CREATIVE AGILITY: HOW TO INSPIRE REAL INNOVATION *page 54*

SCIENTIFIC AMERICAN
MIND
BEHAVIOR • BRAIN SCIENCE • INSIGHTS

March/April 2015
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IS MIDLIFE CRISIS REAL?
THE TRUTH—AND HOW TO DEAL WITH IT
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HOW MUSIC HEALS THE BRAIN
ITS POWER TO LIFT MOOD AND BUILD CONNECTIONS

"OF COURSE, I COULD DIE"
STANDING UP TO EBOLA

CAT QUALM
PROBLEMS FROM A PARASITE?

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COVER PHOTOGRAPH BY AARON GOODMAN; ILLUSTRATION BY AMI COLLECTIVE (*music notes*); SPENCER HEYFRON (*DiChristina*); *SCIENTIFIC AMERICAN MIND* AND HENRY HOLT ARE AFFILIATES

Music, Midlife and Magic

Steven Pinker, the Harvard University psychologist, has called it "auditory cheesecake." It is noted for its powerful influence on mood. Many studies have even looked at it as another form of language. "It," of course, is music—what Albert Einstein said gave him the "most joy in life."

And indeed, as psychologist William Forde Thompson and neuroscientist Gottfried Schlaug write in this issue's cover story, "The Healing Power of Music," tunes do evince a beneficial lift in mood. But rhythm, beat and melody do much more than set our toes to tapping: they also can help patients with brain disorders, such as from Parkinson's disease, stroke, autism and dementia, to recover spoken language, hearing, motion and emotion. Therapies that incorporate songs can foster neural connections and pathways that compensate for impairments in damaged areas of the brain. Turn to page 32 to learn more about how music can be like medicine.

Sometimes medicine is not enough, as journalist Molly Knight Raskin explores in her harrowing report, "Standing Up to Ebola," starting on page 43, about the fearsome virus that has raged through West Africa, killing more than 8,000 people by early January. Truly quelling a large-scale public health crisis such as that caused by Ebola requires infrastructure that tackles the associated critical mental health issues for the populace, as well as curing the infection itself.

Treating diseases that have physical causes is one thing. But what about when we simply *think* we have a problem—and we think it lasts for a long time? Consider the widespread belief that we must run amok sometime between the ages of 40 and 60. In "Debunking Midlife Myths," psychologist Hanna Drimalla takes an evidence-based look at our seemingly wayward years, when happiness often reaches a low ebb as life changes threaten to overcome our equanimity. The good news: "midlife" is really not as bad as we think it is, and "crisis" turns out to be a bit of an exaggeration. Find out why on page 58.

Speaking of perceptions brings to mind Susana Martinez-Conde, who, with Stephen L. Macknik, writes our Illusions column each issue, sits on *Mind*'s board of advisers and has co-authored *Sleights of Mind: What the Neuroscience of Magic Reveals about Our Everyday Deceptions* (Henry Holt, 2010). In recognition of her work communicating neuroscience to the public, the Society for Neuroscience recently gave its annual Science Educator Award to Martinez-Conde. Congratulations, Susana! Go to http://bit.ly/1pwO9JZ to read more.

Mariette DiChristina
Editor in Chief
editors@SciAmMind.com

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SCIENTIFIC AMERICAN MIND

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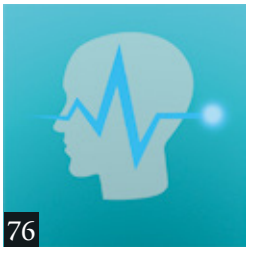

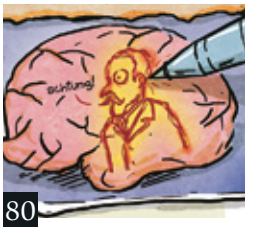

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TECHNOLOGY'S PROMISE AND PERIL

Your November/December 2014 issue is a wonderful reminder that the brain is an electromagnetic organ. I have incorporated much of what you describe in my clinical work as a doctor. Interested readers should look into a technique called a quantified electroencephalogram, which allows us to discern brain areas that are functioning either too fast or too slow and to discover poor inner communication. Such dysfunction can be corrected by brain biofeedback, in which we employ audio and visual entrainment of brain-activity patterns to correct clinical problems. We engage the peripheral nervous system with this biofeedback so it can also improve physiological functions. Some of us doing this work begin to think of ourselves as coaches or trainers who might be teaching someone how to hit a backhand by using a vocabulary that fits the action during the process; we similarly talk in different metaphors as we engage different areas of the brain.

Another benefit of understanding the electromagnetic origins of many brain disorders is the relief it brings patients. I'm reminded of a concept in narrative therapy: "You are not the problem; the problem is the problem." Many people who feel ashamed or guilty about their problems are greatly relieved to know that they have some brain frequency and coherence problems to correct, and the sense of personal worth and competence that comes with successful correction is a pleasure to all.

David Tinling
Rochester, Vt.

I have just finished enjoying *Scientific American Mind*'s 10th-anniversary issue, and the prospects for technological enhancements of the human brain look bright. But the dark side was also well represented by articles such as "Virtual Assault," by Elizabeth Svoboda, "Kid Gloves for Young Offenders?" by Scott O. Lilienfeld and Hal Arkowitz [Facts and Fictions in Mental Health], and "Turing's Test," by Dwayne Godwin and Jorge Cham [Mind in Pictures].

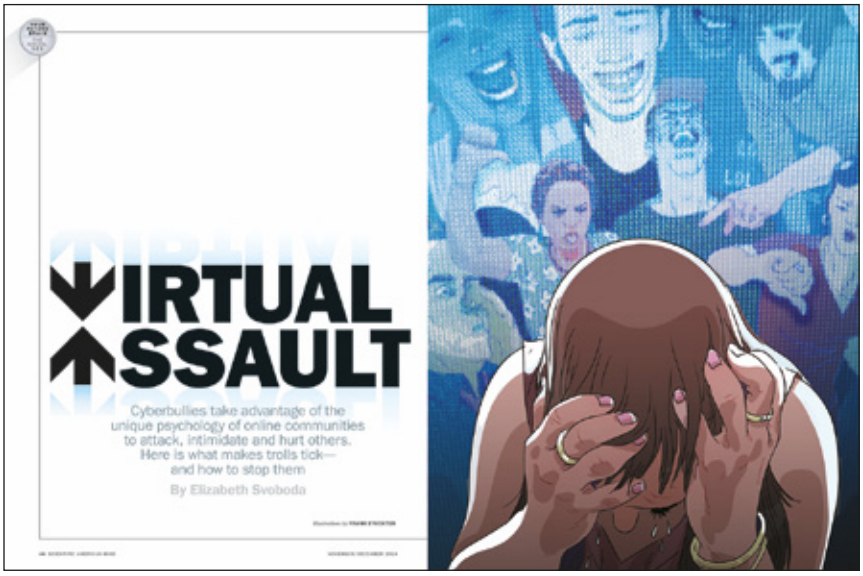
In "When Two Brains Connect," Rajesh P. N. Rao and Andrea Stocco prescribe "highly secure communications protocols" and "laws to minimize any possibility of abuse" to "minimize the risks" of the new brain-to-brain communication technology they describe. To anyone who has had to deal with a corrupt cop, all this is less than reassuring.

Hadn't we better deal scientifically with what theologians call evil before going any further in pursuit of our Wellsian science-fiction dreams?

David Matthew Mooney
Ottawa

YOUNG OFFENDERS NEED EMPATHY

I was elated after reading "Kid Gloves for Young Offenders?" by Lilienfeld and Arkowitz. Someone is finally seeing the light and understanding that treating violence by exposing the offender to more violence is counterproductive. As a middle school science teacher, I have witnessed students who have returned from programs such as boot camp or "Scared Straight" even more determined to cause trouble but now armed with the proper skills to get away with it. They have learned how to circumvent cameras and be more discreet so as not to get caught. Obviously, the programs they were in did not teach them the right skills.



What we would like for these children is that they learn to develop a sense of empathy and to see past their own needs and feelings through the eyes of their victims. One of the most important rules my parents instilled in me is to treat others the way I would want to be treated. Nobody wants to be abused or treated badly, but oftentimes individuals haven't known anything else, and that kind of treatment is what they come to expect and, in turn, dish out. I am not saying that there is no such thing as a true sociopath. My question is: How many more are we creating?

Nicole Le Floc'h
via e-mail

HELP STOP ONLINE BULLIES

It's good to read that people are doing something about cyberbullying, as Svoboda writes in "Virtual Assault." The work described is excellent, and I'm encouraged that people can do something simple—add a comment of their own telling the bullies their remarks are not welcome—to make a difference and reduce the incidence of bullying online. Thank you.

"pragmix"
Commenting online at
Mind.ScientificAmerican.com

WILL GET POKED FOR $$$

"A Brain Structure Looking for a Function," by Christof Koch [Consciousness Redux], is brilliant. It's a pity the research is stalled because implanting electrodes can only happen when medically necessary. I'd volunteer for the electrodes, for a day, in exchange for three brain PET scans of my devising. And for a price, I'd let you keep the electrodes in for a month.

Why can't people get paid to volunteer for relatively harmless procedures like this? This is not organ selling, by any means.

"DunningKrugerAffected"
Commenting online at
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PRACTICE AND TALENT MAKE PERFECT

Regarding "Practice Doesn't Always Make Perfect," by Nathan Collins [Head Lines]: The basic premise that with enough practice anyone can succeed is as false today as it was when those psychologists came up with it in 1993. No matter how much you practice, you are very, very unlikely to be able to run the 100-meter dash in less than 10 seconds. Only a handful of individuals, out of the billions of human beings who ever lived, have been able to pull it off. And probably no more than a few thousand ever even had the potential of pulling it off but were unable to do so because of their personal circumstances (historic, economic, and so on)

One has to have what it takes—the raw material—and work very hard. Either condition on its own will not get you to the top. We have been selling people on the idea that "you'll get to the top if you work hard" or "you'll get to the top if you put your mind to it" for too long. Such assertions are blatant falsehoods. Although it is true that you will do better if you work hard, your mental and physical limitations will always be there.

"SSK"
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SALIVATING FOR CUTENESS

"Why do we want to bite cute things, like adorable newborn babies?" Emma Poltrack asks in Ask the Brains. We can learn much by watching animals. I have farmed most of my life, and I believe the correct answer is really about transferring saliva so that we can recognize the cute object as part of our family.

A cow that has undergone a cesarean section or other trauma and therefore cannot lick her own new calf dry will not recognize it. Smart farmers will sprinkle some grain on the calf for the cow to lick off and transfer her saliva so that she will acknowledge it as her calf. Indeed, this technique works even in a herd with many similar-looking calves.

I once brought a new puppy home, and the old dog stood over it and drooled on the puppy, to the point that it took a full roll of paper towels to wipe up the mess. He then accepted the new puppy as his own.

That is why we have a strong urge to kiss new babies and cute things. The nibbling is simply a way to transfer our saliva, an extension of that personal smell, so that we and others will know them as our family.

Allen Wilford
Owen Sound, Ontario

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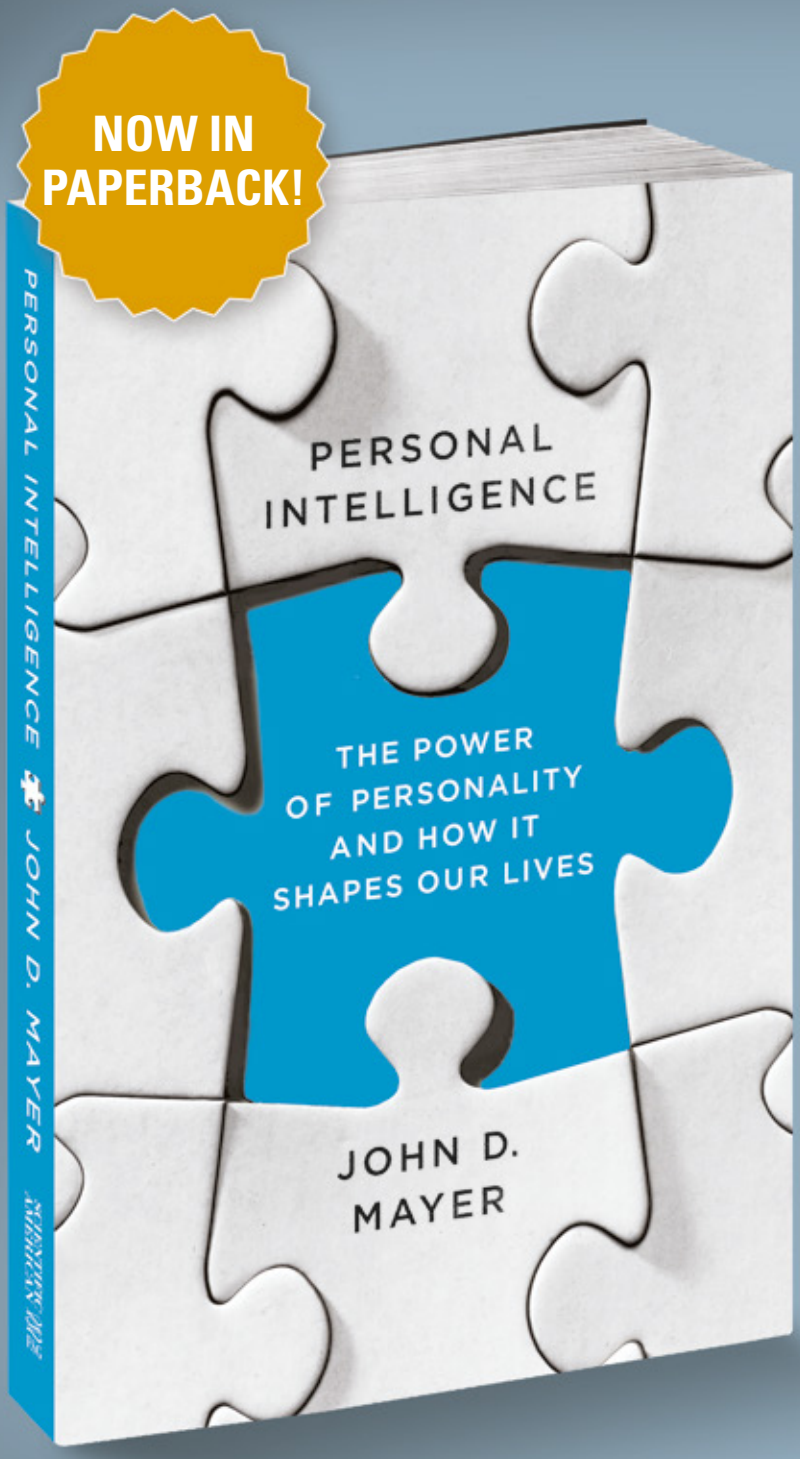

"A deep and intriguing read into how our personalities evolve from infancy to adulthood . . . Mayer's insights challenge us to broaden our understanding of what it means to be successful in our society. They underscore the importance of personality—how we learn to know ourselves and how we act on that understanding."
—MARILYN PRICE-MITCHELL, *Psychology Today*

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—PETER SALOVEY, president and Chris Argyris Professor of Psychology, Yale University

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—ELAINE FOX, director of the Oxford Centre for Emotions and Affective Neuroscience and author of *Rainy Brain, Sunny Brain*

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The Perils of Conformity

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FRIENDS AND ENEMIES: How Groupthink Drives Us Apart

Even the most fair-minded of us harbor unconscious biases, rooted in our instinct to conform to the groups we most identify with and shun those who do not. New research reveals this instinct is visible even

HARSHER PUNISHMENTS FOR THE OBESE

Groups that elicit disgust are judged more severely for "impure" acts

We like to think of our moral judgments as consistent, but they can be as capricious as moods. Research reveals that such judgments are swayed by incidental emotions and perceptions—for instance, people become more moralistic when they feel dirty or sense contamination, such as in the presence of moldy food. Now a series of studies shows that hippies, the obese and "trailer trash" suffer prejudicial treatment because they tend to elicit disgust.

Researchers asked volunteers to read short paragraphs about people committing what many consider to be impure acts, such as watching pornography, swearing or being messy. Some of the paragraphs described the individuals as being a hippie, obese or trailer trash—and the volunteers judged these fictional sinners more harshly, according to the paper in the *Journal of Experimental Psychology: General*. Questionnaires revealed that feelings of disgust toward these groups were driving the volunteers' assessments.

A series of follow-up studies solidified the link, finding that these groups also garnered greater praise for purity-related virtues, such as keeping a neat cubicle. If the transgression in question did not involve purity, such as not tipping a waiter, the difference in judgment disappeared. "The assumption people have is that we draw on values that are universal and important," says social psychologist E. J. Masicampo of Wake Forest University, who led the study, "but something like mentioning that a person is overweight can really push that judgment around. It's triggering these gut-level emotions."

