spouse. That led to the realization that pairs of people connect to other pairs, as he puts it, “to form huge webs of ties stretching far into the distance.”

Christakis joined forces with James H. Fowler, a political scientist now at the University of California, San Diego (both were then at Harvard University), to study social networks of 3,000 or 30,000 or more people. Using computational techniques, they and others have established measures of connectedness that allow sophisticated mapping of these bonds. For example, they count how many friends I would name (“out-degree”) and how many friends name me (“in-degree”) separately—thereby dealing with any mismatch in our perceptions of how close we really are. Their 2009 book, *Connected: The Surprising Power of Our Social Networks and How They Shape Our Lives*, made the case that social connections of up to three degrees of separation have a significant influence on such things as weight as well as on smoking habits, altruism and voting behaviors.

The new way of thinking about friendship also blurs the long-standing distinction between friends and family by theorizing that the quality of a bond might be more significant than its origin. “The relationship with your spouse can be positive and supportive, or it can be the most toxic that you have in your life,” says John Cacioppo, a psychologist at the University of Chicago who pioneered the study of the neuroscience of loneliness. By the logic of this approach, relatives and sexual mates can be considered friends but only if the bond is rewarding. According to this view, family might often come first in part out of convenience. “Friendship is just

To create this diagram, sociologist Nicholas A. Christakis, now at Yale University, and his colleague mapped out the connections among 1,020 individuals. Some of these people were related (siblings, linked by black lines) and others not (spouses and friends, linked in red). Such maps reveal how happy individuals (yellow) tend to have happy close friends. Sad (blue) or more neutral (green) individuals also cluster within a social network.



a word for a persistent, long-term social bond,” Seyfarth says. “Kinship provides an easy start to these bonds.”

Animal Nature

Research in animals has been important in establishing the idea that a strong social bond—all by itself—may have evolutionary significance. Evolutionary theories are hard to prove. Many experiments designed to test these ideas require studying not just a single group or population but their descendants. Most animal species have shorter life spans than humans, however, making measuring generational change a simpler proposition. That can make it easier to tease out cause from correlation. In addition, findings that echo across species suggest biological rather than cultural origins.

studies of baboons—one led by Seyfarth and Cheney, the other by primatologist Jeanne Altmann of Princeton University—that those social relationships, carefully recorded over time, made a big difference in lifetime reproductive success. In 2003 Altmann and her colleague Joan Silk, together with Susan Alberts of Duke University, published a seminal paper in *Science* that was the first to explicitly link adult females’ friendships with the proportion of their infants that survive the first year of life. In 2009 and 2010 Seyfarth, Cheney, Silk and their colleagues presented similar data. They also showed that baboons with stable friendships have lower stress and that female baboons work to form new friendships when a close friend is killed by predators—an important piece of evidence in favor of the social bond’s overarching importance.



To date, horses, elephants, hyenas, monkeys, chimpanzees, whales and dolphins have all been shown to form social bonds that can last for years. Studies of our closest living relatives—monkeys and apes—have been especially groundbreaking. Seyfarth and Dorothy L. Cheney, a biologist at the University of Pennsylvania, have studied the same troop of baboons in Kenya for more than 30 years. When they began, primatologist Robert Hinde had already established that nonhuman primates had notable social relationships. One of the first things Seyfarth and Cheney did was use audio-playback experiments to show that baboons were aware of the relationships of others. When a group of female monkeys heard an offspring’s distress vocalization, they often looked at the infant’s mother. “That suggests that the social relationships were not just a figment of our human imagination,” Seyfarth says.

Eventually it became evident in two separate long-term

The striking and convergent results from the two studies surprised the researchers, who had expected dominance rank to confer the most advantage. It was not that rank was unimportant, but the critical factor was a close set of social bonds. “Primates have these long-term relationships,” Seyfarth says. “They are aware of the relationships in others, and these relationships have a direct impact on reproductive success.”

Studies of college students show that even though friends may come and go, the total number of close contacts an individual maintains largely remains constant.

The Social Genome

A related evolutionary idea about humans has also generated interest. The social brain hypothesis, put forward by evolutionary psychologist Robin Dunbar of the University of Oxford and others, argues that the need for early humans to live in ever bigger social groups led to the enlargement of the human brain. Navigating the complexities of social life after all requires social attention and the ability to take others’ perspectives, to communicate and, ultimately, to cooperate.

The idea is rooted in the earlier observation that monkeys and apes had a much larger brain relative to body size than other animals and that this was probably the result of their social

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GALLERY STOCK (left and right); CORBIS (center)



lives. Archaeological and fossil evidence to bolster the theory includes changes, though slight, in brain size between Neandertals and modern humans at the same time that social groups expanded both in size and, especially, in complexity. A corollary known as Dunbar's number holds that no matter what your Facebook page says, each of us can only maintain a wider social circle of about 150 people. It turns out many forms of social organization from military companies to average holiday card lists hover around that number.

If evolution is steering various species, including our own, toward prosocial behavior, it makes sense to seek evidence in the genome. Already genetic variation has been identified in people with disorders that affect social function, such as autism and schizophrenia. And some genes in the dopamine and serotonin pathways have been consistently linked with social traits. "Genetics started with an understanding of how genes affect the structure and function of our bodies and then our minds," Christakis says. "And now people like us are beginning to ask how genes affect the structure and function of our societies."

Over the past five years Christakis, Fowler and their collaborators have published a series of papers on both cooperation and the possible genetics of friendship. The first examined data on 1,110 twins included in the National Longitudinal Study of Adolescent to Adult Health, in which participants were periodically asked to name friends. Christakis and Fowler's team found that genetic factors account for nearly half of

the variation both in how connected an individual is to a larger friend group (based on the number of in-degree and out-degree associations linked to that person) and, more surprisingly, in the probability that a person's friends are friends with one another, a property known as transitivity. "That's a bizarre result," Christakis says. "If you have Tom, Dick and Harry in a room, whether Dick is friends with Harry depends not only on Dick's genes or on Harry's genes but on Tom's genes. How can that be? We think the reason is that people vary in their tendency to introduce their friends to one another. Some knit the networks around them together, and some people keep their friends apart."

A person's social position, in terms of how central that individual is in his or her network, was also heritable. According to Christakis and Fowler's analysis, 29 percent of the differences in a person's likelihood to have a particular social role could be explained by genetics, as opposed to environment.

In 2011 Christakis and Fowler used six available genotypes from the same database (excluding relatives this time) to test for genetic similarity among friends. They found that the old adage about "birds of a feather" was genetically based. Friends did not just have similar traits; they resembled one another.

Elephants are just one of several animals that form lasting social bonds. In baboons, for example, females work to make new relationships when a close friend dies. Across species these friendships may decrease stress and prolong life.

Some aspects of social behavior seem to be inherited, such as whether you are a central figure in your friendship network and whether you knit your network together by introducing friends to one another.

other on a genotypic level beyond what one would expect from systematic genetic differences that might occur because of shared ancestry, such as being European or Asian. They expanded on this work in a 2014 paper on friendship and natural selection and showed that a degree of correlation in genotypes made friends the equivalent of fourth cousins. And they replicated the results with a second large database, the Framingham Heart Study. “Friends may be a kind of ‘functional kin,’” they surmised.

As part of this work, in a 2012 paper in *Nature*, they even mapped the social network of the Hadza hunter-gatherers of Tanzania, who live essentially as humans did 10,000 years ago. Christakis and Fowler showed that the Hadza form networks with a mathematical structure just like humans living in modernized settings, suggesting something very fundamental about the structure of friendship.

Brent was the first to apply Christakis and Fowler’s social-network analysis to monkeys. Together with neurobiologist Michael Platt, formerly at Duke and now at the University of Pennsylvania, she works with a colony of rhesus macaques on Cayo Santiago, an island off the coast of Puerto Rico, for whom extended genetic records exist. Their 2013 study found that the most sociable monkeys, those with the largest, strongest networks, tended to be descendants of similarly social macaques. More social monkeys also had greater reproductive success, meaning their babies were more likely to survive their first year. In a 2015 paper they showed that social vigilance, the ability to observe and gather social information, had a heritability of 12 percent.

In her newest work, Brent is now exploring whether indirect connections—friends of friends—are as significant for an-

imals as they are for humans. All these studies are based on relatively small samples (dictated by the number of available animals), so they lack the power of Christakis and Fowler’s work, which used extremely large databases. “It remains to be seen how pervasive this is,” Seyfarth says, but he calls the results striking. “This is an exciting time for people interested in trying to map [social behavior] onto genetics.”

Friends for Life

If friendship is so important, the next aim is to understand why by teasing out what exactly social bonds do for us. Our pair of grooming chimpanzees were very much like real duos studied by primatologists Catherine Crockford and Roman Wittig, both at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. In their work, Crockford and Wittig found that the closeness of a pair’s bond would determine the amount of oxytocin circulating in a primate’s blood. The finding might represent an important first step, Seyfarth says: “This is starting to say that there’s something about interacting with individuals that you perceive as close friends that’s physiologically very rewarding.”

There are also clues in human physiological responses to social interaction. Several large longitudinal studies have shown that the strength of our social network can predict mortality to such a degree that strong ties may be as beneficial to our health as quitting smoking and more impactful than well-known risk factors such as obesity and physical inactivity. Studies of loneliness make it clear that a weak social network can be detrimental to well-being [see box on opposite page].