The researchers also looked for real-world effects. After analyzing records of every New York City Police Department patrol stop from 2004 to 2013, they found that when suspects were stopped for purity violations (such as drugs, prostitution or lewdness), overweight people were more likely to be arrested or receive a summons. Each point increase in their body mass index increased the chances of punishment by 1 percent. Next Masicampo will test whether police make more purity arrests during flu season, with infection in mind.

Prior work shows that these unconscious biases can lose their effect once made conscious. By alerting people to their purity prejudices, the researchers hope to bring about more equal treatment of those burdened by stigma. A fine aim because, after all, what is more disgusting than bigotry? —*Matthew Hutson*

Biased Punishment

Appearances matter in a court of law. Studies find that judges and jurors are swayed by a variety of physical features when they evaluate guilt or decide on punishments.

Attractiveness
Jurors tend to judge physically unattractive people more harshly for a crime. If, however, jurors think a person used his good looks to help him commit a crime, say, swindling old ladies out of their life savings, then attractiveness can have a negative impact on juror perception.

Facial maturity
Baby-faced adults are often viewed as innocent and honest and may be judged more leniently for intentional crimes, such as fraud and theft. But when a crime centers on negligence, such as a drunk-driving accident, they may be given harsher punishment.

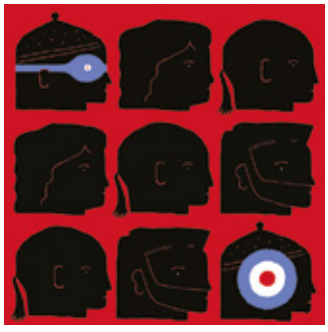
Gender
People seem to judge their own sex more harshly than the opposite sex.

Race
Many studies reveal that nonwhite defendants receive more stringent punishments. One large, notable study found that the more stereotypically black a defendant appears, the more likely a jury will sentence the defendant to death—but only when the victim is white.

—*Victoria Stern*

M Rising prison populations may be the result, in part, of shrinking psychiatric hospitals. | A whiff of oxytocin may help the highly anxious

in young toddlers, and it leads us to mete out harsher punishments and seek misplaced revenge against members of groups that disgust or anger us. Luckily, being aware of such biases can prevent us from acting on them—so read on to find out how to avoid some of the downsides of pack mentality.



Misdirected Vengeance Can Still Feel Just

Revenge is sweet when the target is perceived to be part of a group with the original perpetrator

In the Hollywood movie version of revenge, our wronged hero justifiably vanquishes the villain. In real life, though, revenge is hardly ever so clear-cut. Aggrieved persons typically do not know, or cannot access, the specific individual who did them wrong. Instead a phenomenon occurs that psychologists call "displaced revenge," where avengers target a proxy—someone akin to the original transgressor. A new study finds that displaced revenge is sweeter when the target seems to belong to the same group as the wrongdoer.

The study explored entitativity, which is a measure of how closely people are associated with one another. A random crowd at a bus stop is loosely entitative. Sports team members—allied for a common cause and wearing the same jersey—are highly entitative.

The study's authors ran three experiments that compared displaced revenge against low- and high-entitativity third parties. The first involved hypothetical scenarios; the second had subjects recall a time they had felt wronged and then speculate about how they would feel if they had a chance get revenge on various third parties. In the third experiment, real-life victims could choose to exact revenge on innocent, real third parties. Students were manipulated into believing that their partners in a puzzle-solving test had decided not to share a prize of raffle tickets for a restaurant gift card. Before taking the test, the students had watched a video in which their partner—later their nemesis—either conversed with or ignored two other students who were dressed similarly or dissimilarly to the malfeasant partner. The wronged students could choose to do nothing or pursue vengeance by forcing these other students to view unpleasant images.

Across all experiments, avengers reported higher feelings of justice-related satisfaction against more closely tied people. The study illustrates how displaced revenge can fuel, for example, ethnic gang wars, says Arne Sjöström, co-author of the study and a psychologist at the Philipp University of Marburg in Germany. The results also suggest how cycles of retribution might be broken. "One potential strategy," Sjöström says, "may consist in promoting perceptions of group variability," so that the target group looks less monolithic.

—Adam Hadhazy

CONFORMITY STARTS YOUNG

Toddlers will hide their knowledge of a solution around untrained peers

Nobody likes a show-off. So someone with a singular skill will often hide that fact to fit in with a group. A recent study reported for the first time that this behavior begins as early as two years old.

In the study, led by a team at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and published in *Psychological Science*, two-year-old children, chimpanzees and orangutans dropped a ball into a box divided into three sections, one of which consistently resulted in a reward (chocolate for the children; a peanut for the apes). After the participants figured out how to get the treat on the first try, they watched as untrained peers did the same activity but without any reward. Then the roles were flipped, and the participants took another turn while being watched by the others. More than half the time the children mimicked their novice peers and dropped the ball into the sections that did not produce chocolate. The apes, on the other hand, stuck to their prizewinning behaviors. The children did not simply forget the right answer—if no one watched them, they were far less likely to abandon the winning choice.

The results suggest that the human desire to conform is inborn or at least develops at a very young age. This urge to conform probably evolved to be stronger than that of our ape cousins because group harmony was extremely important in growing hominin communities dependent on the exchange of cultural information, according to the authors. "We all like others who are similar to us," explains psychologist and lead author Daniel Haun. Conforming boosts these feelings of sameness.

Of course, conformity is not always the best choice, nor is it always the norm—plenty of people prefer to lead, not follow. Yet in the absence of all other information about a group, "following the majority is usually a very good first choice," Haun says.

—Bret Stetka

stop feeling fearful. | Certain types of air pollution increase the risk of autism in kids whose mothers are exposed during late pregnancy.

EPIGENETICS

Descendants of Holocaust Survivors Have Altered Stress Hormones

Parents' traumatic experience may hamper their offspring's ability to bounce back from trauma

A person's experience as a child or teenager can have a profound impact on their future children's lives, new work is showing. Rachel Yehuda, a researcher in the growing field of epigenetics and the intergenerational effects of trauma, and her colleagues have long studied mass trauma survivors and their offspring. Their latest results reveal that descendants of people who survived the Holocaust have different stress hormone profiles than their peers, perhaps predisposing them to anxiety disorders.

Yehuda's team at the Icahn School of Medicine at Mount Sinai and the James J. Peters Veterans Affairs Medical Center in Bronx, N.Y., and others had previously established that survivors of the Holocaust have altered levels of circulating stress hormones compared with other Jewish adults of the same age. Survivors have lower levels of cortisol, a hormone that helps the body return to normal after trauma; those who suffered post-traumatic stress disorder (PTSD) have even lower levels.

It is not completely clear why survivors produce less cortisol, but Yehuda's team recently found that survivors also have low levels of an enzyme that breaks down cortisol. The adaptation makes sense: reducing enzyme activity keeps more free cortisol in the body, which allows the liver and kidneys to maximize stores of glucose and metabolic fuels—an optimal response to prolonged starvation and other threats. The younger the survivors were during World War II, the less of the enzyme they have as adults. This finding echoes the results of many other human epigenetic studies that show that the effects of certain experiences during childhood and adolescence are especially enduring in individuals and sometimes even across generations (*right*).

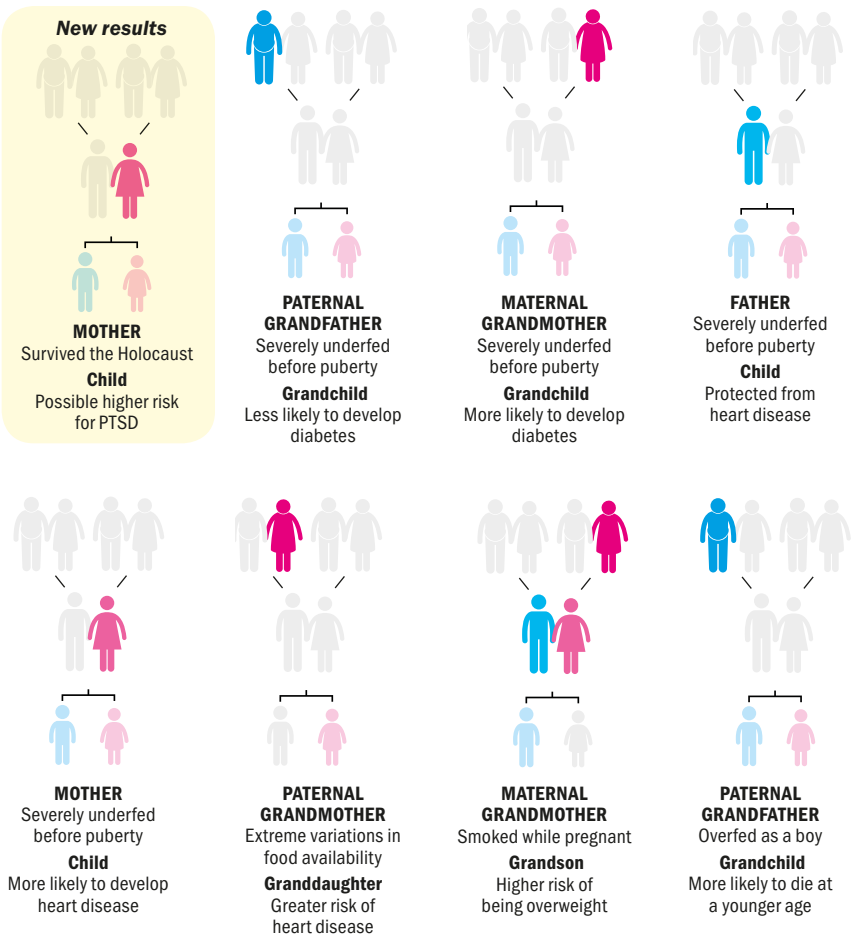
Most recently, a new study looked at the descendants of the Holocaust survivors. Like their parents, many have low levels of cortisol, particularly if their mothers had PTSD. Yet unlike their parents, they have higher than normal levels of the cortisol-busting enzyme. Yehuda and her colleagues theorize that this adaptation happened in utero. The enzyme is usually present in high levels in the placenta to protect the fetus from the mother's circulating cortisol. If pregnant survivors had low levels of the enzyme in the placenta, a greater amount of cortisol could make its way to the fetus, which would then develop high levels of the enzyme to protect itself.

Epigenetic changes often serve to biologically prepare offspring for an environment similar to that of the parents, Yehuda explains. In this case, however, the needs of the fetus seem to have trumped that goal. With low levels of cortisol *and* high levels of the enzyme that breaks it down, many descendants of Holocaust survivors would be ill adapted to survive starvation themselves. In fact, that stress hormone profile might make them more susceptible to PTSD (*below, yellow*); previous studies have indeed suggested that the offspring of Holocaust survivors are more vulnerable to the effects of stress and are more likely to experience symptoms of PTSD. These descendants may also be at risk for age-related metabolic syndromes, including obesity, hypertension and insulin resistance, particularly in an environment of plenty.

Yet it is still too early in our investigation into the epigenetics of this complex stress-response system to know for sure whether these molecular changes indicate any real-world risks or benefits. "If you are looking for it all to be logical and fall into place perfectly, it isn't going to yet," Yehuda says. "We are just at the beginning of understanding this." —*Tori Rodriguez*

Parent's Struggle, Child's Risk

A variety of studies, many using long-term medical records from large populations, have found that certain experiences affect future descendants' health risks. —*Victoria Stern*



ISTOCKPHOTO

M Many people hope casual sexual encounters will lead to more serious relationships, despite insisting otherwise to their partners.

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The Distractible Aging Mind

Practice may improve older brains' ability to filter out unwanted information

As we age, we seem to get worse at ignoring irrelevant stimuli. It's what makes restaurant conversations challenging—having to converse while also shutting out surrounding chatter. New research bears out the aging brain's distractibility but also suggests that training may help us tune out interference.

Scientists at Brown University recruited seniors and twentysomethings for a visual experiment. Presented with a sequence of letters and numbers, participants were asked to report back only the numbers—all the while disregarding a series of meaningless dots. Sometimes the dots moved randomly, but other times they traveled in a clear direction, making them harder to ignore.

Older participants ended up accidentally learning the dots' patterns, based on the accuracy of their answers when asked which way the dots were moving, whereas young adults seemed able to suppress that information and focus on the numbers, the researchers reported last November in *Current Biology*.

In a separate study published in *Neuron*, scientists at the University of California, San Francisco, showed they could train aging brains to become less distractible. Their regimen helped aging rats as well as older people. The researchers played three different sounds and rewarded trainees for identifying a target tone while ignoring distracter frequencies. As the subjects improved, the task grew more challenging—the distracting tone became harder to discriminate from the target.

After the training, both rats and people made fewer distraction-related errors in tests of attention and memory. Electrophysiological brain recordings showed their neural responses to distracters also mellowed out.

Previous brain-training approaches tried to fix distractibility by improving focus, but those efforts failed. "'Focus' and 'ignore' are not two sides of the same coin," explains senior author Adam Gazzaley. "If you consider neural measures of focusing, older people look like 20-year-olds. The deficit is specific for ignoring distractions." —*Esther Landhuis*

So Happy I Could Cry

Negative reactions to positive experiences help to keep our emotions on an even keel

People cry when reunited with loved ones, scream on getting good news and pinch cute babies' cheeks. Yet why do such positive experiences elicit these "negative" reactions? New research suggests we may do it to calm ourselves down so we can handle situations better.

Oriana Aragón, a psychologist at Yale University, and her colleagues surveyed 143 adults about how they tend to react to good and bad experiences. Then they showed the subjects pictures of babies that varied in terms of their "cuteness," based on earlier research that suggests that babies are considered cuter if they have bigger cheeks and eyes and smaller chins and noses. The researchers then asked the subjects how they felt about the babies and how they wanted to interact with them.

Aragón and her colleagues found that the cuter the babies were, the more likely the subjects were to be overwhelmed by positive feelings on seeing their pictures. Subjects were also more likely to want to be "playfully aggressive" with the cuter babies, for instance, by pinching their cheeks. In a follow-up study, Aragón found that when subjects said they wanted to be playfully aggressive with cute babies, they calmed down more quickly—they became more emotionally neutral several minutes later compared with subjects who did not want to be playfully aggressive. "We have the first evidence that these negative expressions may help in regulating overwhelming positive emotions," Aragón says.

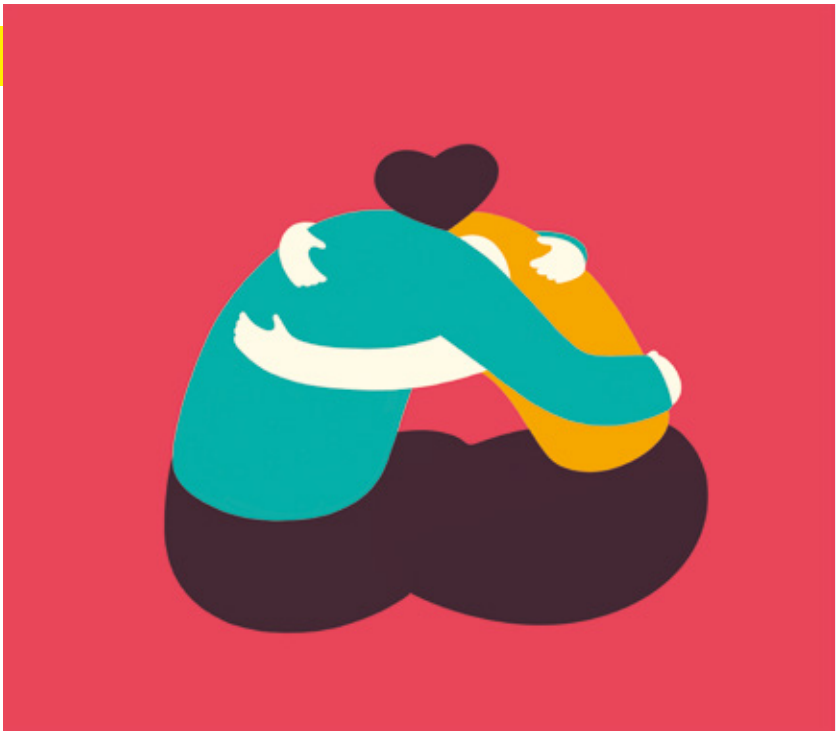
But why would we want to regulate our positive emotions? Research suggests that feeling "too positive" can interfere with decision making and cause people to neglect environmental threats and act impulsively. So if a father who is overwhelmed with joy at the sight of his adorable daughter feels the need to nibble on her toes, the reaction could ultimately be in both their best interests. "The baby is served by these expressions if the expressions calm down the adult who is overwhelmed," Aragón says.

—*Melinda Wenner Moyer*

ISTOCKPHOTO

M Meditation may prevent chromosomes from aging, according to a study of cancer patients. | Looking at cute things improves our focus.

How to Be a Better spouse



Before you get married, everyone tells you that marriage takes work. I never really believed it until my husband and I landed in therapy after four years, two kids and one seismically stressful cross-country move. Turns out you really can't just flip the switch to autopilot and trust love to take care of itself; you have to devote actual time and effort to understanding and appreciating your spouse. Anyone who is married knows that's not always a simple feat. Here's what relationship research (and a touch of game theory) tells us about how to become a better spouse.

#1 Be nice as often as you can. A lot of modern relationship therapy is based on the research of John Gottman, a prolific psychologist famous for videotaping thousands of couples and dissecting their interactions into quantifiable data. One of his most concrete findings was that happier couples had a ratio of five positive interactions to every negative interaction. "That just leapt off the pages of the data analysis," he says. It was true in very different types of relationships, including those in which the people were very independent and even distant or argumentative. These positive interactions don't have to be grand gestures: "A smile, a head nod, even just grunting to show you're listening to your partner—those are all positive," Gottman says.

#2 Think about what your partner needs, even when fighting. To resolve conflicts, Gottman says we can learn from game theory—the study of conflict and decision making used in political science, sociology and economics. It used to be widely accepted that negotiations were mostly zero-sum situations, meaning one party's gain was the other party's loss. In 1950 mathematician John Nash proved there was another, better outcome: a solution in which the parties may have to compromise, but in the end all of them come out satisfied. (This now famous "Nash equilibrium" won him a Nobel Prize in 1994.) I'm reminded of a recent situation in my own marriage—my husband hated the house we bought a couple of years ago and wanted to move to a different neighborhood; I liked the house just fine and didn't want to go *anywhere*. After much discussion, we realized that what we both really want is to settle in somewhere for the long haul. If the current house is not a place my husband feels he can settle in, then *I* can't truly settle in either. So we're moving next month, for both our sakes! Find the Nash equilibrium in your conflict, and you'll both get your needs met.

#3 Just notice them. "People are always making attempts to get their partners' attention and interest," Gottman says. In his research, he has found that couples who stay happy (at least during the first seven years) pick up on these cues for attention and give it 86 percent of the time. Pairs who ended up divorced did so 33 percent of the time. "It's the moment we choose to listen to our partner vent about a bad day instead of returning to our television show," explains Dana R. Baerger, assistant professor of clinical psychiatry and behavioral sciences at the Northwestern University Feinberg School of Medicine. "In any interaction, we have the opportunity to connect with our partner or to turn away. If we consistently turn away, then over time the foundation of the marriage can slowly erode, even in the absence of overt conflict."

#4 Ignore the bad, praise the good. Observations of couples at home reveal that people who focus on the negative miss many of the positive things that their partners are doing. Happy spouses, however, ignore the annoyances and focus on the good. "If your wife is irritable one morning, it's not a big deal. It's not going to become a confrontation," Gottman says. "Then when she does something nice, you notice and comment on that." Guess what that breeds? More of the good stuff.

It's this lesson that I'm going to try to implement right away. The guy I'm married to leaves dirty shirts balled up on the floor, never loads the dishwasher correctly and can be prickly when he hasn't had enough sleep—but he is an amazing husband. He's honest, shares his feelings, hugs and kisses me, and basically acts like I matter. I want to show him how much *he* matters, too, and that all the other stupid little stuff doesn't.

—Sunny Sea Gold

MÁGOZ (*couple*); PAUL PANTAZESCU *iStockphoto* (*globe icon*)

Early school start times put a strain on teens' natural sleep cycles. | Walking with a spring in your step can improve your mood.

PSYCHOSOMATIC ASTHMA ATTACKS

Beliefs and expectations can trigger real symptoms in asthma patients

Asthma attacks can be scary and painful—yet some of them may be avoidable if asthma sufferers can alter their expectations. Evidence is mounting that believing an odor or activity will trigger an asthma attack is sometimes all it takes to induce real physical symptoms.

In one recent study, 17 patients with moderate, persistent asthma took whiffs of a nonirritating odorant. For some patients the bottle was labeled "asthmogenic"; for others the label read "therapeutic." The researchers monitored their rate of exhaled nitric oxide, a marker of airway inflammation. Nitric oxide levels did not change at all among the group who thought the smell was therapeutic, but those who believed it to be asthmogenic had an immediate rise in exhaled nitric oxide that continued to climb. Just after exposure, levels had risen by 36 percent; two hours later they were 56 percent higher, and the next day levels were elevated by 65 percent. "We hope to convince both asthmatics and the physicians who treat them that their beliefs alone can bring about adverse responses," says co-author Pamela Dalton, a cognitive psychologist at the Monell Chemical Senses Center in Philadelphia.

These results align with previous findings. A study published in 2012 in the *Journal of Asthma* found that when asthma patients merely looked at pictures of known allergens, they reported 15 percent more symptoms than when they viewed neutral images. Other studies have shown that asthma patients experience more constricted airways than healthy control subjects in response to emotional stimuli. "Patients' perception of symptoms might be based on learned associations more than on the actual state of their lung function," explains Andreas von Leupoldt, a researcher now at the University of Leuven in Belgium, who co-authored the 2012 study. These associations can arise through experience (such as an allergic reaction after playing with a cat) or be based on a doctor's advice (that exposure to cats may cause an allergic reaction, for example).

Taken together, the findings suggest that certain activities, odors and images may elicit a stress response that causes physiological symptoms in asthma patients. The researchers hope that doctors and public health associations will tweak their messages to asthma sufferers so that they do not overreact to experiences that may be harmless. Von Leupoldt suggests that treatments should change: if a patient complains of increased symptoms but a lung function test does not reveal any changes, a doctor might see if other factors are influencing symptoms, such as anxiety or high stress levels. "This knowledge could give asthmatics more control over how they are affected by their environment," Dalton adds.

—Tori Rodriguez

From Mind to Matter

Many physical maladies can be triggered by negative expectations, a phenomenon known as the nocebo effect.

- **Headache.** Being told you are at risk for a headache, for instance, at high altitudes can alter chemical pathways in the brain and cause a real headache.
- **Itch.** Visual cues or verbal suggestions, such as being told you were exposed to poison ivy, can make you feel itchy.
- **Allergies.** Seeing, smelling or even imagining something you are allergic to can trigger a reaction.
- **Pain.** Expecting that something will hurt increases your perception of the pain.
- **Erectile dysfunction.** Learning that you may be prone to erectile dysfunction increases the chances it will happen.

—Victoria Stern

Gossip Boosts Self-Reflection

Hearing updates about peers, whether positive or negative, can be beneficial

MIKE McWILLIAM *Alamy (asthma sufferer)*; GETTY IMAGES (*whispering*)

Get this: gossip is useful. Researchers at the University of Groningen in the Netherlands have found that gossip triggers self-reflection, helping the listener improve behavior and identify threats.

In experiments designed to measure the effects of gossip, college students either recalled real gossip or role-played as sales reps hearing gossip about fictional co-workers. Hearing positive gossip about others prompted a desire for self-improvement. Negative gossip boosted listeners' egos but also put them on guard—it would be only too easy to become one of the disgraced.

The effects of negative gossip were stronger for women than for men and led to heightened alertness and self-protection concerns. Yet men who heard positive gossip about others experienced more fear than women, apparently because they worried they would not measure up.

"Hearing gossip helps people evaluate themselves more accurately in comparison to others," says psychologist Elena Martinescu, lead author of the study. She notes that although gossip can sometimes be malicious, most of it is shared in good faith: "Contrary to lay perceptions, gossip has an essential role in helping us know ourselves and adapt to our world." ***—David Levine***

M Accidental awareness during surgery may explain some memories of alien abduction. | Eye-tracking technology aims to suss out diners' pizza orders.

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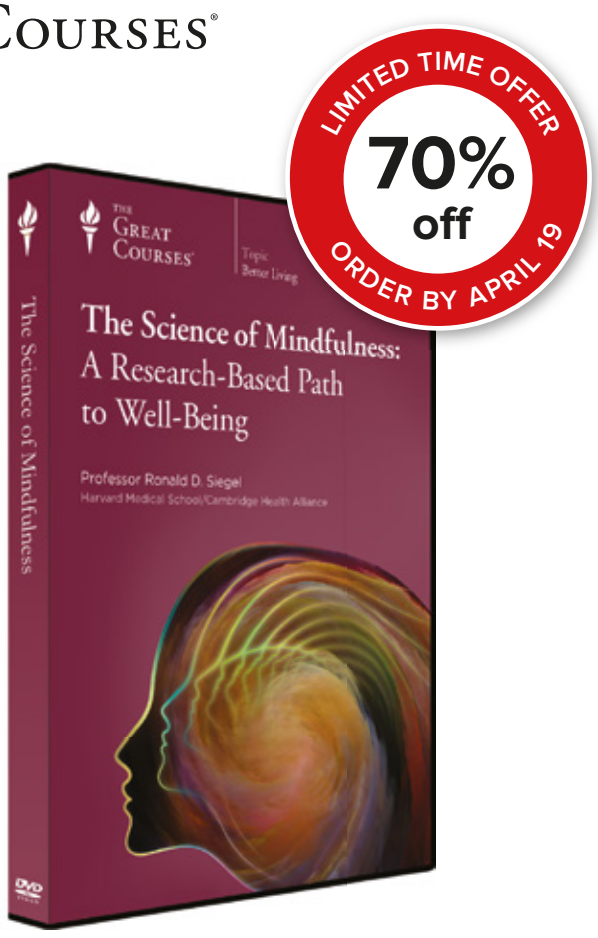

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ILLUSTRATIONS BY BEADY EYES

NEW IDEAS IN ADDICTION TREATMENT

Drug and alcohol addictions are among the most challenging mental illnesses to treat, but new research offers some promising leads. Mounting evidence suggests that helping addicts hold down steady jobs and paying them for staying clean can help reduce drug use. Another intriguing line of work uses unconscious triggers to steer smokers away from cigarettes. And pharmaceutical companies continue to strive for a pill that will do the trick. We rounded up some of the best current options and promising strategies for the future.

Quit Smoking in Your Sleep

People smoke less after smelling cigarettes paired with rotten odors overnight

Many decades of research have shown that people cannot learn new information during sleep and then retrieve it once awake. Yet a growing body of work finds that unconscious associations made during sleep can affect waking behaviors. One new study found that pairing the smell of cigarettes with unpleasant odors made people smoke less during the following week.

Neurobiologist Anat Arzi and her colleagues at the Weizmann Institute of Science in Rehovot, Israel, recruited 66 smokers who wanted to quit and asked them to keep a smoking journal for a week before and a week after spending one night in the laboratory. Some subjects spent the night hooked up to devices that measured breathing and brain activity while they received puffs of the smell of smoked cigarettes followed by puffs of the odor of rotten eggs or decaying fish through a face mask. Other subjects underwent the same odor training during the day while awake. Smokers who got the putrid smells during the restful second stage of sleep cut their smoking by more than 30 percent during the following week. In contrast, subjects who received the odor treatment during rapid eye movement (REM) sleep, an aroused brain state that gives rise to dreams, had a much smaller reduction in smoking, around 12 percent. Smokers trained while awake did not change their smoking behavior.

Arzi presented the work last November at the annual meeting of the Society for Neuroscience in Washington, D.C. She says that the preliminary study was aimed at determining what the sleeping brain is capable of but that the findings might one day be developed into treatments for smoking or other addictive behaviors. —*Stephani Sutherland*

Cash for Quitting

Therapeutic workplaces offer paid work in exchange for staying clean

Drug addicts often have trouble holding down a job. Yet many experts believe that having a steady income is key to helping addicts quit. To that end, psychiatrist Kenneth Silverman of the Johns Hopkins University School of Medicine and his colleagues created "therapeutic workplaces." The technique features frequent drug tests, unlimited second chances and cash bonuses to addicts who keep clean. Research in recent years has suggested that Silverman has indeed homed in on a winning strategy.

In a therapeutic workplace, full-time employees agree to be tested at least three times a week to see if they are clean or becoming cleaner. If not, they are sent home—but they can return the next day to try again. If clean, they can work full-time for an hourly wage until the next drug test.

Paychecks come frequently, and cash bonuses are a constant possibility if workers meet drug- or job-related goals, such as staying clean for a certain period or performing, say, a data-entry task more proficiently. In early trials, researchers worried that giving addicts cash would tempt them to buy drugs, but results showed the opposite—workers who got cash bonuses stayed clean longer than those who simply drew their hourly wage.

The researchers' theories about therapeutic workplaces have now been validated in a series of randomized controlled trials using data-entry training regimens or jobs at a business that served the Johns Hopkins research community. Some trials enrolled cocaine users; others tested opiate addicts with medication-assisted treatment such as methadone or naltrexone. The studies consistently showed that around 80 percent of subjects in the therapeutic workplace regimen remained clean and refrained from other addictive behaviors, compared with 50 percent of the groups that worked without financial incentives.

A 2012 review of therapeutic workplaces concluded that this method is highly effective to ensure long-term abstinence, perhaps because it acknowledges the nuanced reality of addiction recovery—relapses are to be expected, but if sobriety continues to offer immediate rewards, addicts will move toward abstinence.

In 2014 the federal Office of National Drug Control Policy honored Silverman for his concept of therapeutic workplaces, although it has not widely spread throughout the addiction community. The intense monitoring required prevents most businesses from being able to embrace the model. Silverman has now teamed up with American Substance Abuse Professionals, the organization behind the "Drug-Free Workplace" campaign, to try to figure out how to bring this technique to the masses.

—*Cara Tabachnick*

M A new blood test may help predict how long concussion symptoms will last. | Language matters: people are more likely to believe in "climate

(PHARMA WATCH)

A PILL TO TREAT ADDICTION?

Prescription medication can help some people quit—but not without complications

Several pharmaceutical drugs promise to help addicts quit, and many people embrace the ease of popping a pill. Yet research continues to show that although medication can help, support networks and therapy targeting the underlying behaviors are still the best available ways to kick addiction over the long term. In addition, some of these medications come with scary side effects—hundreds of people have reportedly committed suicide while on the smoking-cessation drug Chantix, for example. Read on for short profiles of the addiction drugs currently on the market, as well as a few compounds that may hit shelves soon. —*Roni Jacobson*

Drug	Addiction	How It Works	Success Rate	Downsides
Chantix	Nicotine	Drug molecules block nicotine receptors in the brain, lessening both withdrawal symptoms and the pleasure of smoking	20 percent of users quit long-term, double the rate of those taking a placebo	In 2009 the FDA slapped Chantix with its most dire "black box" warning for risk of depression, anxiety, aggression and suicide
Zyban	Nicotine	This antidepressant alters the brain's reward system to lessen cravings and withdrawal symptoms	15 percent of users quit long term—about the same as with nicotine gum and patches	People who have seizures, head injuries, bipolar disorder, alcohol abuse problems and eating disorders should not take Zyban; it also carries a "black box" warning for depression and suicide
Campral	Alcohol	May bind to the receptors habituated to alcohol, reducing withdrawal symptoms such as insomnia, anxiety, depression and irritability	Significantly improves quit rates when used with therapy as intended. Users are 14 percent less likely to relapse than those taking a placebo	Some people report headache, nausea, diarrhea, gas and excessive sweating, but Campral is generally well tolerated
Antabuse	Alcohol	Blocks the enzyme involved in metabolizing alcohol. If a person taking Antabuse drinks, that individual becomes nauseated and has heart palpitations	Sticking with the drug may be a problem, but Antabuse is a good option for people highly motivated to quit; about half of its users achieve long-term sobriety	Be warned: even a tiny drop of alcohol can set off the deterring symptoms, so people on Antabuse must avoid mouthwash, cough medicine, foods that contain cooking wine and even vinegar
Naltrexone	Alcohol and opioids	Blocks the effects of opioids at their receptors, inhibiting both the rewards of and cravings for alcohol and opioid drugs such as heroin; most effective with counseling	Only 10 percent of alcoholics became fully sober in trials, but the drug did reduce the amount most people drank; opioid addicts fared better: 90 percent stayed abstinent in one trial, compared with 35 percent taking a placebo	Common side effects include stomach pain, headache, anxiety, nausea and trouble sleeping; in rare cases, it can also cause liver damage, prompting a "black box" warning from the FDA
Methadone	Heroin	Binds to receptors for the neurotransmitter glutamate; low doses can ease withdrawal symptoms, whereas higher doses block heroin's euphoric effects	Has been found to reduce or eliminate opioid use and associated behaviors such as crime; meant to be used with therapy because recent studies suggest it is not effective alone	Patients taking methadone can experience tolerance, dependence and withdrawal if they stop taking it; there is also a risk for overdose, causing some critics to call methadone no better than what it is treating
Buprenorphine	Opioids, including heroin	Blocks action at opioid receptors in the brain and at lower doses is used to treat chronic pain	Buprenorphine and methadone work about equally well; suboxone, a combination of buprenorphine and a drug used to treat overdoses, has an even higher success rate	Users may get headaches, drowsiness, nausea, decreased libido and dizzy spells; dependence is also a risk, though much lower than with methadone

TOMORROW'S TREATMENTS

These compounds have shown experimental promise and are being developed for larger human trials:

Gabapentin is an anticonvulsant under investigation for the treatment of cocaine and marijuana dependencies. It works by increasing the presence of the neurotransmitter GABA, reducing stress and anxiety.