If the new science of friendship can paint a clearer picture



For rhesus macaques on Puerto Rico’s Cayo Santiago, social success boosts reproductive success. Behavioral ecologist Lauren J. N. Brent has found that babies are more likely to survive if their parents have a lot of “friends.” At the left, a female grooms a group mate. At the right, sisters rest while their teenage daughters (in the middle) attend to each other.

COURTESY OF LAUREN J. N. BRENT, University of Exeter

The Perils of Loneliness

Another way to look at the question of how friendship affects us is to study its flip side: loneliness. University of Chicago psychologist John Cacioppo has been at the forefront of that field and has shown that a perceived lack of social connection leads to increased mortality, depression, aggressiveness and stress responses, as well as social withdrawal, poorer sleep and elevated blood pressure. The standard sociological explanation is “social support,” meaning that strong social ties encourage better health behaviors and blunt the negative effects of stress.

For Cacioppo, however, that was not a good enough answer. He is looking deeper—in the brain. “The brain is the organ for forming, evaluating, monitoring, maintaining, repairing and replacing salutary connections, as well as regulating the physiological responses that contribute to healthy lives or morbidity and mortality,” he says.

Cacioppo’s theory is that perceived isolation—whether feeling alone in a crowd or experiencing unwanted solitude—makes us feel unsafe. “When you perceive that you’re on the social perimeter, it doesn’t just make you feel sad,” he says. “It’s also a threat to your survival. [Your] brain goes into self-preservation mode.” In that state, he says, like an animal on the edge of the herd, you become more worried about yourself than others around you, and you are hypervigilant to possible social threats. What suffers? Social skills. “The essence of social skills is you’re taking the perspective of and [being] empathetic with others,” Cacioppo says.

In the laboratory, he and his colleagues have induced loneliness in human study participants. Using hypnosis and prepared scripts, the researchers led the participants through moments in their life when they had experienced both profound social connectedness and loneliness to alter their emotional states. They then administered psychological tests and found that even gregarious types showed poorer social skills once they were made to feel iso-



lated. In one experiment, subjects tackled the task of identifying the color in which a string of letters (forming a word) was presented. Lonely subjects were slower to name the color associated with social words, such as “compete,” and even slower if the social word had negative emotional associations, such as “reject.” “The delay indicated an interference effect,” Cacioppo wrote in 2009. “Even when the task had nothing to do with sociality, and with no awareness of any intention to do so, the lonely participants were scanning for, and being distracted by, negative social information.” When you most need social connection, it would seem, you are the least able to achieve it.

This “loneliness loop,” Cacioppo posits, then activates neurobiological and behavioral mechanisms that contribute to poor health outcomes. Using functional MRI, he has found that the brains of lonely individuals show greater activation to negative social cues than negative nonsocial cues. This pattern did not hold true in more social participants. The fact that isolation can have such measurable effects on brain activity underscores the importance of friendship in human lives. —L.D.

of how and why we make friends, researchers hope to use that information in a variety of ways. In an ambitious randomized trial involving 30,000 people in 160 villages in Honduras, Christakis and Fowler are exploring whether targeting influential individuals, identified through social-network analysis, can be used to change health habits and reduce childhood mortality. On Cayo Santiago, Platt and Brent hope to be able to establish normal variation in social behavior among macaques as a way of then studying behavior that falls outside that range. “One of the first things that seems to fall apart in autism is attention to others,” Platt says.

But of course, the most straightforward result of this work would be to spark a deeper appreciation of just how important our friends are in our life. “Other individuals are in fact the source of some of our greatest joys,” Cacioppo says. And now we know that they do not just make us happy—they help keep us alive. **M**

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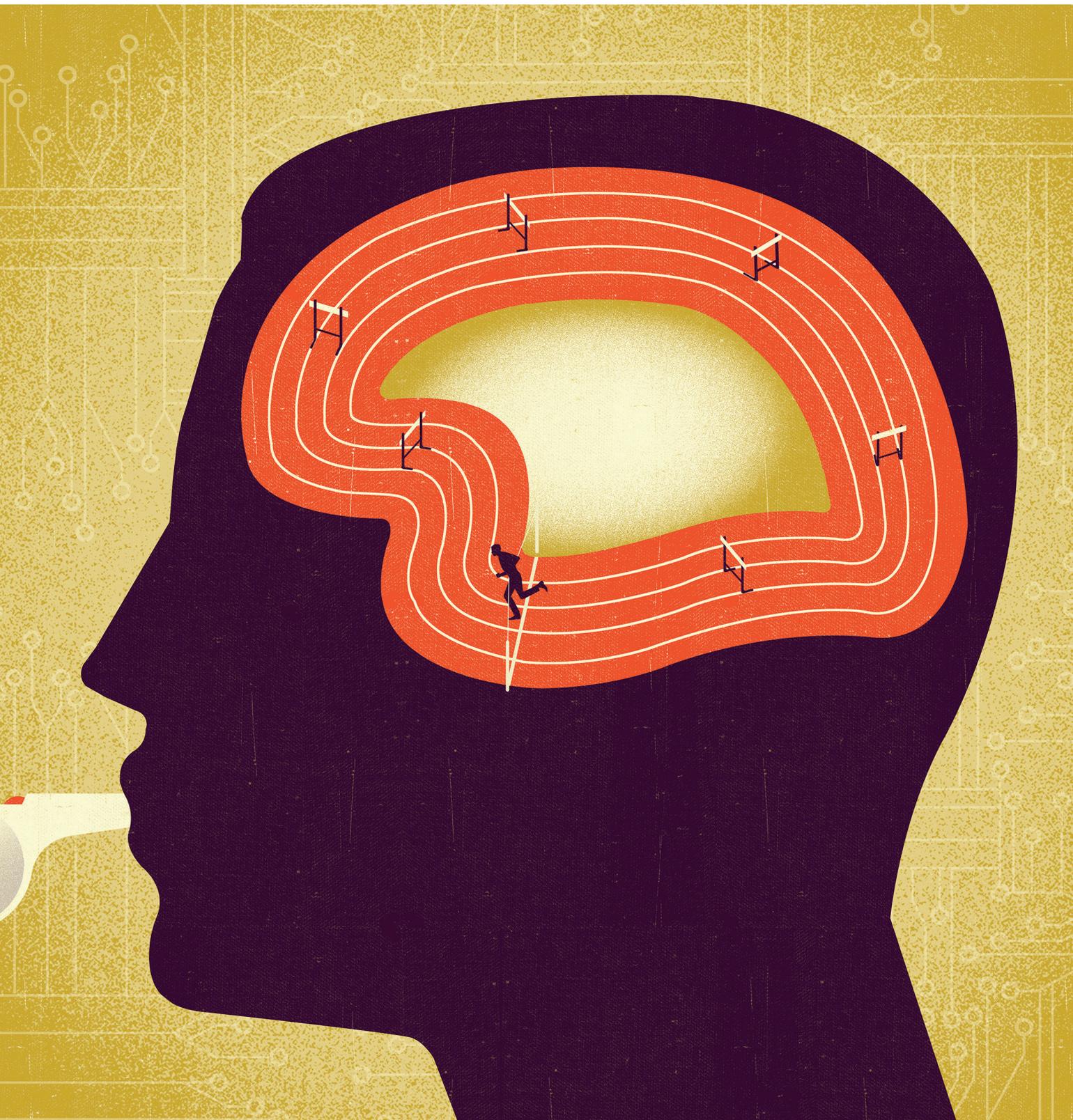
The **For-Real** Science of Brain Training

Despite skepticism, research shows how cognitive exercises benefit cancer survivors, children with attention deficits, people with schizophrenia, and others

By *Dan Hurley*

ILLUSTRATIONS BY NEIL WEBB







Have you heard the news? Brain training is a scam: overhyped and understudied— a waste of time worse than Angry Birds.

That, at least, is the gist of news reports that ran this past January, when the country's best-known brain-training company, Lumosity, was fined \$2 million by the Federal Trade Commission for making exaggerated claims in its advertisements. The FTC action came 15 months after the release of a statement from more than 70 neuroscientists who said they objected to unsubstantiated claims from the burgeoning brain-game industry.

"Despite widespread claims, there is little evidence that brain-training games provide easy boosts to cognitive function," concluded an article by Simon Makin published in these pages just last summer. "Making brain training look effective is easy because performance on the games inevitably gets better with practice."

But is that all there is to it? Does training on cognitive games result only in improvements on those games, as critics allege, with little evidence of meaningful real-world benefit? No young science is without controversy, and a number of studies by reputable scientists have indeed failed to find substantive cognitive benefits from such training. Yet shortly after the release of the "consensus" statement against brain training in 2014, more than 120 other scientists signed a response that cited 132 published studies showing that brain training does work.

No one is claiming that brain games will transform an av-

erage Joe into a Shakespeare or an Einstein. But there is plenty of evidence that computer-based cognitive training offers real benefits for certain populations. Most notably it can cut an older person's risk of having a car accident in half, mitigate the loss of basic cognitive abilities in people with schizophrenia, and improve the working memory of children who have attention deficits or are recovering from cancer. Quietly and persistently, outside the spotlight of news coverage, mainstream scientists at leading medical institutions around the world are building an ever stronger case for cognitive training targeted to such groups. Supported by the National Institutes of Health, the U.S. Naval Research Laboratory and other prominent funding organizations, they have published hundreds of randomized, placebo-controlled clinical trials in peer-reviewed medical journals.