Ibogaine is a psychoactive substance found in an African flowering plant. Promising studies have suggested that a single dose of ibogaine—which sends users into a hallucinogenic dream state—can stop addiction in its tracks. In the U.S., ibogaine is classified as an illegal psychedelic and is therefore not used in treatment, but some European countries have started to deregulate it.

A vaccine to prevent addiction has been a pipe dream of scientists for decades, but now a team at Weill Cornell Medical College may be close to cracking the case. In early 2014 the researchers began human testing. The vaccine works by binding to drug molecules in the bloodstream and preventing them from reaching the brain. —*R.J.*

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change" than "global warming." | Poorly managed diabetes ages the brain, causing 19 percent more cognitive impairment over 20 years.

The Pain of Pursuing Beauty

In an odd twist, believing beauty is attainable leads to negative feelings

Believing that we can change a trait for the better tends to be self-fulfilling, and vice versa. People who contend that intelligence or creativity cannot be improved, for example, tend to develop less in these areas than those who think these facets are malleable. This finding holds in a variety of settings [*see box below*], which has led many to conclude that having a growth mind-set is an unconditionally good thing. Yet beliefs about beauty have now emerged as the first notable exception to this trend, according to two studies reported last October in *Social Cognition.*

Researchers at Oklahoma State University found that women with malleable beliefs about beauty—for instance, believing they could become more beautiful with effort—had a higher risk for appearance-related anxiety and were more likely to base their self-worth on their looks, as compared with those who have fixed beauty beliefs. They were also more likely to express interest in cosmetic surgery. The effects were not found among men.

Whether a malleable belief is beneficial or not may depend on how realistic the pursuit is. Beauty ideals typically presented in media images—young, thin and photoshopped to be flawless—are unattainable for most women. "Prior research has shown that malleable beliefs increase motivation, which is good if we are talking about being motivated to stay in school or improve one's math skills," says study co-author Melissa Burkley, a professor of social psychology. "But when the domain is as unrealistic as the beauty standards we have for women today, increasing motivation may lead to harmful behaviors."

—Tori Rodriguez

I Think I Can, I Think I Can …

A large body of research shows that when people believe traits are malleable, they can indeed improve their performance. Here are some domains in which these beliefs have proved to be beneficial:

- People who believe **intelligence** is malleable have greater academic success. Such students tend to be more intellectually ambitious, exert greater effort and get better grades.
- In romantic relationships, partners who think that **personality** is malleable work harder to resolve conflicts directly and to seek a mutually beneficial solution.
- People who see their **potential adversaries** as adaptable view them more sympathetically. In one study, when Israeli Jews believed Palestinians had flexible natures, they exhibited more positive attitudes toward them and were more willing to compromise.
- Minority students who believe people's **perceptions or biases** can change over time may be more motivated and resilient, even in the face of adversity.
- People who treat **negotiation tactics** as flexible outperform their more closed-minded peers because they tend to be more persistent and willing to adapt to the shifting circumstances.

—Victoria Stern

Helpless No More

When we get stuck guessing wildly, relieving stress could get us back to strategizing

Sometimes the best approach to problem solving is no strategy at all—an exploratory, "try anything" gambit. Such wild guessing can be a smart way to face a challenging competitor or explore unfamiliar terrain. Yet occasionally we get stuck in this random-guessing mode—we essentially keep pressing buttons with no thought to strategy. That is a phenomenon called learned helplessness, observable in people and animals who believe nothing they do can produce a desired outcome. Now scientists at the Howard Hughes Medical Institute's Janelia Research Campus in Ashburn, Va., have discovered the molecular switch that allows rats to flip between strategic and random behavior, a finding that could reveal how individual neural circuits contribute to decision making and provide clues for dealing with learned helplessness in humans.

To uncover the brain switch, biologist Alla Karpova and her colleagues challenged rats to compete against one of three computerized competitors. The competitors attempted to predict which of two holes the rats would poke their head through to earn a treat. The treat only appeared, however, if the computer failed to predict the rats' behavior. Against the first two competitors, the rats took a strategic approach and satisfied their sweet tooth. But the third competitor was devilishly capable, and the rats resorted to guessing. Then Karpova's team surreptitiously replaced the third competitor with one that rewarded a specific behavior pattern—something rats can usually figure out. Yet these rats floundered. They were stuck in random mode, insensitive to the cues that would have led to a reward. They never discovered the pattern after even thousands of attempts.

By manipulating levels of the stress hormone epinephrine, the researchers demonstrated that a part of the brain called the anterior cingulate cortex (ACC)—a crescent of brain tissue behind the frontal lobes in humans—was key. When norepinephrine levels were high in the ACC, as they would be during stress, the rats abandoned strategic behavior. By suppressing norepinephrine in the ACC, Karpova's team was able to rescue rats stuck in random mode and restore their ability to learn from their mistakes.

The results jibe with earlier studies of learned helplessness in rats, which found that both exercise and antidepressants effectively eliminated the helpless behavior that often accompanies depression. These remedies are also known to relieve stress. "Because norepinephrine is regulated in stress, anything that lowers stress could help us behave strategically," Karpova says.

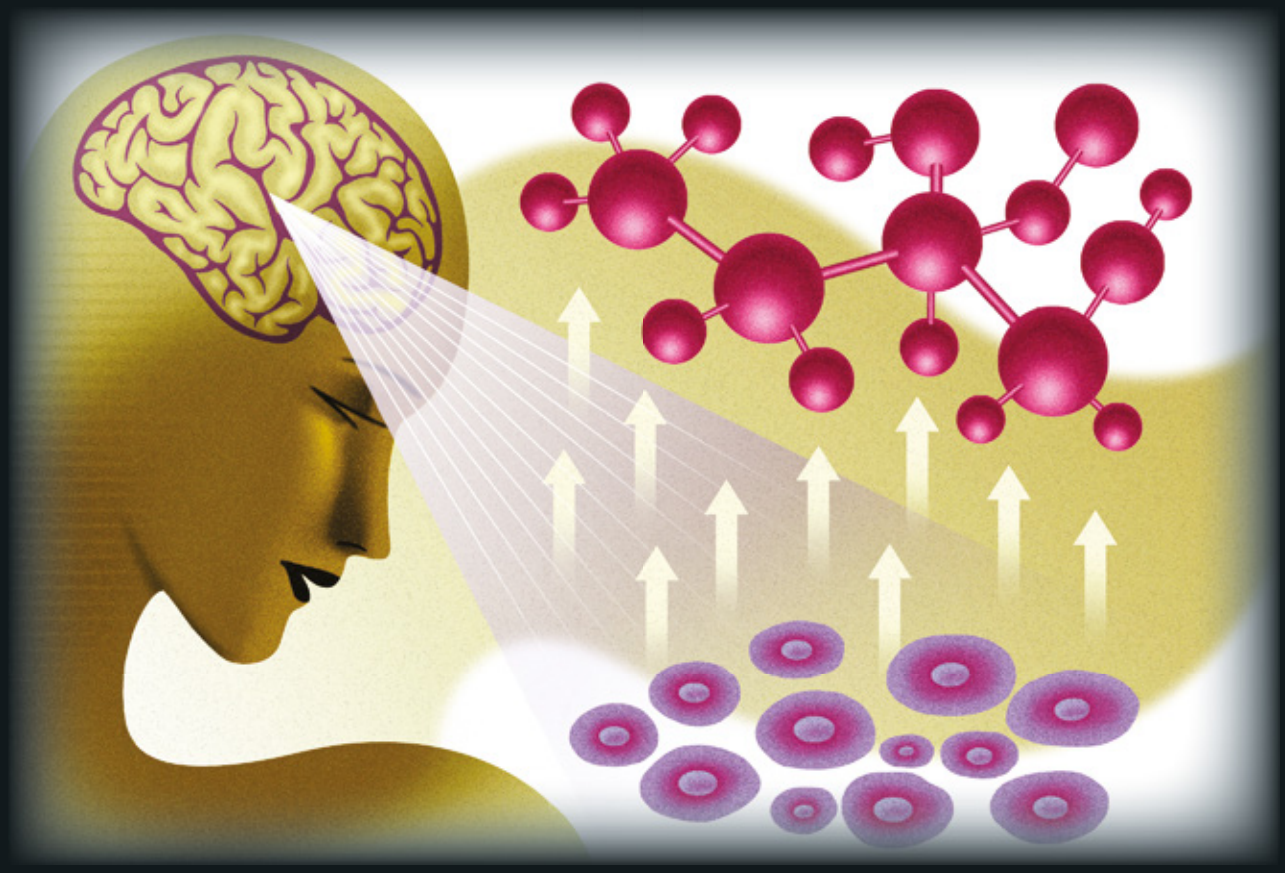
—Jenni Laidman

ALAMY

M Prenatal exposure to phthalates, common chemicals found in household goods such as some soaps and plastic items, may lower IQ. | New studies—and certain

ON THE HORIZON

THOUGHT-CONTROLLED GENES



People can control prosthetic limbs, computer programs and even remote-controlled helicopters with their mind, all by using brain-computer interfaces. What if we could harness this technology to control things happening inside our own body? A team of bioengineers in Switzerland has taken the first step toward this cyborglike setup by combining a brain-computer interface with a synthetic biological implant, allowing a genetic switch to be operated by brain activity. It is the world's first brain-gene interface.

The group started with a typical brain-computer interface, an electrode cap that can register subjects' brain activity and transmit signals to another electronic device. In this case, the device is an electromagnetic field generator; different types of brain activity cause the field to vary in strength. The next step, however, is totally new—the experimenters used the electromagnetic field to trigger protein production within human cells in an implant in mice.

The implant uses a cutting-edge technology known as optogenetics. The researchers inserted bacterial genes into human kidney cells, causing them to produce light-sensitive proteins. Then they bioengineered the cells so that stimulating them with light triggers a string of molecular reactions that ultimately produces a protein called secreted alkaline phosphatase (SEAP), which is easily detectable. They then placed the human cells plus an LED light into small plastic pouches and inserted them under the skin of several mice.

Human volunteers wearing electrode caps either played Minecraft or meditated, generating moderate or large electromagnetic fields, respectively, from a platform on which the mice stood. The field activates the implant's infrared LED, which triggers the production of SEAP. The protein then diffuses across membranes in the implant into the mice's bloodstream.

Playing Minecraft produced moderate levels of SEAP in the mice's bloodstream, and meditating produced high levels. A third type of mental control, known as biofeedback, involved the volunteers watching the light, which could be seen through the mice's skin, and learning to consciously turn the LED on or off—thereby turning SEAP production on or off.

"Combining a brain-computer interface with an optogenetic switch is a deceptively simple idea," says senior author Martin Fussenegger of the Swiss Federal Institute of Technology in Zurich, "but controlling genes in this way is completely new." By using an implant, the setup harnesses the power of optogenetics without requiring the user to have his or her own cells genetically altered. Fussenegger and his co-authors envision therapeutic implants one day producing chemicals to correct a wide variety of dysfunctions: neurotransmitters to regulate mood or anxiety, natural painkillers for chronic or acute pain, blood-clotting factors for hemophiliacs, and so on. Some patients would benefit greatly from having conscious control over intravenous dosage rather than relying on sensors—especially in cases such as pain, which is hard for anyone but the sufferer to measure, or locked-in patients or others who are conscious but cannot communicate.

—Simon Makin

STUART BRIERS; SCOTT DUNLOP *iStockphoto (sun icon)*

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Mathematics

Speaker: Arthur Benjamin, Ph.D

The Secrets of Mental Math

Dr. Benjamin will demonstrate and explain how to perform amazing feats of mental calculation. You'll improve your ability to manipulate and memorize numbers, learn how to figure out the day of the week of any date in history, and other astounding feats of mind.

The Mathematics of Games and Gambling

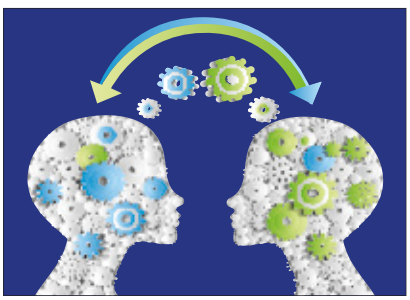
What are the best and worst games to play at the casino? When should you hit, split, or double down in blackjack? How much should you bet? Learn the answer to these questions, along with some games you can't lose, once you know the secret.

My Favorite Numbers

What makes the number 9 so magical? Explore the beauty of the Fibonacci Numbers 1, 2, 3, 5, 8, 13, 21, … and the golden ratio 1.618 … Is it irrational to be in love with Pi?

Discrete Mathematics

Learn the mathematics that underlie computer science and cryptography. Topics include combinatorics (the art of counting), number theory, and graph theory. But don't let the names of these topics scare you. You don't need much more than arithmetic and a logical mind to enjoy this lecture.



Psychology

Speaker: Jennifer Crocker, Ph.D.

Does Self-Esteem Matter?

Despite a huge volume of studies, researchers hotly debate whether self-esteem is actually important to well-being. We'll consider some of the major controversies in the field, such as whether high self-esteem people are happier, more successful, or more popular than low self-esteem people, and what factors actually affect our self-esteem.

For more info please email Info@InsightCruises.com or visit ScientificAmerican.com/travel

Pursuing Self-Esteem

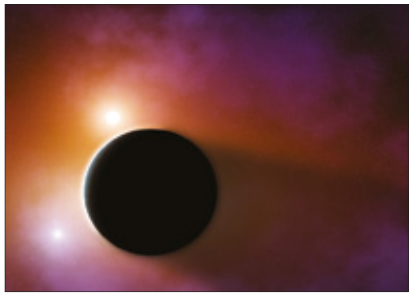
People tend to invest their self-esteem in just a few endeavors, such as academics, appearance or sports. Learn what research tells us about the benefits and pitfalls of pursing self-esteem by striving for success and avoiding failure in these domains, as well as successful strategies for avoiding the downsides of pursuing self-esteem.

Principles of Close Relationships

Many scientists assume that people in relationships are fundamentally self-interested, and aim to promote their own ends. Yet people can also transcend self-interest and care about relationship partners as much as themselves. Learn which relationships are likely to be governed by which set of principles, and what factors prompt these principles to shift.

The Key to Good Relationships

Learn how to create relationships that are good for your health and well-being through positive intentions. Evidence shows that when people strive to be supportive and constructive toward their partners, they tend to become so. Their partners notice and respond in kind, and the relationships tend to improve for everyone.



Astronomy

Speaker: Edwin L. Turner, Ph.D.

Exoplanets: Strange New Worlds

The first planet-sized body orbiting a star beyond the sun was discovered two decades ago. Since then, a torrent of new finds has come. Today we have catalogued and studied a few thousand exoplanets. Take a tour of these strange new worlds and learn about the future outlook for finding more.

The Quest for Earth's Twin

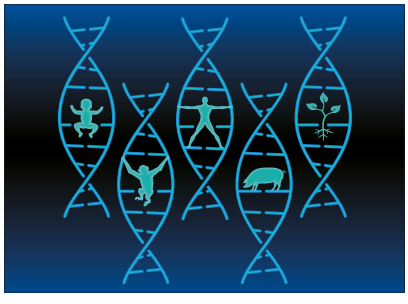
Is life on Earth unique in the universe? If not, our best hope for finding extraterrestrial organisms is to find a planet resembling our own, with the conditions and liquid water we think life probably requires. Learn how we search for Earth twins, and the prospects for detecting alien life from afar.

Life as We Don't Know It

Astrobiologists tend to search for extraterrestrial organisms resembling those found on Earth. But it's quite plausible that the universe contains life that is radically different from ours. Learn how scientists are beginning to study this topic, and how we might eventually hope to recognize life beyond our ability to imagine it.

Abiogenesis: Life's Origins

The biggest mystery about life is how it got started—that is, how it arose from a completely abiotic, or sterile, environment. Scientists have proposed radically different scenarios for this spark, and so far we have no way to discriminate between them. We'll discuss the latest thinking on the perplexing origins of life.



Evolution

Speaker: Spencer C.H. Barrett, Ph.D.

The Evolution Revolution

Evolution provides an explanation for all biodiversity on Earth, including human origins. Learn how and why evolution occurs, and why understanding the process of evolution is not only of profound biological importance but is also crucial for many contemporary issues affecting society.