These researchers worry that unjustified claims akin to those that drew the FTC's ire will tarnish the field and cause their own findings to be thrown out with the bathwater. "As an advocate and researcher for children who have, at this point, no other viable options, it's frustrating for me to hear the attacks on cognitive training," says psychologist Kristina K. Hardy, who works with childhood cancer survivors at Children's National Health System in Washington, D.C. (and who reports no financial connection with any brain-training company). "The science is promising. There's every reason to be optimistic about this approach."

Aging, Interventions and Independence

We should first get one thing straight: there is no evidence that cognitive training can prevent or slow the progression of Alzheimer's disease. Even for the condition known as mild cognitive impairment, often a precursor to Alzheimer's, the evidence is murky. But maintaining and improving the cognitive abilities of healthy older adults enough to have lasting, real-world benefits? Now we are on terra firma.

It should be noted that physical exercise—in particular, resistance training—has plenty of evidence showing it builds the brain as well as the body in older adults. And when you combine exercise with a healthy diet, ample social interaction and the use of brain games, as Finnish researchers did in a randomized controlled study published last year in the *Lancet*, you get especially good results on cognitive function. But let's zoom in on the easiest intervention: computerized cognitive exercises that anyone can do and that may require as little as 10 total hours of practice.

Perhaps the most startling study in older adults, published in 2014, involved 2,832 volunteers in six cities across the U.S., whose average age was 73 when the research began. A team at Johns Hopkins University randomized the volunteers into one of three different types of cognitive training or into a no-contact control group. The training groups targeted memory, speed of processing or reasoning; each group tackled a series of tasks that essentially taxed those skills

FAST FACTS

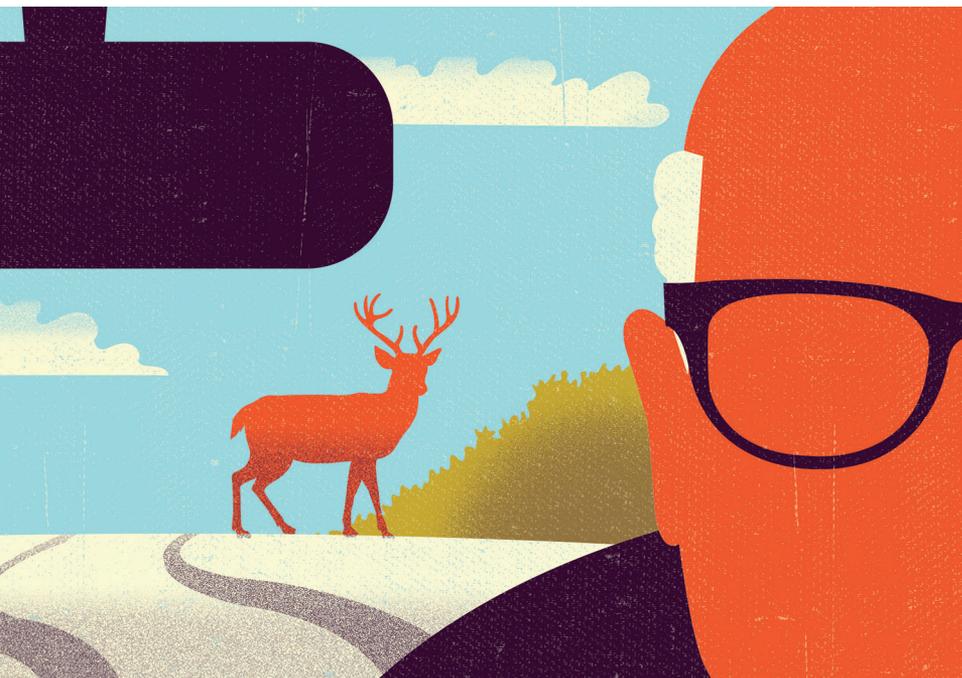
BRAIN BOOSTERS

- 1 Companies offering brain training have recently come under intense scrutiny as scientists debate the degree to which the lessons learned benefit users.
- 2 But certain exercises allow people to practice and strengthen specific skills in ways that can improve day-to-day life. For instance, "useful field of view" training may help older drivers maintain the speed of processing needed to stay alert on the road.
- 3 Other tasks may help populations overcome handicaps that they face, as when working-memory training enhances cognition in childhood cancer survivors.

with progressively tougher challenges. Participants completed 10 one-hour sessions, followed in some cases by four booster sessions.

The people who did memory training saw no benefit. (Go figure.) But those who had undergone training for reasoning or speed of processing did gain from the experience. A full 10 years later people in this group continued to outperform the

2010 a study by Ball and her colleagues involving 908 older drivers found that 10 hours of training could cut the participants' rate of motor vehicle crashes in half for up to six years later. The training has also been shown to help drivers respond four tenths of a second faster in response to an unexpected obstacle. "I refer to that as the difference between seeing a deer cross ahead of you on the highway and seeing it crash through



THE MOST EFFECTIVE TRAINING IN A STUDY OF OLDER ADULTS WAS ONE THAT DEVELOPED THEIR “USEFUL FIELD OF VIEW,” A SKILL THAT MADE THEM SAFER DRIVERS.

control group on those functions. In addition, a modest but significant proportion of the participants was also less likely to report a decline in their ability to conduct activities of daily living (for example, bathing, dressing, walking and eating)—probably the most meaningful measure of quality of life and continuing independence.

The study, known as ACTIVE (Advanced Cognitive Training for Independent and Vital Elderly), found that the most effective computerized training was the one that targeted speed of processing, specifically a game challenging people's “useful field of view,” or UFOV. For a brief blip of a moment, the player sees one of two similar-looking objects in the center of a computer screen and, simultaneously, a third object on the far edge of the screen. The challenge is to correctly identify which of the two objects was in the center and where exactly the object on the periphery was. Easy at the beginning, it becomes harder as the images flash by ever more quickly. Most everyone, however, gets more accurate at faster speeds over a period of days and weeks.

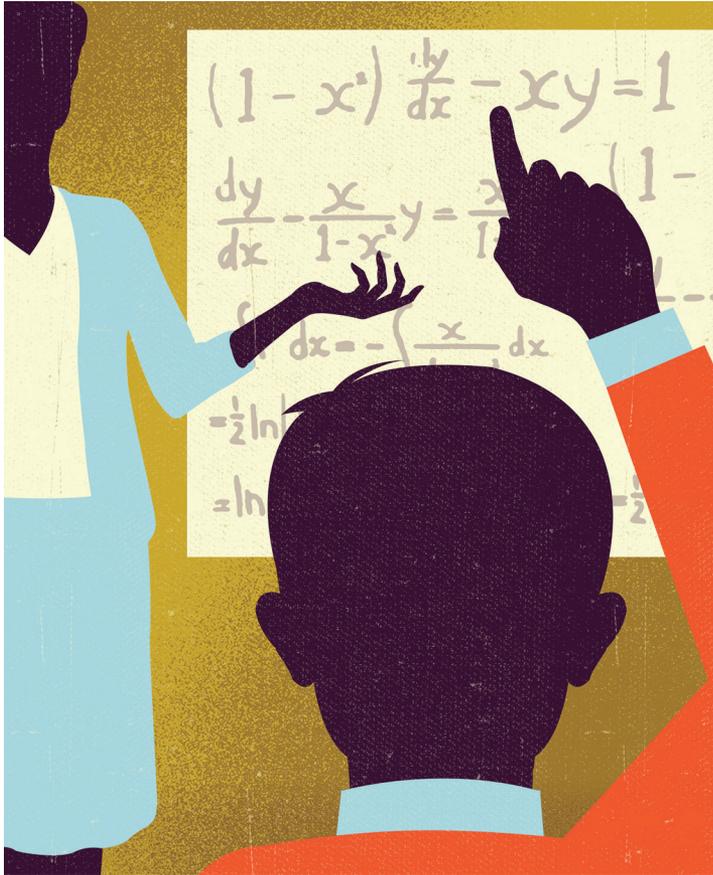
Psychologist Karlene Ball, now at the University of Alabama at Birmingham, first developed the task in the 1970s. In

your windshield,” says gerontologist Fred Wolinsky of the University of Iowa, who has collaborated on studies involving Ball's UFOV game.

The results have been impressive enough to gain the interest of the American Automobile Association and some car insurers, who are offering the training free or at a discount. “I've been working on this for the past 40 years of my life,” Ball says. “I was very surprised that, first, we could get as much improvement as we did and, second, that it lasted for so long.” Volunteers who participated in the same 10 hours of UFOV training, she found in a separate study, were also 30 percent less likely to exhibit symptoms of depression five years later.

Ball licensed the game in 2008 to Posit Science, a company co-founded by neuroscientist Michael Merzenich, formerly at the University of California, San Francisco. Customers can access versions of the game at www.drivesharp.com.