Plant Sex for Grown-ups

The reproductive strategies of plants exhibit greater variety than those of any other group of organisms. Why should this be so? We'll address a variety of fundamental questions about plant sex, highlight some of the bizarre floral adaptations associated with pollination, and discuss how experimental studies can yield insight.

Evolution On Islands

Islands can act as "evolutionary laboratories," providing some of the clearest evidence for natural selection. We'll contrast the case histories of Australia and New Zealand, highlighting the similarities and differences between the floras and faunas of the two regions, and discuss why islands provide such a rich source of biological novelty.

Biological Invaders

Invasive species can cause huge economic losses and threaten biodiversity and ecosystem function. We'll discuss the fascinating new field of applied science known as invasion biology. Learn why some invasive species have the capacity to evolve rapidly in response to local environmental conditions in their adopted homes, whereas others are characterized by genetic uniformity.

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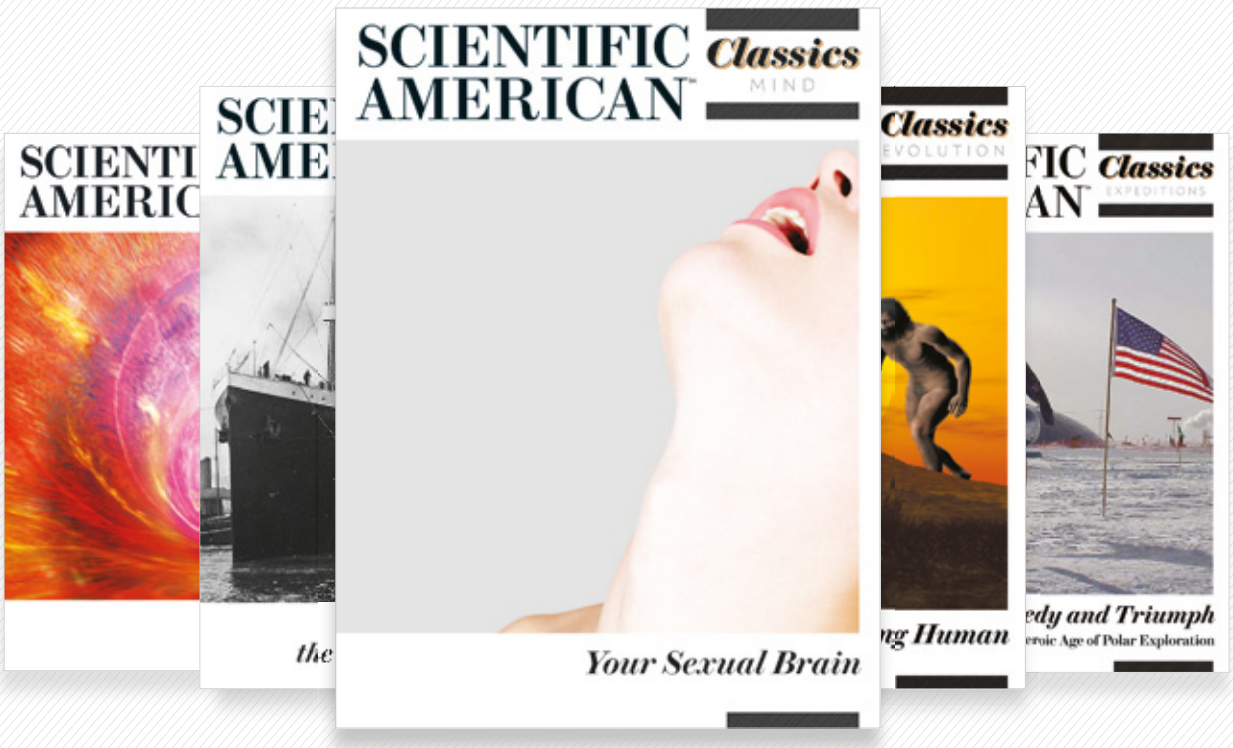

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Warped Perceptions

The work of famous painters reveals how visual and neural pathologies can shape great art

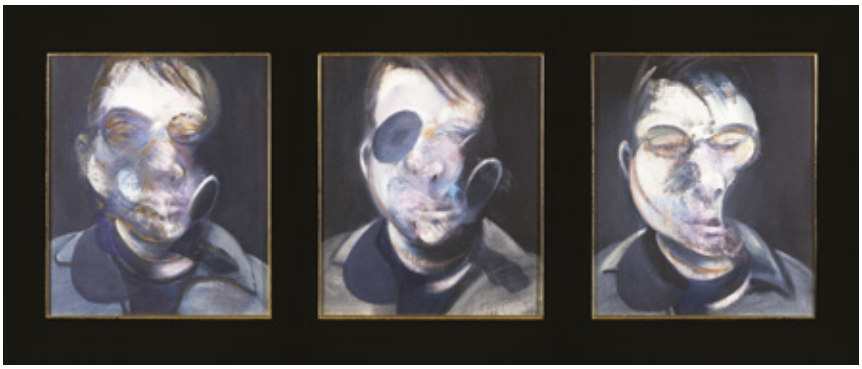
All visual art is illusory in that it involves a departure from reality, a filtering through the mind of the artist. This subjectivity applies not only to abstract works but also to representational art, in which the artist translates his or her perception into a physical object capable of inducing a similar perception in the viewer.

Painters render the three-dimensional world on a flat surface. These representations are enough to suspend our visual system's disbelief and trigger barrages of neuronal firing that become visions of bathers, bridges and water lilies. It is never about reality but about how the artist sees and wants to portray it. This artistic vision is a mishmash of expectations, memories, assumptions, imagination and intent. It is also, in a sense, a reflection of neural shortcuts and basic visual processes.

The picture becomes even more complicated when painters suffer from pathologies of the eyes or brain that force them to see their surroundings in ways that diverge from standard experience. The artwork produced by such artists allows us to participate in their perception—and misperception—of the world.

For example, failing vision can translate into an eerie loss of precision and detail in paintings. The pictures of American artist Georgia O'Keeffe became flatter and less intricate as she developed bilateral age-related macular degeneration, a retinal disease that affects central, high-resolution vision. The later works of American painter Mary Cassatt similarly show an uncharacteristic absence of delicacy in faces as she developed cataracts. French impressionist Claude Monet also had cataracts, which rendered his paintings imprecise and muted in color. After he underwent successful cataract surgery, his paintings regained definition and vibrancy.

As the examples in this column attest, the effects of vision or brain diseases can sometimes be traced in great works of art. M



© CHRISTIE'S IMAGES *Corbis (Bacon)*; SEAN MCCABE (*Martinez-Conde and Macknik*)

FRANCIS BACON'S DISTORTIONS

The works of 20th-century British painter Francis Bacon are notorious for their power to unsettle viewers. The artist, once described by Margaret Thatcher as "that man who paints those dreadful pictures," was up-front about his intent to provide a "visual shock" to audiences. Neuroscientists Semir Zeki and Tomohiro Ishizu, both at University College London, have argued that Bacon's distorted faces and disfigured bodies—often reminiscent of violence and mutilation—are almost universally disturbing because of the way they subvert our brain's template for the human form. Several brain regions, such as the fusiform face area and the fusiform and extrastriate body areas, are specialized in the recognition of faces and bodies. According to Zeki and Ishizu, Bacon's paintings are just consistent enough with the real human figure that these parts of the brain are engaged. The troubling part for the viewer is that the details of Bacon's portraits are so distorted that they violate the brain's expectations for the body. This creates the viewer's sense of discomfort.

Avinoam B. Safran of the University of Geneva in Switzerland and his colleagues have proposed that the painter suffered from a rare neurological disorder called dysmorphopsia, which produces progressively changing and distorted perceptions. In some sufferers, the illusory transformations and deformations primarily affect their perception of faces and bodies. Indeed, Bacon described his perception of faces as ever changing, with the mouth and the head in constant motion. According to Safran and his colleagues, the effects of Bacon's perceptual deformations on his art were not unique: the drawings made by a patient with dysmorphopsia (caused by a meningioma tumor) who also experienced abnormal perceptions of people bear a striking resemblance to Bacon's portraits.

BY SUSANA MARTINEZ-CONDE AND STEPHEN L. MACKNIK

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

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DEGAS'S FAILING VISION

French artist Edgar Degas, who lived from 1834 to 1917, experienced progressive visual loss in the last 30 years of his life. In 2006 ophthalmologist Michael F. Marmor used information from Degas's correspondence and computational simulations of the painter's perception in an attempt to diagnose Degas and better understand how the artist would have experienced the world.

Marmor concluded that Degas's central vision, where acuity is sharpest, weakened in his later years. Many aspects of Degas's art, such as the shading, color and overall composition of his paintings, were remarkably robust to his visual loss, however. As his central vision grew blurry, his paintings became coarser and lost refinement. Yet Degas himself might not have noticed a fundamental difference between his earlier work and later paintings, such as this depiction of ballerinas from his later years. This is because he would have been equally unable to focus his central vision on the older paintings. Marmor suspects that Degas's later works looked smoother and more natural to the painter (filtered through his own visual pathology) than to viewers with healthy eyes.

WAS EL GRECO ASTIGMATIC?

The 16th- and 17th-century paintings of El Greco are populated by famously elongated figures. These curious forms have kindled speculation that the painter may have suffered from astigmatism, an optical defect. The reasoning goes that spectacle lenses could have overcorrected El Greco's astigmatism, producing retinal images that were stretched horizontally, thus causing the master to paint tall and skinny objects that appeared normal to him.

To test this idea, vision scientist Stuart Anstis of the University of California, San Diego, transformed experimental subjects with normal eyes into "artificial El Grecos" with a special telescope that stretched their retinal images horizontally by 30 percent. When the subjects attempted to draw a square from memory, they drew a tall, thin rectangle instead. But when they tried to copy an actual square, they drew a flawless replica. That is, there was an "El Greco" effect in the drawings made from memory but not in the copies. Then, to simulate lifelong astigmatism, Anstis persuaded a volunteer to wear the distorting telescope for two days straight. She copied squares and drew squares from memory four times each day. The copied squares were always picture-perfect, but the squares from memory were not always so: they started 50 percent too tall and grew progressively shorter with time. By the end of the second day, she was drawing impeccable squares. Anstis concluded that even if El Greco suffered from astigmatism, he would have quickly adapted to it.

So why would El Greco employ such strange figures? Artistic evidence offers a different explanation. El Greco sketched his subjects with standard proportions first and only elongated them in his paintings. And he did so selectively, portraying angels as taller and svelter than people. The fact that El Greco did not always employ an elongated style suggests that the lengthening was an aesthetic choice.

CORBIS (*Degas*); GETTY IMAGES (*El Greco*)

REMBRANDT'S STEREO BLINDNESS

Close your left and right eye in quick succession, and you will notice that each eye has a slightly different perspective. Neurons in the visual cortex of the brain use the horizontal shift between the two eyes to produce stereoscopic vision, one of the primary ways in which we are able to see depth in the world. Because our two retinas are fundamentally two-dimensional structures, our perception of the third dimension is an illusion, a brain construct.

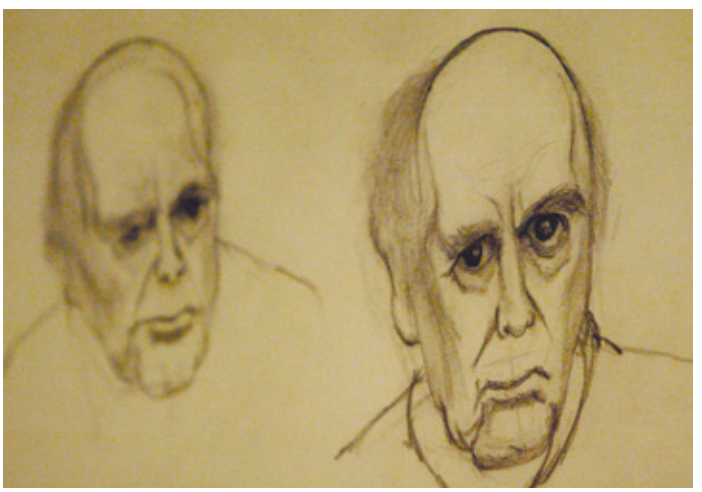
In 2004 neuroscientists Margaret S. Livingstone and Bevil R. Conway, both then at Harvard Medical School, observed that 17th-century Dutch painter Rembrandt van Rijn's eyes were often misaligned in his self-portraits, so that one eye appeared to look directly at the viewer, whereas the other eye looked off to the side. Livingstone and Conway wondered whether Rembrandt had painted himself with ruthless accuracy, which would suggest that the painter was actually walleyed. They measured aspects of Rembrandt's gaze in 36 self-portraits and found that if these paintings were true to life, Rembrandt did not have normal stereovision. In short, he would have struggled to see depth with stereoscopic cues.

Rembrandt's poor stereovision may have been advantageous. Art students routinely learn to close one eye to replicate the three-dimensional world onto a flat medium with greater accuracy. Stereo blindness, or the inability to use the horizontal shift between our eyes to see in 3-D, can therefore aid artists in rendering the world in two dimensions.

Livingstone and Conway went on to show that art students have poorer stereovision than students not majoring in arts and that the eyes of established artists have a more pronounced misalignment than the eyes of nonartists. Stereo blindness may not make you an artist—many established artists have normal stereovision, and most stereo blind people are not artists—but the early sketches of stereo blind artists may be more accurate than those of people with normal stereovision. Thus, people with poor stereovision may feel more encouraged to persevere in their artistic training.

CORBIS (*Rembrandt*); AP PHOTO (*Utermohlen*)

SELF-PORTRAITS OF A CRUMBLING MIND



American artist William Utermohlen received a diagnosis of probable Alzheimer's disease in 1995, at the age of 61. For the next five years, as his dementia worsened, he used his art to track the disintegration of his mind. Utermohlen's self-portraits, such as the sketches above from 1996, offer a window into the artist's experience of the progression of Alzheimer's. Many of the stylistic changes in the depictions are likely the result of the quick decline of Utermohlen's visuospatial and motor skills over the course of a few short years. Yet the portraits are also heartbreaking in that they expose a mind trying against hope to understand itself despite deterioration.

FURTHER READING

- **Some Workmen Can Blame Their Tools: Artistic Change in an Individual with Alzheimer's Disease.** Sebastian J. Crutch et al. in *Lancet,* Vol. 357, pages 2129–2133; June 30, 2001.
- **Was Rembrandt Stereoblind?** Margaret S. Livingstone et al. in *New England Journal of Medicine,* Vol. 351, No. 12, pages 1264–1265; September 16, 2004.
- **Ophthalmology and Art: Simulation of Monet's Cataracts and Degas' Retinal Disease.** Michael F. Marmor in *JAMA Ophthalmology,* Vol. 124, No. 12, pages 1764–1769; December 2006.
- **A Neurological Disorder Presumably Underlies Painter Francis Bacon Distorted World Depiction.** Avinoam B. Safran et al. in *Frontiers in Human Neuroscience,* Vol. 8, Article No. 581; August 29, 2014.

SOCIAL SKILLS

Asking Advice Makes a Good Impression

People are far too reluctant to ask for help, research shows

By Alison Wood Brooks and Francesca Gino

What do you do when you cannot figure out how to finish a tricky task at work? Or you are lost on back roads? Or you are trying a new do-it-yourself project in your house and just cannot seem to make it look like the photograph that inspired you on Pinterest? In life when you are stuck, there are many solutions. For example, you could invest more time and effort by brainstorming alternative approaches, using trial and error or looking up tricks of the trade online.

But one thing most people know to avoid *for sure:* asking for advice. It is inconsiderate. We do not want to bother others. After all, other folks have their own problems to solve. Also, the person we ask may not have the answer we need anyway. These reasons may or may not be true. But we are pretty confident that people will think less of us. Thus, good reasons or no, we do not ask for help.

Yet our recent research suggests that the instinct to avoid seeking advice is wrong. Though extremely common, fears about appearing incompetent by asking for help or information are sorely misplaced. Here is why: when you ask for advice, people do not think less of you; they think you are *smarter.* They reason, "I'm brilliant (of course), so this guy's smart for asking for my advice." And by asking someone to share his or her wisdom, a person strokes the adviser's ego and can gain valuable insights. Indeed, seeking guidance from others encourages information exchange and meaningful connection between us and our friends and colleagues.

Boosting "Competence"

Our counterintuitive conclusion about advice seeking emerges from a series of experiments we conducted between 2010 and 2013 with behavioral scientist Maurice Schweitzer of the Wharton School at the University of Pennsylvania. In one of these studies, which were published earlier this year, we asked 199 students to complete a "challenging brainteaser" that consisted of seven IQ test questions. We told half of the subjects that they would be paid $1 for each correct answer. We told the other half that they would be paid based on a partner's rating of their competence on a scale from 1 to 7 and would earn $1 for each point on the rating scale. Before answering the questions, participants could

JUN CEN

ALISON WOOD BROOKS and **FRANCESCA GINO** are behavioral scientists and professors at Harvard Business School.