But UFOV games are not the only ones shown to improve, or at least preserve, cognitive abilities in older people. Last November scientists at King's College London and their colleagues—using data from a six-month online experiment involving 2,912 adults older than 60—reported that partici-



AFTER 10.5 HOURS OF WORKING-MEMORY CHALLENGES, CHILDREN WITH ADHD SHOWED MARKED IMPROVEMENTS ON OTHER, UNTRAINED MEMORY MEASURES.

memory to recall the beginning of a paragraph even as you are reading the end or to do mental math. Working memory is essential for learning, reasoning and comprehension.

The strength of an individual's working memory was long believed to be a fixed trait until a small 2002 study by cognitive neuroscientist Torkel Klingberg of the Karolinska Institute in Sweden suggested it might be developed. He had children practice four tasks designed to stretch memory muscles, such as listening to a string of numbers or letters and then recalling them in reverse order. After a total of 10.5 hours of practicing games that put progressively tougher demands on their working memory, children diagnosed with attention-deficit/hyperactivity disorder (ADHD) showed improvements on other, untrained measures of working memory.

Since then, more than 200 studies of working-memory training have been published in the scientific literature about adults and children, healthy or diagnosed with ADHD and other conditions. Not all the studies have demonstrated benefits; a 2013 meta-analysis concluded that "current findings cast doubt on both the clinical relevance of working memory training programs and their utility as methods of enhancing cognitive functioning in typically developing children and healthy adults."

But a more recent, 2015 meta-analysis from a group of Dutch researchers found reliable evidence of gains for children and adolescents with learning disabilities. And a second 2015 meta-analysis of 12 previously published studies involving children or adults with ADHD or other working-memory impairments found "persisting training benefits for inattention in daily life."

Klingberg's working-memory games are now offered by psychologists and other trained therapists through a program called Cogmed, owned by Pearson Education, an education

pants randomized to training in reasoning or general cognitive skills showed enhanced performance on reasoning tasks that were different from the ones they had practiced. They also self-reported that they were better able to participate in essential activities of daily living. Most interestingly, there was a dose-response effect, so the more people trained, the better they did.

Working-Memory Workout

Another area of intense research is the use of computerized games for children and adults with attention deficits. The games target working memory, which is the ability to maintain and juggle multiple items in your head—the cognitive equivalent of chewing gum while walking. You need working

THE AUTHOR

DAN HURLEY is a journalist who specializes in neuroscience, psychology and the social sciences. His latest book, *Smarter: The New Science of Building Brain Power*, was published by Penguin Group/Hudson Street Press in 2013.

time. That's one of the reasons we are so excited about Cogmed. It specifically targets a neurocognitive domain that's among the first to be impacted in these children." She is now collaborating on two randomized trials aimed at preventing cognitive decline in childhood cancer survivors rather than merely trying to correct it after the fact.

Social Training and Schizophrenia

Hallucinations and delusions may be the most obvious symptoms of schizophrenia, but serious cognitive dysfunction is also commonly part of the picture, and antipsychotic medications do little to address it. Pioneering research by psychiatrist Sophia Vinogradov of U.C.S.F. has shown that com-

ever increasing levels of distracting background noise.

Vinogradov settled on such auditory challenges because people with schizophrenia are known to have basic defects in sensory processing, which are believed to underlie, at least in part, the defects in higher-level thinking skills long known to accompany the disease. Her studies have now demonstrated benefits in adults with established schizophrenia, in those with recent onset, and in adolescents and young adults at high risk for psychosis. "We definitely are seeing improvements in cognition, specifically with auditory training, where we see large gains in verbal cognitive operations," says psychologist Melissa Fisher, who collaborates with Vinogradov at U.C.S.F. and has served as a consultant to Posit Science. "I don't think

PEOPLE WITH SCHIZOPHRENIA HAVE IMPAIRED SOCIAL COGNITION, INCLUDING SLOW PROCESSING OF FACIAL EXPRESSIONS. BRAIN TRAINING APPEARS TO HELP.



puterized cognitive training can make a major difference.

Partnering with Posit Science, Vinogradov and her colleagues have published more than two dozen randomized studies finding significant improvements in verbal memory, learning and daily functioning after training. Most of the studies have employed auditory training that might seem, at first glance, more fitting for people with hearing loss than for people with schizophrenia. "Sound sweeps," for instance, present a series of tones either rising or falling, like the sound of a siren approaching or receding. Laughably easy at a slow speed, they quickly become seemingly impossible to distinguish when played at, say, 12 milliseconds. Nonsense syllables are likewise presented at progressively faster speeds, with

we have a definitive answer yet as to how much it is helping. But it's definitely promising."

Equally promising and perhaps even more surprising are the benefits seen in early studies of computerized *social* training for people with schizophrenia, who often struggle with interpersonal relationships. A 2013 paper by Vinogradov and Fisher found that combining auditory training with computerized social training significantly improved scores on tests of social perception.

In 2014 they collaborated with psychologist Mor Nahum, director of research and development at Posit Science, on a pilot study involving SocialVille, a program designed to strengthen social cognition. "One exercise shows a person

with facial expressions, and then you have to match it to the same expression afterward,” Nahum explains. “A healthy adult might need to see this face for only 15 milliseconds to be able to correctly identify it afterward, whereas a [person with schizophrenia] needs much longer—orders of magnitude longer. The differences are striking. So they train to get better.” After 24 hours of online game play from home or a clinic, people with schizophrenia significantly improved their performance on SocialVille and on standardized psychological measures of social cognition, social functioning and motivation.

Now Nahum is working with Vinogradov, Fisher, and others on a four-site, randomized trial of SocialVille with 128 patients aimed at gaining FDA approval as a treatment for the social deficits associated with schizophrenia—a development that, if successful, would be a milestone in the field of computerized cognitive training. “Our goal is to move this out of the lab and into the community,” Fisher says.

To Incrementality and Beyond

Researchers such as Fisher insist that the cloud hanging over the field of cognitive training in the wake of the action against Lumosity has a silver lining. “In the short term,” she says, “there has been concern that all cognitive training will be seen as fraudulent. But eventually I think it will be good for our field. Lumosity really did not have the research backing up their programs. But our group and many others do have strong evidence.”

Scientists are also assessing several additional populations who could benefit from these training exercises. The SocialVille program, for instance, is now being studied as a means of strengthening the interpersonal skills of people with autism. A handful of studies have shown that computerized training can better the mental functioning of people with Parkinson’s disease. A small-scale study involving 21 children with Down syndrome found that Cogmed boosted their short-term memory. Another study published last November concluded it could enhance working memory in children with epilepsy. And a third, published this past February, indicated that such training has a long-term benefit in preschoolers who had been very low birth-weight babies. All these results need to be confirmed by additional and larger studies.

Should positive results continue to accumulate, the next step is to find a way to make computerized cognitive training affordable for those who could benefit from it. “Most people can’t afford to pay \$1,500 to \$2,000 out of pocket for this intervention,” Hardy says. “It already has as much evidence behind it as some of the drug-based interventions that are covered by insurance. There isn’t an FDA approval for stimulant medications given to survivors of childhood cancers. Yet that certainly is covered by most insurance plans for these kids, and it is prescribed all the time.”

And what about the great white whale of cognitive training: increasing intelligence in people with average or even above-average intelligence? Some academics who specialize in the study of IQ insist that improving it is a mission impossible. But that has not deterred the U.S. Office of the Director of National Intelligence from funding research into making intelligence analysts (read: spies) more, well, intelligent. Under the direction of the Intelligence Advanced Research Projects Activity, a program with the apt acronym “SHARP” (Strengthening *H*uman Adaptive Reasoning and Problem-Solving) is now in its third year of sponsoring studies of computerized training and other methods, including physical exercise, mindfulness meditation and mild electrical stimulation of the brain.

Results from the SHARP program will likely be published in scientific journals later this year. “I don’t want to steal the thunder of the research teams, and it’s important to say that not everything worked,” says neuroscientist Alexis Jeannotte, the program’s manager, “but I will say that they have seen some small but significant gains in IQ. We really feel there’s strong evidence for what they’re seeing. They have tested interventions in literally hundreds of subjects in multiple sites.”

Jeannotte’s phrase “small but significant” is key. There are no shortcuts in the realm of human intelligence, no “limitless” brain boosters. We should be skeptical of anyone who promises them—particularly if they stand to make a profit. But there is good evidence to convince any skeptic that incremental and compounding improvement in cognitive function is achievable.

After all, our brain is clearly receptive to persistence and practice in education (just as negative events such as trauma or abuse hurt our cognitive abilities). Malleability is the defining attribute of the astonishing human brain. New studies of cognitive exercises and brain games—especially in vulnerable populations—underscore that. And that means, as Samuel Clemens might have put it, the reports of brain training’s death have been greatly exaggerated. **M**

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FOR SHAME

Psychologists have long seen shaming as destructive, but new science suggests we can harness it to motivate positive change **By Diana Kwon**

When Valerie Starks, a mother from Denver, found out that her 13-year-old daughter was posing as an older teenager to post raunchy photographs to the Web, she took to social media to teach her a lesson. She berated her child in a Facebook video that spread like wildfire in May 2015—in less than a week it had more than 11 million views. Starks was not alone. In the past year numerous parents have used social media to punish their kids.

Throughout history communities have used public humiliation to discourage rule breakers from further bad behavior. And today those of us who commit moral misdeeds can be exposed on the Internet and subject to chastising from all over the world. From the Twitter storm that raged over multiple accounts of Bill Cosby's alleged sexual predations to the #droughtshaming campaign in California, social-media shaming has become a common occurrence. A digitally smeared reputation is like a permanent scarlet letter, displayed for all to see in the grand and timeless expanse of the Web.

Shaming is one of many forms of punishment, and psychologists puzzle over what kind of penalties encourage reform. Studies have shown that inducing shame might not be the best choice, as it often leads to counterproductive reactions, such as avoidance and aggression, and can be destructive to one's well-being.

Recent evidence has brought about a surprising revelation, however. Under certain circumstances, shame may spur positive change, including cooperation and a desire to make amends.

Psychologists are finding that there are many shades of shame—some better than others in promoting constructive behavior—and that the way we communicate disapproval to a wrongdoer can lead to drastically different outcomes. This new research could transform the way we handle crime and punishment, whether in the courtroom or at home.

The Blame Game

Shame and its close relative, guilt, are both negative feelings associated with wrongdoing. Guilt is linked to a specific action or behavior, whereas shame is focused on the self. Given this distinction, it should be no surprise that shame has long been associated with negative outcomes. After all, concluding you are a bad person is more disturbing than just acknowledging that you have done something wrong. Public shaming shakes not only one's self-respect but also the respect of others.

Decades of research have confirmed that shame hurts. The emotion is associated with a wide range of psychological problems, such as depression and post-traumatic stress disorder, as well as physiological changes, including an increase in harmful cytokines, proteins that promote inflammation, and cortisol, the primary stress hormone.

The message from this research seemed clear: feeling shame triggers a deluge of painful consequences that in no way ensures people will mend their ways. If anything, studies found that shame led individuals to become angry, aggressive and self-defensive. It provoked them to deny accusations, try to hide or even lash back against an accuser. Consequently, many

psychologists adopted the rule of thumb that “guilt is good, shame is bad.”

Yet psychologists and criminologists have also uncovered instances where shame *is* effective in motivating good behavior. In 2008 a group of psychologists at Tilburg University in the Netherlands reported that when people felt shame after imagining, recalling or experiencing a failure, they acted more cooperatively in

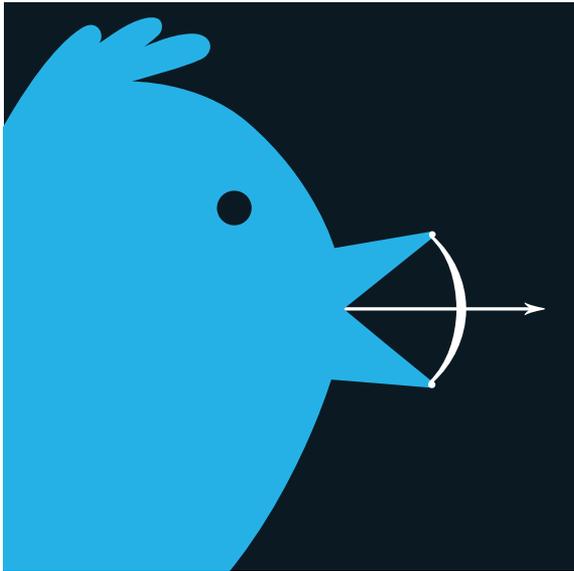
a past offense than those who blamed a scapegoat. “There may be some situations and some people for whom shame is a vehicle for making really substantial change in the self,” Tangney says. There is a well-established path from shaming to blaming to further criminal behavior, according to Tangney. But the factors leading to the opposite outcome are not yet fully understood.

tions. According to the researchers, the feelings of rejection and inferiority that come with a tarnished reputation are what lead to the negative outcomes traditionally attributed to shame.

They later confirmed this observation in a 2012 study in which they reminded 379 Norwegians of their country’s past persecution of ethnic minorities. Using a detailed questionnaire, the team found that concern for condemnation and feelings of rejection prompted self-defensive inclinations, whereas a sense of personal shame led to remorse and the desire to offer restitution. They uncovered similar effects at the level of an individual’s wrongdoing in a 2015 study that assessed how 197 participants reacted to moral failures such as mistreating a family member or failing to keep a secret.

A comparable idea emerges from the work of psychologist Rupert Brown of the University of Sussex in England and his colleagues. In a 2014 study of British people’s attitudes toward the atrocities committed by their country during the Iraq war, they proposed that people will respond differently to shame depending on whether it relates to their personal morality or simply hurts their public image.

Across three studies, the researchers recruited hundreds of people and had them read articles in British media outlets (the BBC and the *Guardian*) that gave accounts of prisoner abuse carried out by British soldiers in Iraq. Participants then rated how much they agreed with a series of statements about their attitude toward their country’s actions. Some of these declarations involved personal morality—for example, “Our treatment of Iraqi people makes me feel somewhat ashamed about what it *means* to be British.” Other statements, such as “To think how Britain is *seen* for this treatment of Iraqi people makes me feel ashamed,” related more to reputation. People who felt morally ashamed were more likely to support restoring the country’s relationship with Iraq with an official apology or financial assistance, whereas those who principally felt their image was at risk exhibited more defensive strategies, such as avoidance, anger



Public shaming on social media such as Twitter is a powerful punishment, but it risks making the wrongdoer defensive rather than repentant.

social dilemmas. A subsequent 2010 study revealed that when individuals recalled or experienced shame about an achievement-related failure, such as poor athletic performance or failing a test, they were motivated to restore a positive self-image and exert greater efforts to achieve.

In a longitudinal study of 476 inmates, published in 2014, George Mason University clinical psychologist June Tangney and her colleagues found that among inmates who felt shame, those who did not seek to pin their wrongdoing on someone else were less likely to repeat

Shades of Shame

If shame applies to the “self,” an important and long-overlooked question is just how the self is maligned when a person does something shameful. “You can either think, ‘Who am I as a person who has done this?’ or ‘What will other people think of me?’” says psychologist Nicolay Gausel of Østfold University College in Norway. In other words, you can reevaluate yourself or become preoccupied by how others see you.

In 2011 Gausel and psychologist Colin Leach of the University of Connecticut suggested that people who think in the former manner will conclude that they have failed to live up to their own expectations, which in turn can lead to efforts to improve themselves and repair social relationships. But the latter option, which is tied to others’ evaluations, might encourage self-defensive motiva-

THE AUTHOR

DIANA KWON is a former intern at *Scientific American Mind* and a freelance science writer with a master’s degree in neuroscience from McGill University.

and the desire to cover up the mistake.

These distinctions can help make sense of the way people respond to shaming on social media. After Cosby's exposure on Twitter, he denied all allegations and filed a defamation lawsuit against seven of the women who had accused him of sexual assault. Public shaming is a double-edged sword. Tweets are very effective in spreading the word and changing the public perception of the accused. But widespread defamation may also slow a perpetrator's acceptance and repentance.

The Power to Change

Shame, however, is often tied to reputation. Fortunately, a second set of findings suggests that the resulting damage to one's public image need not inexorably lead to Cosby-like defensiveness and retaliation.

In a meta-analysis of 71 shame studies published last December, Leach and Atilla Cidam, a doctoral student at the University of Connecticut, found that even when shame tarnishes a person's social image, it can prompt constructive choices, provided the individual has an opportunity to make amends.

According to Leach, because shame affects our self-evaluation, it is most damaging when there is nothing the person implicated can do to change the situation. But when we believe change is possible, it can be a strong motivator for good behavior. In fact, a 2014 study in *Emotion* revealed that feeling shame was more likely than guilt to motivate the desire to change oneself for the better. Along these lines, water authorities in areas plagued by drought notify their most wasteful citizens that their names will be publicly listed unless they mend their ways and offer support to help reduce consumption. The tactic works. Last November the *Guardian* reported that this method "often proved an effective way of changing water-use habits" for the Southern Nevada Water Authority.

Even if a specific error cannot be fixed, people can redeem their image. For example, emphasizing the fact that prisoners can change despite their past crimes may help prevent them from re-

offending. "Some people think [their moral identity] is more flexible and believe it can be improved and developed, like a skill. Some people feel that it's fixed," Leach says. His findings suggest the former group is more likely than the latter to mend its ways.

Therapists, loved ones and society as a whole can shape these attitudes. "What's nice about [reparability] is that the belief is malleable—it's a point of intervention," Tangney says. She suggests that counselors can help people "come up with a creative, reparative plan. It may not be possible to undo the harm done, but there are other ways to have a positive effect."

Similar ideas are well established among researchers who study criminal behavior. In 1989 criminologist John Braithwaite of the Australian National University introduced the idea of reintegrative shaming, in which the community helps a wrongdoer return to society after confronting his or her crime. He linked societies that use this combination of punishment and compassion to lower rates of crime than communities that use more stigmatizing forms of shaming.

Certain cultures apply reintegrative shaming by viewing a transgressor as someone in need of repair rather than an irreversibly damaged criminal. For example, the Native American Navajo people believe that *nayéé* ("monsters") act as obstacles to living fulfilled lives. They organize healing ceremonies to help rid themselves of these beasts. In Japan there is a concept of a *musubi* ("bug" or "worm") that infects people, leading them to commit atrocities. Community support can help cure this sickness.

Shame has the potential for good, but people need to believe they can

change. Leaving people who have been shamed feeling "irredeemably bad about themselves," Braithwaite says, "is what we want to avoid."