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send a message to their partner, who had purportedly completed the brainteaser earlier. They could ask their partner for advice ("Hey, can you give me any advice?"), send no message or send a neutral greeting ("Hey, I hope you did well").

We found that 73.5 percent of participants who were paid based on their accuracy sought advice, whereas just 32.7 percent of those who were paid to make a good impression did. In other words, people were two times less likely to seek advice when they focused on appearing competent in the eyes of their partner.

In another study in this series, we collected data from the perspective of the person whose advice was being sought. We told 170 students that they would be matched with an anonymous partner in the same room. In reality, the partner was just a computer program. Subjects had to complete a brainteaser under time pressure and then were told that their partner would complete the same brainteaser later in the study. After the participants completed the problem, they received one of the following two messages from their partner: "I hope it went well. Do you have any advice?" or, simply, "I hope it went well." Then they evaluated their partner's competence and indicated how likely they would be to ask their partner for advice on a similar problem-solving task.

Compared with those receiving the neutral greeting, participants who were asked for advice both rated their partner as more competent and reported that they would be more likely to ask their partner for advice on a similar task in the future. Thus, being asked for advice *increased* judgments of the advice seeker's competence. In this work, we also learned why being asked for guidance has this positive effect: the request flatters the adviser and increases his or her self-confidence. When others ask for our advice, therefore, we think that they were smart to come to us for help!

In general, flattery reflects positively on the flatterer, even if the fawning is insincere. In studies published in 2010 marketing researchers Elaine Chan and Jaideep Sengupta, both then at Hong Kong University of Science and Technology, found that people who were given a printed advertisement from a department store that complimented their sense of fashion had higher opinions of the store than did those who received the same ad without any flattering message.

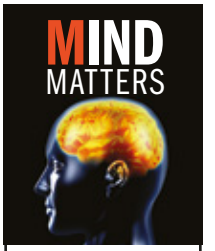
Asking for Favors

Soliciting advice is an effective strategy not only when we are facing a difficult task but also when we have made a mistake or experienced failure or conflict. In her Ph.D. thesis, published in 2010, organizational behavior scholar Katie A. Liljenquist, then at Northwestern University, had M.B.A. students engage in a simulated performance review. When those playing the role of a junior manager received a surprisingly negative performance review and asked for advice on how to improve, those playing their bosses considered them to be more likable and competent than those who did not. Similarly, Liljenquist found that when facing conflict in negotiations, asking your counterpart for advice increases perspective taking, leading to a more rapid and likely resolution of the conflict.

Another unfounded assumption is the fear that people will refuse requests for information or assistance, leaving us embarrassed. In research published in 2008 organizational behavior researcher Francis Flynn and social psychologist Vanessa Bohns, both then at Columbia University, told participants to ask for favors in campus settings after estimating how many people they thought would comply with their requests. The favors included borrowing a stranger's cell phone to make a call, soliciting individuals to fill out questionnaires, and asking students to help locate the campus gym and walk at least two blocks toward it. Participants estimated that they would have to ask 50 percent more people than they actually needed to ask.

The power of advice seeking has limits. For example, in one of our recent studies we asked people to identify areas of personal strength and weakness, such as their knowledge of sports, musical instruments or geography. Next, an experimenter approached them for advice in their area of self-identified *weakness*. The nonexperts were perplexed by these requests and viewed the asker as less competent for seeking their help. This makes sense: you cannot stroke someone's ego when they are 100 percent sure they are not knowledgeable about a topic. Yet in a final study in the same paper, we found that even asking for advice on a very easy task—although it did not increase judgments of competence—did not harm evaluations either. Asking for advice is not nearly as risky an endeavor as we tend to think. M

> FLATTERY REFLECTS POSITIVELY ON THE FLATTERER, **EVEN IF THE FAWNING IS INSINCERE.**



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 in Boston.

FURTHER READING

- **"Why Didn't You Just Ask?" Underestimating the Discomfort of Help Seeking.** Vanessa K. Bohns and Francis J. Flynn in *Journal of Experimental Social Psychology,* Vol. 46, No. 2, pages 402–409; March 2010.
- **Sidetracked: Why Our Decisions Get Derailed, and How We Can Stick to the Plan.** Francesca Gino. Harvard Business Review Press, 2013.

A DEBATE

Two Natural Philosophers, Centuries Apart, Converse about the Mind

Can you guess who they are?

MICHAEL WITTE (*illustrations*); SEAN McCABE (*Koch*)

In the Dutch countryside, a tall, older man, dressed in a maroon sports coat, his back slightly stooped, stands out because of his height and a pair of extraordinarily bushy eyebrows. His words, inflected by a British accent, are directed at a middle-aged man with long, curly brown hair, penetrating eyes and a dark, scholarly gown, who talks in only a halting English that reveals his native French origins. Their strangely clashing styles of speaking and mismatched clothes do not seem to matter to them as they press forward, with Eyebrows peering down intently at the Scholar. There is something distinctly odd about the entire meeting—a crossing of time, place and disciplines.

Eyebrows: So I finally meet the man who doubts everything.

The Scholar: (*not missing a beat*) *At this time, I admit nothing that is not necessarily true*. I'm famous for that!

Eyebrows: Is there anything that you are certain of? (*sotto voce*) Besides your own fame?

The Scholar: (*evading the sarcastic jibe*) I can't be certain of my fame. Indeed, I can't even be certain that there is a world out there, for I could be dreaming or hallucinating it. I can't be certain about the existence of my own body, its shape and extension, its corporality, for

BY CHRISTOF KOCH

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

again I might be fooling myself. *But now what am I, when I suppose that there is some supremely powerful and, if I may be permitted to say so, malicious deceiver who deliberately tries to fool me in any way he can?* Given this evil spirit, how do I know that my sensations about the outside world—that is, it looks, feels and smells in a particular way—are not illusions, conjured up by Him to deceive me? It seems to me that therefore I can never know anything truly about the world. Nothing, *rien du tout*. I have to doubt everything.

Eyebrows: So what's left after your lucubrations dissolve everything?

The Scholar: Ah, but I only doubt to establish with more absolute certainty one fact that cannot be denied: I exist! For there is something that does the perceiving and the thinking. *I am therefore precisely nothing but a thinking thing; that is, a mind or intellect, or understanding, or reason. I think, therefore I am.*

Eyebrows: Yes, in my own time, schoolchildren learn all about your "*je pense, donc je suis*." The only direct acquaintance you have with anything in the universe is with your own conscious sensations and thoughts. Everything else, the existence of your body, of other bodies, animals, trees and the heavens has to be inferred. I've taken the liberty to reformulate your phrase as "I am conscious, therefore I am." Some have called this deduction of yours the most famous one in Western thought.

Scholar: (*flushing with pleasure but unflinching in his arrogance*) Yes, yes, I'm not surprised. But even better, I can also prove the necessary existence of God.

Eyebrows: (*curtly*) Never mind—that proof didn't amount to much. (*then tauntingly*) But tell me your thoughts on the relationship of this I, this self, this mind with the body that it inhabits.

The Scholar: Speaking as a *physician,* that is, as a natural philosopher …

Eyebrows: Yes, what I would call a scientist …

The Scholar: (*testily*) Pray, can I continue without interruption? Speaking as such a scholar, I have shown that the bodies and brains of animals and humans are entirely made out of material stuff that has extension and weight and can exert force. This corporeal substance I call *res extensa*. Like flowing water that powers the moving statues of gods, satyrs, tritons, nymphs and heroes in the fountains at the court of the king in Versailles, animal spirits flow through the arteries, cerebral cavities and nervous tubules of all creatures, making them move. In this manner, the way animals and people run, climb, burrow, chew, move their eyes and otherwise act can be explained mechanically. Based on my dissections of the brains and bodies of animals, their behaviors are caused by the action of particles distinguished by their size, shape and motion. This is also true of the dumb movement and reflexes of men, which can be explained by thinking of their bodies and brains as machines. But I don't accept, as do the libertines, that the animals have minds like those of men.

Eyebrows: (*interrupting*) And women, too, I suppose.

The Scholar: (*with irritation*) Anyhow, men differ in that they have true language and not just simple utterances and warning cries like animals. And unlike animals, men have an immortal soul. My conception of *res cogitans* explains all of that. This thinking substance is responsible for speaking, imagining and sensing, remembering and reasoning. Two substances explain it all. Everything is either physical or mental. Quite elegant, if I might say so.

Eyebrows: But let me tell you that in my time they build mechanical contrivances, machines that reason, recognize, count and remember based on something called algorithms, mathematical recipes or procedures that break down any task into minuscule steps, each one well specified and fully detailed. Starting with some input, a precise command—such as "Add these two 'numbers'" or "What is a large city in Europe?"—an algorithm will take that input and transform it, using the language of 0's and 1's, into some output. After an uncountable number of such elementary operations, the algorithm will come up with an answer, the sum of the two numbers or maybe simply just "London." You don't need thinking stuff to get a machine to add or to reason.

EYEBROWS: OUR ONLY ACQUAINTANCE WITH THE UNIVERSE IS WITH OUR OWN CONSCIOUS SENSATIONS … EVERYTHING ELSE HAS BE TO BE INFERRED.

The Scholar: (*with surprise*) These be wondrous automatons, like the chess automaton that I have heard the Turkish sultan has in his palace. But tell me, Englishman—these simulacra of human brains, these machines that you talk of, can they truly speak?

Eyebrows: Yes, you can speak to them, and they answer back in a voice that has

a certain tinlike, mechanical quality to it. Our artisans excel at building these wondrous machines so small that they fit into the palm of one's hand, made out of glass and copper and sand. But more important is that the existence of these speaking machines implies that your kind of dualism is wrong. We don't need your ethereal thinking stuff to explain how men talk and reason. We have algorithms that can recognize a picture, play chess, drive a carriage, learn from experience, search for things on the world's marketplaces, determine how much taxes you owe the queen and reason about logical puzzles. People are but intricate machines made out of nothing but matter, your *res extensa*.

The Scholar: (*with urgency*) But where does this leave the divine soul, the immortal soul that God himself placed into each man and each woman?

Eyebrows: Sir, I have no need of that hypothesis.

The Scholar: Heathen! Atheist! Amoralist!

Eyebrows: (*condescendingly*) Well, we know better. (*then quickly, to quiet his companion's discomfort*) But tell me your ideas concerning the import of the pineal gland.

The Scholar: Well, the nature of each of our sensations or experiences is unitary. When I look at the full moon at night, I don't have two experiences, one of a bright disk and a second experience of the color yellow. Rather I see the yellow moon. And, of course, I have but one will. I know from my dissections of cadavers that everything in the brain comes in pairs: there are two hemispheres inside the skull, and they, in turn, consist of smaller structures, such as the cerebral ventricles, that come in pairs, matched on the left and on the right. So they can't be the places where the thinking substance acts. But there is only one pineal gland, right at the center of each brain. This is where the *res extensa* meets *res cogitans;* this is the seat of the soul.

Eyebrows: (*admiringly*) Very clever. Linking a structure in the body to a specific function. I, too, in my youth, made such a structure-function inference about the molecule of life and became famous for it. But, unfortunately, you got your anatomy wrong. For when you look with a microscope …

The Scholar: (*interrupting*) Yes, I heard of this wondrous instrument, invented not far away from where I live, but I don't have one.

Eyebrows: Anyhow, when you peer through a miscroscope, you see two pineal glands, one for each hemisphere, interdigitated. And when you lose your pineal gland, neither life nor consciousness leaves the body. It's neither the pineal gland nor the fluid circulating in the ventricles that do the job. In my time, we learned from doctors and scientists that it is the gray matter of the cortex that is the seat of perception, intelligence and reason. It is in the catacombs of the cere-

THE SCHOLAR: THERE IS ONLY ONE PINEAL GLAND AT THE CENTER OF EACH BRAIN. **THAT IS THE SEAT OF THE SOUL.**

bral cortex, made out of billions of tiny specialized organs called nerve cells, that any one conscious sensation is born. I myself thought for a while that I had discovered the footprints of the conscious mind in the brain—that a particular type of vibration in the activity of nerve cells located deep in the windings of the cerebral sheet was the imperial purple, the signature of mind. But more recent experiments suggest that these oscillations are linked to the effects of paying attention to a particular event and not of becoming conscious of the event. So my pretty oscillation hypothesis looks to be as wrong as your pineal gland guess.

EYEBROWS: I THOUGHT I HAD FOUND TRACES OF CONSCIOUSNESS—AN ERROR SIMILAR TO **ASSUMING THE SOUL IS IN THE PINEAL GLAND.**

The Scholar: So we were both wrong. (*then triumphantly*) But wait—how do you squeeze incorporeal consciousness, a sensation, out of matter, out of physical stuff? Your theory lacks something essential.

Eyebrows: (*engagingly*) Ah, therein lies the rub. For you are right—whether it is the pineal gland, 40-hertz spiking patterns of layer 5 pyramidal cells projecting to the frontal part of the cortex (never mind, you wouldn't understand), or something far stranger—why does THIS mechanism give rise to feelings, to subjectivity, but not THAT mechanism? It seems arbitrary. For nowhere in physics does consciousness appear, yet the brain—a physical object—is conscious. A famous German scholar wrote a bit after you: "*Moreover, we must confess that the perception, and what depends on it, is inexplicable in terms of mechanical reasons, that is, through shapes and motions. If we imagine that there is a machine whose structure makes it think, sense, and have perceptions, we could conceive it enlarged, keeping the same proportions, so that one could enter into it, as one enters into a mill. Assuming that, when inspecting its interior, we will only find parts that push one another, and we will never find anything to explain a perception.*" In my times, philosophers refer to this as the Hard Problem, with a capital H, forever unsolvable by science. But they underestimate the power of natural philosophy, of science, to fully plumb and measure the world and render it comprehensible to reason.

The Scholar: Your world appears to worship at the altar of science. I hope this science has given all of its citizens peace and happiness. Yet you still haven't explained consciousness, how the soul comes into the body. Maybe I was wrong about the need for special thinking stuff; maybe machines can reason or speak without it. But do they feel anything when they do reason or speak?

Eyebrows: (*sobering*) I must admit my ignorance. Today we have a concept called information. We can quantify how much information a message contains, such as a letter or cypher communicated by lanterns between ships, and how to send this information across the globe. A modern Italian doctor and natural philosopher, an intellectual descendant of Galileo Galilei with whom you are well familiar, has invented something that he calls integrated information—the difference that makes a difference to the brain itself, from its own intrinsic perspective, that might solve the seemingly insurmountable difficulty of explaining how matter is linked to sensation, how the water of the brain is turned into the wine of conscious experience.

Not understanding much of this last bit but mollified by the metaphor from the New Testament, the Scholar and Eyebrows continue their learned disputation, walking slowly off into the Dutch countryside, the home of the Scholar, until gradually we lose sight of them. M

This imaginary dialogue takes place between biologist Francis Crick, the explorer of genes and neurons, and mathematician and philosopher René Descartes, the exponent of dualism, that metaphysical teaching that the mind and brain are two separate magisteria. The italicized parts of the Scholar's speech are verbatim translations from Descartes's texts. The famous citation about the mill is from Gottfried Leibniz, the mathematician, scientist, lawyer and philosopher who invented binary numbers and co-invented calculus. The last reference is to Giulio Tononi's integrated information theory.

COURTESY OF CHRISTOF KOCH

Eyebrows (*left*) and Koch. Many years ago Koch graduated from a high school named after René Descartes, and he worked closely for years with Francis Crick.

FURTHER READING

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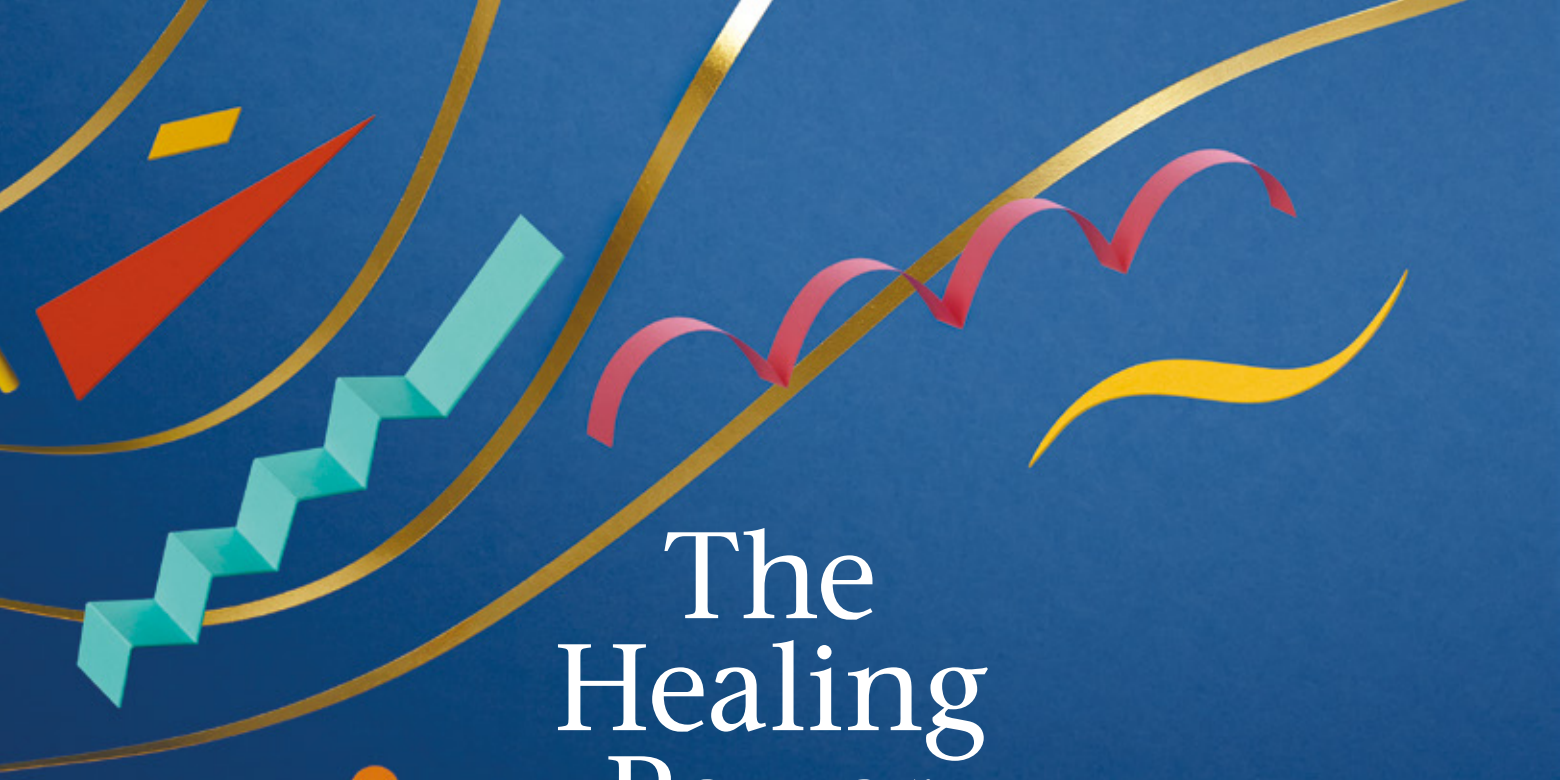


The Healing Power of Music

New therapies are using rhythm, beat and melody to help patients with brain disorders recover language, hearing, motion and emotion

By William Forde Thompson and Gottfried Schlaug

ILLUSTRATIONS BY CHRISSIE MACDONALD

One day when Laurel was 11, she began to feel dizzy while playing with her twin sister and some friends in a park on Cape Cod. She sat down, and one of her friends asked her if she was okay. And then Laurel's memory went blank. A sudden blockage in a key blood vessel leading to the brain had caused a massive stroke. Blood could no longer reach regions crucial for language and communication, resulting in permanent damage. Laurel was still able to understand language, but she struggled to vocalize even a single word, and what she managed to say was often garbled or not what she had intended.

Except when she *sang*.

Through a type of treatment called melodic intonation therapy, Laurel learned to draw on undamaged brain regions that moderate the rhythmic and tonal aspects of language, bypassing the speech pathways on the left side of her brain that were destroyed. In other words, she found her way back to language through music.

The therapeutic program that helped Laurel—like the others we focus on in our work as scientists and clinicians—is one of a new class of music-based treatments based directly on the biology of neurological impairment and recovery. These treatments aim to restore functions lost to injury or neurological disorders by enlisting healthy areas of the brain and sometimes even by reviving dysfunctional circuitry. As evidence accumulates about the effectiveness of these techniques, clinicians and therapists from a variety of fields have begun to incorporate them into their practices, most notably music therapists, who are at the intersection of music and health and important mediators of these interventions, as well as speech therapists and physical therapists. And among the beneficiaries are people diagnosed with stroke, autism, tinnitus, Parkinson's disease and dementia.

As scientists learn more about the effect of music on cognitive and motor functions and mental states, they can tailor these therapies for each disorder, targeting specific brain injuries or dysfunctions. In Laurel's case, the treatments were designed to trigger, over time, the development of alternative neural pathways in healthy parts of the brain that would compensate for the lost pathways in the damaged language centers. But the ultimate aim was to help her recapture as much as she could of the world that had collapsed around her that day in the park.

Music as Medicine

Across cultures and throughout history, music listening and music making have played a role in treating disorders of the mind and body. Egyptian frescoes from the fourth millennium B.C. appear to depict the use of music to enhance fertility in women. Shamans in the highland tropical forests of Peru use chanting as their primary tool for healing, and the Ashanti people of Ghana accompany healing ceremonies with drumming.

Much of the power of music-based treatment lies in its ability to meld numerous subtle benefits in a single, engaging package [*see boxes beginning on this page*]. Music is perhaps unrivaled by any other form of human expression in the range of its defining characteristics, from its melody and rhythm to its emotional and social nature. The treatments that take advantage of these attributes are rewarding, motivating, accessible and inexpensive, and basically free of side effects, too. The attractive quality of music also encourages patients to continue therapy over many weeks and months, improving the chance of lasting gains.

The view that music can be useful in treating neurological impairment gained some scientific heft in a landmark study published in 2008. Psychologist Teppo Särkämö of the University of Helsinki and his team recruited 60 patients who had suffered a stroke in the middle cerebral artery of one hemisphere. They split the patients into three groups: the first participated

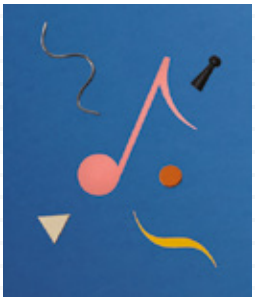
MUSICAL ATTRIBUTES

Music is a uniquely effective tool for treating neurological impairment because it recruits nearly every region of the brain. Imaging studies show that both listening to and making music spur activity and foster connections across a wide swath of brain regions typically involved in emotion, reward, cognition, sensation and movement. Here are seven ways music might work to benefit our mind and brain: ⇨

FAST FACTS

MUSICAL PRESCRIPTIONS

1. Music can be a powerful tool in the treatment of brain disorders and acquired injuries, helping patients recover language and motor skills.
2. New music-based therapies can trigger neuroplasticity—fostering local connections and long-range pathways that compensate for impairments in damaged regions of the brain.
3. The greatest benefits from therapy—cognitive, emotional and social—come from effortful engagement with music.



Music is Physical

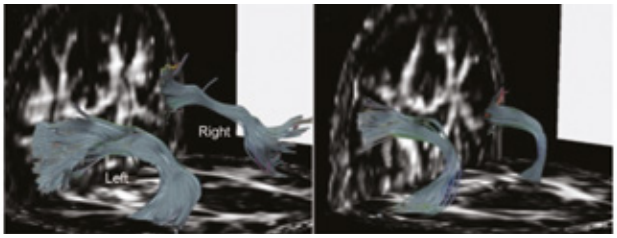
Music encourages people to move with the beat. The more salient the beat, the more sweeping and emphatic the body movements. Physical exercise can help improve circulation, brain health, and fine and gross motor function.

in daily sessions of music listening, the second listened to audiobooks every day and the third received no auditory treatment. Researchers observed the patients over two months. Those in the group that listened to music exhibited the greatest recovery in verbal memory and attention. And because listening to music appears to improve memory, the hope now is that active music making—singing, moving and synchronizing to a beat—might help restore additional skills, including speech and motor functions in stroke patients.

The Singing Cure

The variety of music-based treatment that Laurel received springs from a remarkable observation about people who have had a stroke. When a stroke affects areas of the brain that control speech, it can leave patients with a condition known as nonfluent aphasia, or an inability to speak fluently. And yet, as therapists over the years have noted, people with nonfluent aphasia can sometimes sing words they cannot otherwise say.

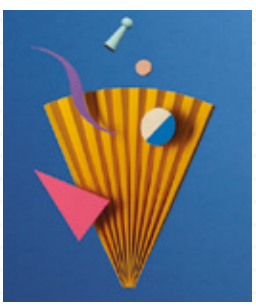
In the 1970s neurologist Martin Albert and speech pathologists Robert Sparks and Nancy Helm (now Helm-Estabrooks), then at a Veterans Administration hospital in Boston, recognized the therapeutic implications of this ability and developed a treatment called melodic intonation therapy in which singing is a central element. During a typical session, patients will sing words and short phrases set to a simple melody while tapping out each syllable with their left hand. The melody usually involves two notes, perhaps separated by a minor third (such as the first two notes of "Greensleeves"). For example, patients might sing the phrase "How are you?" in a simple up-and-down pattern, with the



Images show the arcuate fasciculus, an auditory-motor tract, in each hemisphere of a healthy musician (*left*) and a healthy nonmusician, both in their early 60s, demonstrating the brain-enhancing benefits of lifelong music making.

stressed syllable ("are") assigned a higher pitch than the others. As the treatment progresses, the phrases get longer and the frequency of the vocalizations increases, perhaps from one syllable per second to two.

Each element of the treatment contributes to fluency by recruiting undamaged areas of the brain. The slow changes in the pitch of the voice engage areas associated with perception in the right hemisphere, which integrates sensory information over a longer interval than the left hemisphere does; as a consequence, it is particularly sensitive to slowly modulated sounds. The rhythmic tapping with the left hand, in turn, invokes a network in the right hemisphere that controls movements associated with the vocal apparatus. Benefits are often evident after even a single treatment session. But when performed intensively over months, melodic intonation therapy also produces long-term gains that appear to arise from changes in neural circuitry—the creation of alternative pathways or the strengthening of rudimentary ones in the brain. In effect,



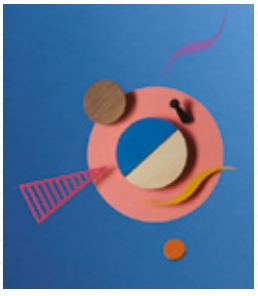
Music is Emotional

Music induces emotional states by initiating changes in the distribution of neurochemicals that can induce positive moods and heightened arousal, which may in turn increase the rate of change in the brain, speeding rehabilitation.

FROM "MUSIC MAKING AS A TOOL FOR PROMOTING BRAIN PLASTICITY ACROSS THE LIFE SPAN," BY CATHERINE Y. WAN AND GOTTFRIED SCHLAUG, IN *NEUROSCIENTIST*, VOL. 16, NO. 5; OCTOBER 2010

for patients with severe aphasia, singing trains structures and connections in the brain's right hemisphere to assume permanent responsibility for a task usually handled mostly by the left.

This theory has gained support in the past two decades from studies of stroke patients with nonfluent aphasia conducted by researchers around the world. In a study published in September 2014 by one of us (Schlaug) and his group at the Beth Israel Deaconess Medical Center and Harvard Medical School, 11 patients received melodic intonation therapy; nine received no treatment. The patients who received therapy were able to string together more than twice as many appropriate words per minute in response to a question. That same group also showed structural changes, assessed through MRI, in a right-hemisphere network associated with vocalization. The laboratory is now conducting studies to compare the benefits of melodic intonation therapy with other forms of therapy for patients with aphasia.



Music is
Engaging

Musical treatments are engrossing and rewarding, so patients are highly motivated to participate with enthusiasm, focus and dedication.

Because melodic intonation therapy seemed to work by engaging the right hemisphere, researchers then surmised that electrical or magnetic stimulation of the region might boost the therapy's power. In two recent studies that we conducted with our collaborators—one in 2011 at Beth Israel Deaconess and Harvard and the other in 2014 at the ARC Center of Excellence in Cognition and Its Disorders in Sydney, Australia—researchers stimulated an area in the right hemisphere called the inferior frontal gyrus, which helps to connect sounds with the oral, facial and vocal movements that produce them. For many participants, combining melodic intonation therapy with noninvasive brain stimulation yielded improvements in speech fluency after only a few sessions.

The benefits of melodic intonation therapy were dramatic for Laurel (who was part of a study led by Schlaug). The stroke had destroyed much of her left hemisphere, including a region crucial for language production known as Broca's area. When she began therapy in 2008, she could not string together more than two or three words, and her speech was often ungrammatical, leaving her frustrated whenever she tried to communicate. Her treatment plan was intensive—an hour and a half a day for up to five days a week, with 75 sessions in all. By the end of the 15-week treatment period, she could speak in sentences of five to eight words, sometimes more. Over the next several years she treated herself at home using the techniques she learned during the sessions. Today, eight years after her stroke, Laurel spends some of her time as a motivational speaker, giving hope and support to fellow stroke survivors. Her speech is not quite perfect but remarkable nonetheless for someone whose stroke damaged so much of her left brain. Evaluation of the long-term benefits of combination therapy is next on researchers' agenda.

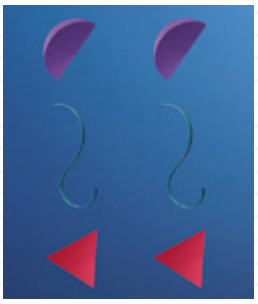
When performed intensively over months, melodic
appear to arise from changes in neural circuitry—the

Music and Motion

Music making can also help stroke survivors living with impaired motor skills. In a study published in 2007 neuropsychologist and music educator Sabine Schneider and neurologist Eckard Altenmueller, both then at the Hannover University of Music, Drama and Media in Germany, asked patients to use their movement-impaired hand to play melodies on the piano or tap out a rhythm on pitch-producing drum pads. Patients who engaged in this intervention, called music-supported training, showed greater improvement in the timing, preci-

THE AUTHORS

WILLIAM FORDE THOMPSON is a professor of psychology at Macquarie University in Sydney, Australia, and a chief investigator at the ARC Center of Excellence in Cognition and Its Disorders there. **GOTTFRIED SCHLAUG** is an associate professor of neurology at Harvard Medical School and Beth Israel Deaconess Medical Center and is a leading researcher on plasticity in brain disorders and music-based treatments for neurological impairments.



Music permits Synchronization

Music helps listeners synchronize rhythm (by tapping along) and melody (by singing along), addressing problems of timing, initiation and coordination in people with stroke, Parkinson's disease, and other brain disorders involving sensory and motor systems.

sion and smoothness of fine motor skills than did patients who relied on conventional therapy. The researchers postulated that the gains resulted from an increase in connections between neurons of the sensorimotor and auditory regions.

Rhythm is the key to treatment of people with Parkinson's, which affects roughly one in 100 older than 60. Parkinson's arises from degeneration of cells in the midbrain that feed dopamine to the basal ganglia, an area involved in the initiation and smoothness of movements. The dopamine shortage in the region results in motor problems ranging from tremors and stiffness to difficulties in timing the movements associated with walking, facial expressions and speech.

Music with a strong beat can allay some of these symptoms by providing an audible rhythmic sequence that people can use to initiate and time their movements. Treatments include so-called rhythmic entrainment, which involves playing a stimulus like a metronome. In neurologist Oliver Sacks's 1973 book *Awakenings*, musical rhythm sometimes released individuals from their immobility, letting them dance or sing out unexpectedly.

The use of rhythm in motor therapy gained momentum in the 1990s, when musician, music therapist and neuroscientist Michael Thaut of Colorado State University and other researchers around the world demonstrated a technique called rhythmic auditory stimulation, or RAS, for people who had trouble walking, such as stroke and Parkinson's patients. A therapist will first ask patients to walk at a comfortable speed and then to an audible rhythm. Tempos that pushed patients slightly past their comfort zone yielded the greatest improvements in velocity, cadence and stride length.

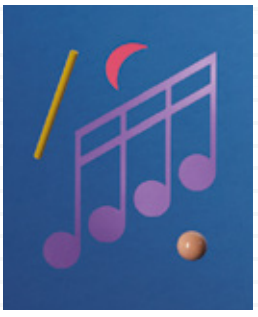
Despite these encouraging outcomes, the neural mechanisms that trigger improvements have been difficult to pin down. Imaging work suggests that during rhythmic auditory stimulation, neural control of motor behavior is rerouted around the basal ganglia; instead the brain stem serves as a relay station that sends auditory input to motor networks in the cerebellum, which governs coordination, and to other cortical regions that could help synchronize sound and motion.

Recovered Memory

Fewer neurological disorders inspire greater fear than dementia, one of the most common diseases of the elderly. According to some estimates, 44 million people worldwide are living with dementia, a number expected to reach 135 million by 2050. Alzheimer's disease, a neurodegenerative condition, accounts for more than 60 percent of the cases; multiple strokes can also cause so-called vascular dementia.