Making Good

Researchers are only beginning to understand how to induce the constructive forms of shame. Most studies to date have focused on motivation rather than action; whether the desire to become better will consistently result in better behavior remains unclear.

In the interim, there are a few basic rules of thumb that could help our society and communities reap the benefits of shame. For example, we can emphasize positive growth and avoid degradation and disrespect. "It's not rocket science what we do need to do—it's taking wrongdoing and shame seriously because we don't want to live in a society where rape and violence are not shameful," Braithwaite says. "But we want to be careful about how we communicate it."

To do that, we need to create safe spaces for those who have experienced moral failures and avoid tactics that make them pariahs. Soon after Starks shamed her daughter online, Wayman Gresham, a father in Florida, posted his own video to Facebook. The clip starts like other shaming videos, with Gresham standing over his child wielding an electric razor, about to shave his son's head as a punishment, saying, "When it's time to do the right thing, I expect for my son to not forget what he has learned."

But there is a twist. Instead of proceeding with a punishment, Gresham gives his son a hug and says, "There's no way in the world I would ever embarrass my son like that." **M**

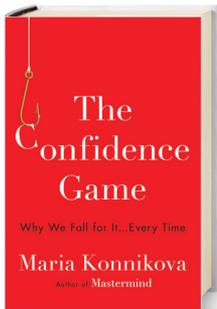
MORE TO EXPLORE

- **Crime, Shame and Reintegration.** John Braithwaite. Cambridge University Press, 1989.
- **Concern for Self-Image and Social Image in the Management of Moral Failure: Rethinking Shame.** Nicolay Gausel and Colin Wayne Leach in *European Journal of Social Psychology*, Vol. 41, No. 4, pages 468–478; June 2011.
- **So You've Been Publicly Shamed.** Jon Ronson. Riverhead Books, 2015.
From Our Archives
- **True Crimes, False Confessions.** Saul M. Kassin and Gisli H. Gudjonsson; June/July 2005.
- **When Character Crumbles.** Ingfei Chen; November/December 2010.

PRIMED FOR DECEPTION

The Confidence Game: Why We Fall for It ... Every Time

by **Maria Konnikova**. Viking, 2016 (\$28; 352 pages)



Texas rancher J. Frank Norfleet came to Dallas with one task: raise enough cash to buy 10,000 acres of his neighbor's Panhandle ranch. He was a "cash man," who didn't believe in credit. But after only a few days in the big city, he left \$90,000 in debt,

having been swindled not once but twice by a conman called Stetson.

How could such a sensible man abandon his usual frugality? Because Stetson exploited psychological principles that foster trust and cooperation, argues psychologist and best-selling author Konnikova in her new book. To forge a bond with Norfleet, Stetson pretended to lose his wallet; when Norfleet returned it, he offered him a reward. Stetson's feigned gratitude, and Norfleet's good-deed after-glow helped blind Norfleet to the very possibility of Stetson's impending fraud.

Norfleet is hardly unique. As Konnikova explains, nearly anyone can be a good mark under the right circumstances. When we are emotionally raw or flustered, we are especially vulnerable to a scam. And con artists are adept at identifying an easy target using appearance, speech or body language, such as a harried gait or distracted eye movements.

Drawing on autobiographies, news reports and original interviews, Konnikova builds a narrative rich with details of confidence games spanning hundreds of years, from snake oil salesmen in the late 1800s to present-day Bernie Madoffs. In each chapter, she focuses on one aspect of a swindle and the psychological factors at play. In "The Grifter and the Mark," for example, she examines whether all con artists are psychopaths. She reveals that although grifters share some of the same personality traits and brain morphology as psychopaths, not all con artists qualify, clinically speaking. Con artists do tend to exhibit Machiavellianism—or the ability and inclination to manipulate others—and narcissism. Of course, so do many lawyers, businesspeople and psychiatrists.

Konnikova's descriptions of the psychology involved are insightful but pale in comparison to her captivating narratives of the cons themselves. Her portrayal of the notorious Ferdinand Waldo Demara, for instance—a man who conned his own biographer into sending him money again and again—is far more entertaining than her explanation of the negative recency effect, whereby people think a coin cannot flip heads up again if it just landed that way three times in a row.

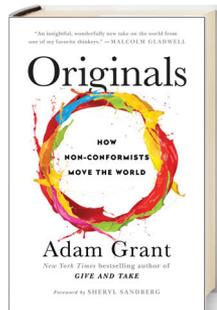
Overall, Konnikova does a great job of mapping the various parts of a con to known psychological effects, but the

book falls short in two minor respects. First, it skims over religious cons, exploring cults only in the last chapter. Also, Konnikova does not give away many con artists' tricks, which left me wanting a more inside-baseball point of view. Even if she did, though, most of us would still be an easy mark, thanks to our innate inclination to trust. The confidence man does not need to work hard to dupe us, she notes. "We're quite good at getting over that hurdle ourselves." —*Meredith Knight*

Read an interview with Konnikova at www.ScientificAmerican.com/confidence-game

THE ORDINARY IN EXTRAORDINARY

Originals: How Non-Conformists Move the World by **Adam Grant**. Viking, 2016 (\$27; 336 pages)



When economist Michael Housman wanted to understand why some customer service agents performed better than others, he considered scores of variables and found one in particular that distinguished those with happier customers and higher sales: the browser they used. Agents using Firefox and Chrome consistently outperformed agents using Internet Explorer on a number of measures—but not for reasons that had anything to do with the browsers themselves.

Housman concluded that agents on Internet Explorer, the default browser in the Windows operating system, were approaching their work as they approached their software, relying on built-in scripts and routines. In contrast, the Firefox and Chrome users, who had taken the time to download their

browsers, were also showing more initiative on the job.

Browsers aside, the fact is that most of us don't always take that extra step. "We live in an Internet Explorer world," explains University of Pennsylvania's Wharton School professor Grant in his new book. But true originals do take that step, he says. Grant draws on his own research conducted in tech companies, banks and governments to showcase what leads to success. To be original, he notes, a person cannot simply have a new idea but must also act on that vision. For many of us, going the extra mile seems out of our reach. We think Steve Jobs, Jerry Seinfeld, Jackie Robinson and their ilk are simply cut from a different cloth. But Grant argues, "Originals are actually far more ordinary than we realize."

After studying these nonconformists in depth, he discovered that "their inner experiences are not any different from our own. They feel the same fear, the same doubt, as the rest of us." Yet they take action anyway. Grant shares their wisdom, providing insights on how they nurture creativity, overcome the fear that often holds us back and distinguish good ideas from bad ones.

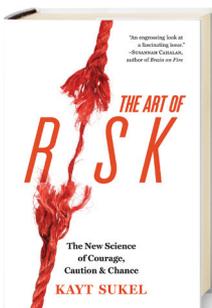
Got the jitters? Reframe fear as excitement, Grant says: "Rather than trying to suppress a strong emotion, it's easier to convert it into a different emotion—one that's equally intense, but propels us to step on the gas." Feel like you are procrastinating and wasting time? Instead of quitting or getting discouraged, use these delays—as innovators tend to do—as incubation periods to separate the half-baked ideas from the winners. Martin Luther King, Jr., may have waited until the night before the March on Washington to finalize his "I Have a Dream" speech, for example, but he spent the weeks before reviewing ideas and approaches with close advisers.

Grant tackles complex ideas at a fast, sometimes frenetic pace, which can feel overwhelming. But overall, his engaging style and sharp insights make for a compelling read. His best advice for would-be game changers? Be curious. "When we become curious about the dissatisfying defaults in our world, we begin to recognize that most of them have social origins: Rules and systems were created by people," he writes. "And that awareness gives us the courage to contemplate how we can change them." —*Lindsey Konkel*

RISKY BUSINESS

The Art of Risk: The New Science of Courage, Caution and Chance

by Kayt Sukel. National Geographic Books, 2016 (\$26; 288 pages)



Sukel used to do a lot of crazy stuff. She explored Africa and the Middle East with an infant strapped to her back when her first husband was deployed in Iraq. Then the science writer got divorced and settled in the suburbs with her son

and a mortgage. Life became predictable. After a surprise marriage proposal from her boyfriend of only a few months, though, Sukel decided to reengage with her more daring self.

To do so, she realized she needed to understand what risk really is—research that gave rise to her new book. In it, she delves into the economics and neuro-

science of risk and interviews people who make dicey decisions everyday to learn what holds people back or encourages them to take chances. Risk, Sukel discovers, is not just laying down \$100 on a roulette table or jumping out of a plane; it pervades our daily life. Any decision that could end poorly involves risk.

Indeed, Sukel explains that humans possess an internal risk calculator fueled by our intuition about the potential consequences of our choices. Research shows that this risk calculator balances input from emotional and memory centers of the brain with information from the prefrontal cortex, which regulates how we make decisions and inhibits impulsive behavior.

But our sense of risk is also deeply intertwined with our genetics. Scientists have found a few genes that seem to make for daredevils. College-aged men with one variant of the *DRD4* gene, for example, gamble more brazenly in laboratory tests. These gene variants, Sukel says, may set someone's threshold for taking chances lower or higher. Our social environment also plays an important role. Friends' behaviors can shift our ideas of what is unsafe. "If your

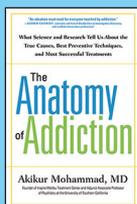
peers are engaging in a particular behavior—whether it be smoking pot, drag racing or running off to an ashram in India—you won't perceive it as overwhelmingly risky," Sukel writes. Teenagers are especially susceptible to this bias because they don't have as much life experience to fuel their intuition about potentially dangerous situations.

In fact, the most successful risk takers are effective planners. Sukel's interviews with a neurosurgeon, a base jumper and a special forces operator reveal just how key preparation is to success in perilous situations. Throughout the book, she guides us through the science of risk and the many factors that influence whether we accept or reject it. Perhaps most important, she helps to redefine risk by highlighting how integral it is to everyday human life. She suggests we can use our understanding of these gambles to maximize the positive consequences of our decisions, such as the possibility of a happy second marriage.

Sukel concludes: "It's time we accept that risk is part and parcel of every single decision we make, every single day—big or small, life-altering or seemingly inconsequential." —Meredith Knight

ROUNDUP

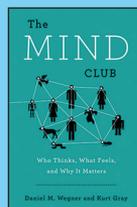
Searching for compelling reads about the brain and how it works? Here are three recent titles that might pique your interest



The Anatomy of Addiction: What Science and Research Tell Us about the True Causes, Best Preventive Techniques, and Most Successful Treatments

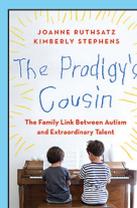
by Akikur Mohammad. Tarcher Perigee, 2016 (\$27; 272 pages)

Addiction is rampant. Millions of Americans use illegal drugs, and in 2014, 88,000 people died from excess alcohol consumption, says addiction expert Mohammad. In his new book, he reviews the developing science of addiction, how different addictive substances work and how such drugs impair brain function. He also explores the flawed tactics we currently use to treat addiction and proposes alternative strategies, such as correcting the brain's chemical imbalance and addressing the emotional urge to self-medicate, which together may prove more effective. Ultimately Mohammad emphasizes that addiction is not simply a behavioral issue; it is a chronic brain disease and must be recognized as such so we can find the best possible ways to help people.



The Mind Club: Who Thinks, What Feels, and Why It Matters
by Daniel M. Wegner and Kurt Gray. Viking, 2016 (\$29; 400 pages)

If we could only mind read, we would know how our first date or job interview really went. In reality, we understand little about what goes on in the minds of others, even those we think we know best. According to psychologists Wegner and Gray, "you can never be certain that other minds even exist." The authors explore these uncertainties, weaving together personal anecdotes and research on human behavior and perception to try to unravel the mysteries of the mind.



The Prodigy's Cousin: The Family Link between Autism and Extraordinary Talent
by Joanne Ruthsatz and Kimberly Stephens. Current, 2016 (\$28; 288 pages)

What makes a prodigy? Psychology professor Ruthsatz and journalist Stephens examine this question with great nuance. Through her own research, Ruthsatz has found that child prodigies tend to exhibit many traits associated with autism. To explain this overlap, she sets out to understand whether savants and individuals with autism share specific genes. The result offers an intriguing look at the nature of genius. —Victoria Stern



Does “pregnancy brain” exist?

—Chelsea Brennan DesAutels
Minneapolis

pregnancy—for example, high levels of estrogens and oxytocin—are associated with heightened maternal responsiveness and sensitivity to the environment and infants’ needs.

Pregnancy primes the brain for dramatic neuroplasticity, which is further stimulated by delivery, lactation and mother-child interactions. Some evolutionary biologists have argued that the development of maternal behaviors is the primary force shaping the evolution of the mammalian brain. Of interest, these alterations may become more pronounced with each successive pregnancy and persist throughout a mother’s life span. But helpful adaptations are rarely achieved without an associated cost—and pregnancy brain may reflect just such a cost.

Although our understanding is still in its nascency, it is clear that pregnancy marks the start of a critical period of neurodevelopment for women. This period prepares mothers for the myriad challenges of providing for a vulnerable infant.



Laura Glynn, a professor and chair of the department of psychology at Chapman University, explains:

Pregnancy brain typically refers to lapses in attention and memory. About 80 percent of new mothers report difficulties remembering things that once came naturally, and although not all studies support this, the weight of the evidence shows that during pregnancy, women exhibit measurable declines in important cognitive skills.

But it’s not all bad news. The maternal brain also features important enhancements. Mother rats score higher in tests of attention, foraging and planning than peers who have never given birth. These gains most likely render them better able to defend and provide for their pups.

The benefits for human moms are less clear, but data are emerging that suggest human pregnancies initiate neural restructuring. A 2010 study found that in the first few months after giving birth, human females show changes in several key brain regions. Specifically, they often exhibit increased volume in the hypothalamus, striatum and amygdala—areas essential for emotional regulation and parental motivation—as well as in regions governing decision making and protective instincts.

We can glean further evidence from behavioral changes

during pregnancy. Many women exhibit blunted physiological and psychological responses to stress, which may afford mother and fetus protection from the potentially adverse effects of taxing situations. And in the postpartum period, the hormones that sustain breast-feeding maintain these dampened stress responses.

Pregnant women are also better at recognizing fear, anger and disgust. This enhanced ability to identify and discriminate among emotions may help mothers to ensure their infants’ survival. Research from my laboratory has shown that the hormone exposures in

Can we prevent addiction using vaccines?

—Lynne Bennetch via e-mail



Ronald Crystal, chair of the department of genetic medicine at Weill Cornell Medical College, replies:

The goal of antiaddiction vaccines is to prevent addictive molecules from reaching the brain, where they produce their effects and

can create chemical dependencies. Vaccines can accomplish this task, in theory, by generating antibodies—proteins produced by the immune system—that bind to addictive particles and essentially stop them in their tracks. But challenges remain.

Among them, addictive molecules are often too small to be spotted by the human immune system. Thus, they can circulate in the body undetected. Researchers have developed two basic strategies for overcoming this problem. One invokes so-called active immunity by tethering an addictive molecule to a larger molecule, such as the proteins that encase a common cold virus. This viral shell does not make people sick but does prompt the immune system to produce high levels of antibodies against it and whatever is attached to it. In our laboratory, we have tested this method in animal models and successfully blocked chemical forms of cocaine or nicotine from reaching the brain.

Is intelligence hereditary?

—Rowena Kong via e-mail



Robert Plomin, a deputy director of the MRC Social, Genetic & Developmental Psychiatry Center at King's College London, responds:

Scientists have investigated this question for more than a century, and the answer is clear: the differences between people on intelligence tests are substantially the result of genetic differences.

But let's unpack that sentence. We are talking about average differences among people and not about individuals. Any one person's intelligence might be blown off course from its genetic potential by, for example, an illness in childhood. By genetic, we mean differences passed from one generation to

Another approach researchers are testing generates what is known as passive immunity against addictive molecules in the body. They have cultured monoclonal antibodies that can bind selectively to addictive molecules. The hurdle with this particular method is that monoclonal antibodies are expensive to produce and need to be administered frequently to be effective.

We have tried to circumvent these issues by genetically modifying the liver of mice to produce and secrete sufficient quantities of antiaddictive monoclonal antibodies, but that work is still in its early stages. If successful, though, addiction vaccines would be a valuable aid to help addicts quit.

the next via DNA. But we all share 99.5 percent of our three billion DNA base pairs, so only 15 million DNA differences separate us genetically. And we should note that intelligence tests include diverse examinations of cognitive ability and skills learned in school. Intelligence, more appropriately called general cognitive ability, reflects someone's performance across a broad range of varying tests.

Genes make a substantial difference, but they are not the whole story. They account for about half of all differences in intelligence among people, so half is *not* caused by genetic differences, which provides strong support for the importance of environmental factors. This estimate of 50 percent reflects the results of twin, adoption and DNA studies. From them, we know, for example, that later in life, children adopted away from their biological parents at birth are just as similar to their biological parents as are children reared by their biological parents. Similarly, we know that adoptive parents and their adopted children do not typically resemble one another in intelligence.

Researchers are now looking for the genes that contribute to intelligence. In the past few years we have learned that many, perhaps thousands, of genes of small effect are involved. Recent studies of hundreds of thousands of individuals have found genes that explain about 5 percent of the differences among people in intelligence. This is a good start, but it is still a long way from 50 percent.

Another particularly interesting recent finding is that the genetic influence on measured intelligence appears to increase over time, from about 20 percent in infancy to 40 percent in childhood to 60 percent in adulthood.

One possible explanation may be that children seek experiences that correlate with, and so fully develop, their genetic propensities.

The ability to predict cognitive potential from DNA could prove tremendously useful. Scientists might use DNA to try to map out the developmental pathways linking genes, intelligence, the brain and the mind. In terms of practical implications, we have known for decades about

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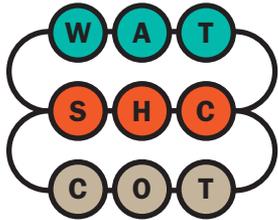
hundreds of rare single-gene and chromosomal disorders, such as Down syndrome, that result in intellectual disability. Finding additional genes that contribute to intellectual disability could help us perhaps prevent or at least ameliorate these cognitive challenges. **M**

Do you have a question about the brain you would like an expert to answer?

**Send it to
MindEditors@sciam.com**

1 LOOPY LETTERS

In the figure-eight diagram below, which two six-letter words can you make using the loop that includes the top two rows and the loop that includes the bottom two rows?



2 ADDITIONAL REQUEST

In the following message, replace each letter with a number such that the math is correct. (Of course, the same number must represent the same letter each time, and not every number is used.)

$$\begin{array}{r} \text{SEND} \\ + \text{MORE} \\ \hline \text{MONEY} \end{array}$$

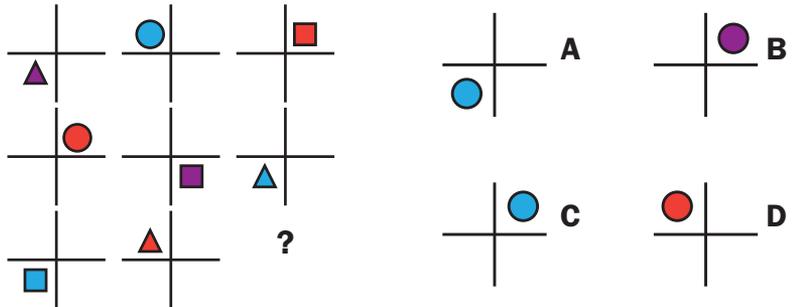
3 MAGIC SQUARE

Use the letters I, I, L, O, O, R, S, S and T to fill out the square such that every row and column spell a word.

S	T	O	P
T	?	?	?
O	?	?	?
P	?	?	?

4 SHAPE-SHIFTING

Based on the patterns of the shapes shown in the images on the left, which of the four pictures on the right should appear in place of the question mark?



5 WORD HUNT

Rearrange the 14 letters to form a four-word phrase meaning "temporary arrangement."

E E H H I M N O R R S T T T

6 ODD WORD OUT

Which of the words below is least like the others?

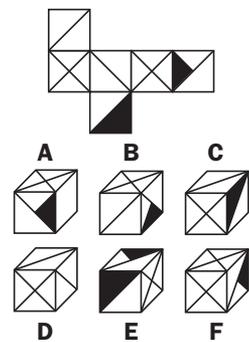
- BANK
- BEAR
- FAIR
- FIND

7 NAME THAT ANAGRAM

To the best of our knowledge, only one other word can be made using all the letters in the word "CERTIFIABLE" just once. Can you figure it out?

8 BOXING MATCH

If you put together and rotate the unfolded box below, which of the two assembled boxes can you make?



Answers

- 5. In the short term.
- 6. FIND. (All the other words have more than one meaning.)
- 7. RECTIFIABLE.
- 8. B and D.

3. S T O P
T R I O
O I L S
P O S T

4. B.

1. SWATCH and SCOTCH.

$$\begin{array}{r} 10,652 \\ + 1,085 \\ \hline 2. 9,567 \end{array}$$

HUMAN 2.0

A bionic body is closer than you think

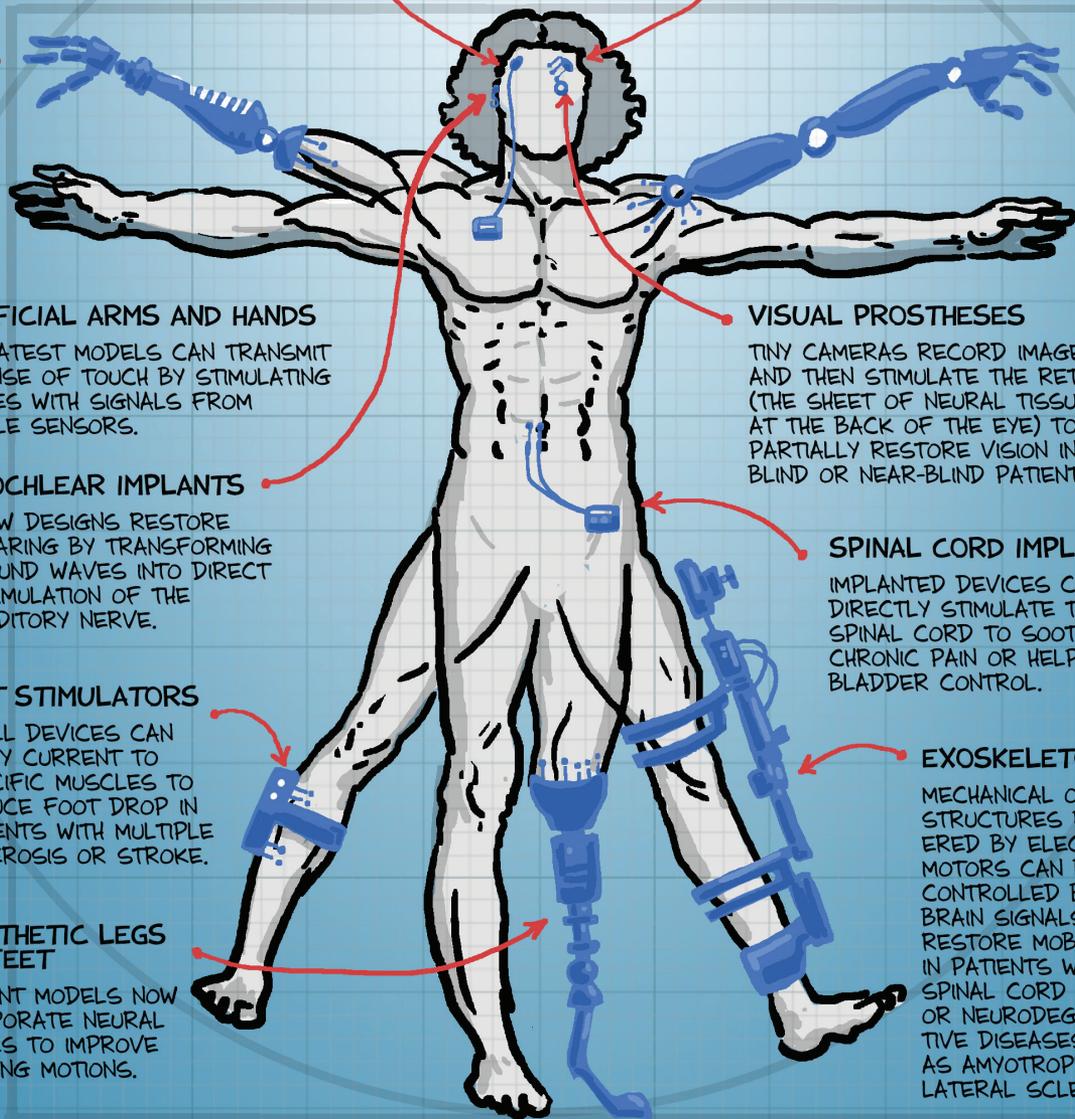
ASSISTIVE TECHNOLOGIES THAT INTERFACE WITH THE NERVOUS SYSTEM TO AUGMENT BASIC ABILITIES ARE MOVING FROM THE LAB INTO CLINICAL USE.

DEEP-BRAIN IMPLANTS

ELECTRODES DEEP WITHIN THE BRAIN CAN ADJUST CURRENT TO REGULATE ABNORMAL BRAIN ACTIVITY CAUSED BY PARKINSON'S DISEASE OR EPILEPSY.

COGNITIVE IMPLANTS

ELECTRODES ARE ALSO BEING TESTED TO STIMULATE SITES SUCH AS THE HIPPOCAMPUS TO COMPENSATE FOR LOSS OF MEMORY FROM STROKE, INJURY OR DISEASES LIKE ALZHEIMER'S.



ARTIFICIAL ARMS AND HANDS

THE LATEST MODELS CAN TRANSMIT A SENSE OF TOUCH BY STIMULATING NERVES WITH SIGNALS FROM TACTILE SENSORS.

COCHLEAR IMPLANTS

NEW DESIGNS RESTORE HEARING BY TRANSFORMING SOUND WAVES INTO DIRECT STIMULATION OF THE AUDITORY NERVE.

GAIT STIMULATORS

SMALL DEVICES CAN APPLY CURRENT TO SPECIFIC MUSCLES TO REDUCE FOOT DROP IN PATIENTS WITH MULTIPLE SCLEROSIS OR STROKE.

PROSTHETIC LEGS AND FEET

CURRENT MODELS NOW INCORPORATE NEURAL SIGNALS TO IMPROVE STEPPING MOTIONS.

VISUAL PROSTHESES

TINY CAMERAS RECORD IMAGES AND THEN STIMULATE THE RETINA (THE SHEET OF NEURAL TISSUE AT THE BACK OF THE EYE) TO PARTIALLY RESTORE VISION IN BLIND OR NEAR-BLIND PATIENTS.

SPINAL CORD IMPLANTS

IMPLANTED DEVICES CAN DIRECTLY STIMULATE THE SPINAL CORD TO SOOTHE CHRONIC PAIN OR HELP BLADDER CONTROL.

EXOSKELETONS

MECHANICAL OUTER STRUCTURES POWERED BY ELECTRIC MOTORS CAN BE CONTROLLED BY BRAIN SIGNALS TO RESTORE MOBILITY IN PATIENTS WITH SPINAL CORD INJURY OR NEURODEGENERATIVE DISEASES SUCH AS AMYOTROPHIC LATERAL SCLEROSIS.

So, are you ready for an upgrade?

BY DWAYNE GODWIN AND JORGE CHAM

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