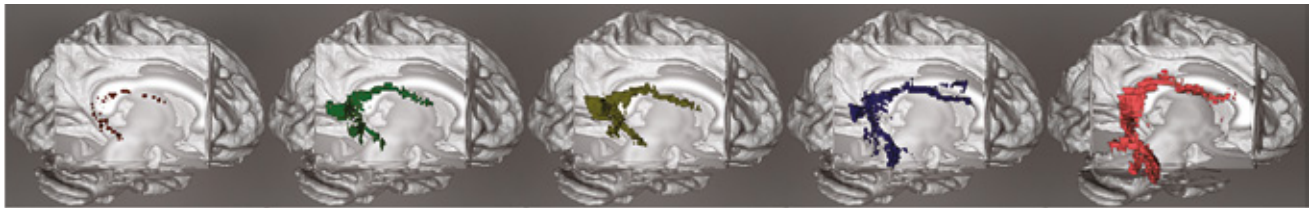
Music may be ideally suited to stimulating memory in people with dementia, helping them maintain a sense of self. Be-

intonation therapy produces long-term gains that creation of alternative pathways in the brain.



Music is Social

Musical activities can be collective experiences. Social isolation is a common consequence of many neurological disorders, and social support through music making helps in recovery, rehabilitation and coping.



The sequence above shows how, over time, melodic intonation therapy built up connections between the hearing and speaking regions in Laurel's healthy right brain.

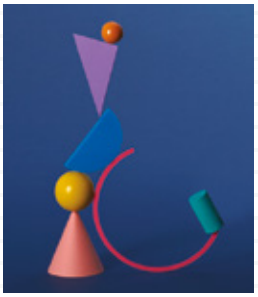
cause music activates neural areas and pathways in several parts of the brain, the odds are greater that memories associated with music will survive disease. Music also stimulates normal emotional responses even in the face of general cognitive decline. In a 2009 study psychologist Lise Gagnon of the University of Sherbrooke in Quebec and her colleagues asked 12 individuals with Alzheimer's and 12 without it to judge the emotional connotations of various pieces of music. The Alzheimer's participants were just as accurate as the others despite

ceive will vary, from receptive (listening) to active (dancing, singing, clapping). Music that the patient selects is most effective because the choice represents a connection to memory and self. The benefits vary, too, and tend to be short-term. But when the treatment does work, it reduces the feelings of agitation that lead to wandering and vocal outbursts and encourages cooperation

The positive response to music opens the way to engage in activities with other people, acquiring

significant impairments in different areas of judgment. Other research suggests that taking part in musical activities throughout life keeps the mind young and may even decrease the risk of developing dementia [see "Everyone Can Gain from Making Music," on page 40]; the continuous engagement of the parts of the brain that integrate senses and motion with the systems for emotions and rewards might prevent loss of neurons and synapses.

The type of therapy that individual dementia patients re-



Music is Persuasive

Music can make associated media such as lyrics and films seem more compelling. When patients believe in their treatment, their attitude tends to remain positive.

and interaction with others. Music therapy can also help patients with dementia sleep better and can enhance their emotional well-being.

These emotional and social benefits are clear in the case of June, an 89-year-old woman from New Hampshire. June has severe, irreversible dementia and is cared for at home by her daughter (who described her mother's circumstances to a clinician in Thompson's lab). Throughout the day, June is mainly nonresponsive and sits with her head hanging low. She cannot talk or walk, and she is incontinent. Yet when her daughter sings to her, June comes alive. She bangs her hands on her legs, smiles widely and begins to laugh. June especially loves Christmas songs and may even blurt out a word or two. When listening to music, she can bang her leg in time with the beat.

Music on the Spectrum

Perhaps the most fascinating interplay between music and the brain lies in the case files of people with autism spectrum disorder, a neurodevelopmental syndrome that occurs in 1 to 2 percent of children, most of whom are boys. Hallmarks of autism include impaired social interactions, repetitive behaviors and difficulties in communication. Indeed, up to 30 percent of people with autism cannot make the sounds of speech at all; many have limited vocabulary of any kind, including gesture.

One of the peculiarities of the neurobiology of autism is the overdevelopment of short-range brain connections. As an

COURTESY OF GOTTFRIED SCHLAUG

Music is Personal

Neurological impairment can make people feel that they have lost touch with themselves. The personal nature of music can evoke memories and help individuals maintain a sense of identity.

ing drums while singing or speaking words and phrases. In a proof-of-principle study, six completely nonverbal children took part in 40 sessions of this training over eight weeks. By the end, all were able to produce some speech sounds, and some were even able to voice meaningful and appropriate words during tasks that the therapy sessions had not covered. Most important, the children were still able to demonstrate their new skills eight weeks after the training sessions ended.

Quiet, Please

Music-based treatments can also train the brain to tune out the phantom strains of tinnitus—the experience of noise or ringing in the ear in the absence of sound that affects roughly 20 percent of adults. Age-related hearing loss, exposure to loud sounds and circulatory system disorders can all bring on the condition, with symptoms ranging from buzzing or hissing in the ears to a continuous tone with a definable pitch. The sensation can cause serious distress and interfere with the ability to concentrate on other sounds and activities. There is no cure.

The past decade has seen a surge in understanding of the neurological basis of the disorder. In one view, cochlear damage (most likely caused by exposure to loud sounds) reduces the transmission of particular sound frequencies to the brain. To compensate for the loss, neuronal activity in the central au-

treatments that can help children with autism social, language and motor skills as they do.

apparent consequence, children with autism tend to focus intensely on the fine details of sensory experience, such as the varying textures of different fabrics or the precise sound qualities emitted by appliances such as a refrigerator or an air conditioner. And this fascination with sound may account for the many anecdotal reports of children with autism who thoroughly enjoy making and learning music. A disproportionate number of children with autism spectrum disorder are musical savants, with extraordinary abilities in specialized areas, such as absolute pitch.

The positive response to music opens the way to treatments that can help children with autism engage in activities with other people, acquiring social, language and motor skills as they do. Music also activates areas of the brain that relate to social ways of thinking. When we listen to music, we often get a sense of the emotional states of the people who created it and those who are playing it. By encouraging children with autism to imagine these emotions, therapists can help them learn to think about other people and what they might be feeling.

Recently the Music and Neuroimaging Laboratory at Beth Israel Deaconess and Harvard (which Schlaug directs) developed a new technique called auditory-motor mapping training, or AMMT, for children whose autism has left them unable to speak. The treatments have two main components: intonation of words and phrases (changing the melodic pitch of one's voice) and tapping alternately with each hand on pitch-produc-

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ditory system changes, creating neural "noise," perhaps by throwing off the balance between inhibition and excitation in the auditory cortex, leading to the perception of sounds that are not there. Also at play might be dysfunctional feedback to auditory brain regions from the limbic system, which is thought to serve as a noise-cancellation apparatus that identifies and inhibits irrelevant signals.

Music treatment seeks to counteract this dysfunction by inducing changes in the neural circuitry. For those with tonal tinnitus, one treatment involves listening to "notched music," generated by digitally removing the frequency band that matches the tinnitus frequency. The notching—pioneered and proved effective by neurophysiologist Christo Pantev and his group at the University of Münster in Germany—might help reverse the imbalance in the auditory cortex, strenghtening the inhibition of the frequency band that might be the source

Everyone Can Gain from Making Music

The perks of learning to play an instrument last for decades

By Julia Calderone

REGINE MAHAUX *Alamy*

Think back to your elementary school music class. You absorbed commands from a baton-wielding conductor while deciphering inky notes on a page. You kept tempo with the rest of the band while your contorted fingers sped from key to key. There is no doubt that musical training is a challenge for the brain. And in the past decade an abundance of studies have found that this effort confers cognitive benefits on all who study music, from toddlers to retirees.

Researchers became interested in the effects of music on the brain when a provocative study in the early 1990s claimed that simply listening to a Mozart sonata could make you brainier—so dubbed the "Mozart effect." The finding was never confirmed. Various studies followed that showed listening to music has transient effects on cognitive functions such as spatial ability, speed of processing and creative problem solving—but such effects last only about 10 minutes once the music is switched off. Experts continue to debate whether frequently engaging with music has longer-term effects on cognition. In recent years new techniques to measure the brain's response to auditory cues in real time have given researchers valuable data to address the issue. "We can see how these ingredients of sound are processed by the brain," says Nina Kraus, an auditory neuroscientist at the Northwestern University School of Communication. Today some evidence suggests that musical training may enhance a suite of cognitive functions, including listening, linguistics, focus and memory, along with spatial, motor and mathematical skills.

Better Reading through Music?

Young children are ripe subjects for research in this field because their brains are primed to develop language skills, which music seems to enhance. Many studies suggest that children who are musically trained have stronger cognitive abilities, including better vocabulary, reading skills and sound perception. Yet these studies leave unanswered the important question of correlation: Are musicians better at certain tasks because of musical practice alone? Or are they drawn to music because they have these skills already or because they come from advantaged backgrounds?

Kraus and her colleagues have conducted a number of studies to tackle this question. In one experiment published last September, they gathered 44 children aged six to nine from disadvantaged schools in Los Angeles and asked them to participate in musical instruction for two hours a week. One group practiced for one year; the other practiced for two. After administering a battery of neurophysiological tests that recorded their brain activity, Kraus's team found that those who participated in the music program for two years, independent of their age, were markedly better at processing speech syllables—such as differentiating between the sounds [ba] and [ga]—than those who had only one year of training.

As Kraus explains, a key element of literacy is the ability to discern meaningful differences between speech sounds—so studying music, which shares characteristics with speech such as pitch,

of the phantom sound in the first place. Another approach involves playing a series of pitches to patients and then asking them to imitate the sequence vocally. As the patients refine their accuracy, they learn to disregard irrelevant auditory signals and focus on what they want to hear. In time, the stimulus of effortful attention might help the auditory cortex return to its normal physiological state.

For any novel therapy, enthusiasm can sometimes outpace the evidence, and researchers have rightly pointed out that the new music-based treatments must prove their efficacy against the more established therapies. But of all the techniques for addressing neurological disorders, music-based therapies seem unique in their capacity to tap into emotions, to help the brain find lost memories, to let patients resume their place in the world. We are only now beginning to understand the science behind the belief in the power of music to heal. **M**

timing and timbre, may help kids read better. The authors say the study provides the first direct evidence that a community music program for at-risk youth has a biological effect on the children's developing nervous systems. Other experts urge caution when interpreting these results. "We already know that music training makes you a better listener," says psychologist Glenn Schellenberg, who researches music's effect on cognition at the University of Toronto Mississauga. Until researchers have behavioral evidence that kids who get music training become superior at reading or perceiving speech, he explains, the question of whether music can influence language development remains open.

Empathetic Multitaskers

As a musician grows up, other cognitive benefits appear, among them a better ability to multitask, according to a 2014 study by psychologist Melody Wiseheart and her colleagues at York University in Toronto. The team recruited 153 university students aged 18 to 31, about half of whom were musicians with about 12 years of formal musical training; the others were nonmusicians. The students performed multitasking exercises, such as switching between identifying how many numbers were on a screen and indicating which particular number was on the screen or tracking a moving white dot with their mouse while monitoring a flashing set of letters.

"We found that musicians were doing a lot better," Wiseheart says; they were about 30 percent more accurate than the nonmusicians when performing two tasks at once. She says that musicianship appears to enhance working memory, which underlies the ability to multitask and can boost skills both in and out of the classroom—when holding numbers in mind to compute an equation, for instance, or avoiding distractions while driving.

Playing in a band or singing in a choir provides another type of benefit important for this age group. Studies show that making music in a group improves communication, coordination, cooperation and empathy among group members. Many of these advantages of musicianship may be felt for decades, but some may not. For example, child musicians appear to have better spatial reasoning than their nonmusician peers, but adult musicians do not.

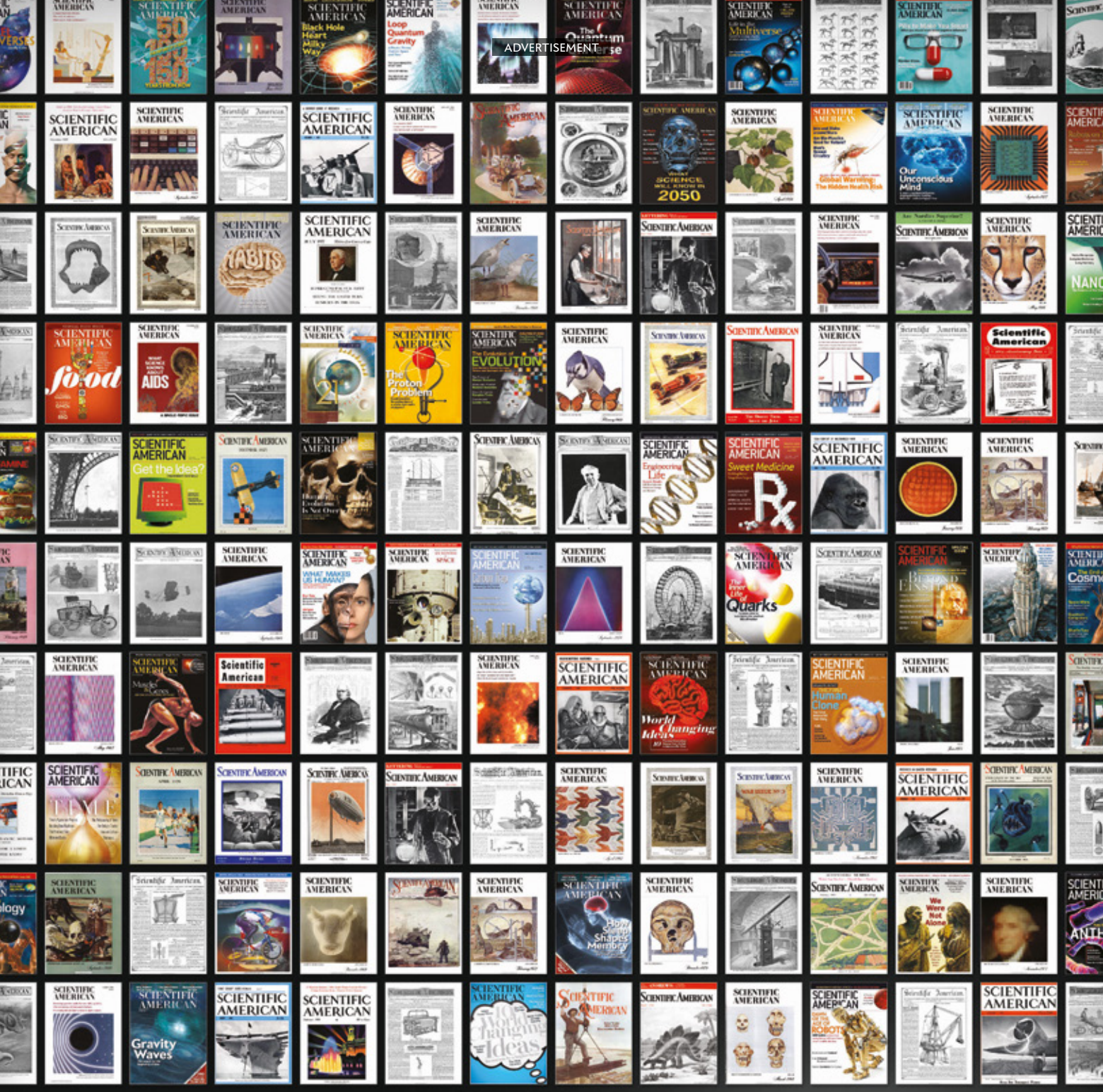
Preventing Age-Related Decline

Many areas in which child and young adult musicians outperform their nonmusician peers—such as processing speed, memory and attention—also happen to correlate with areas of cognitive decline in old age. A small but growing body of evidence suggests that lifelong musical practice makes our brains healthier as we age—especially in combating hearing loss, which affects an estimated two thirds of adults older than 70 in the U.S. A series of studies by neuroscientist Alexandra Parbery-Clark of the Swedish Medical Center in Seattle and her colleagues found that musicians aged 45 to 65 appear to lack four of the five hallmark declines of speech processing in old age—they maintained consistent and speedy brain responses to speech, for example, and the ability to understand speech in noisy settings.

In addition, studies suggest that older adult musicians tend to have stronger memory, more focused attention and faster brain processing. Although such effects are most evident in adults who have practiced their instrument at least twice a week for 20 minutes a session since childhood, researchers think that such benefits may also exist for less enthusiastic hobbyists. The act of making music appears to be key because it requires the integration of various senses, motor coordination and concentration in a way that even very attentive listening does not.

What this means is that learning to play a musical instrument is very good for you. And when that practice begins early in life, its positive effects can stretch into old age. "Biologically, our past shapes our present," Kraus says. Both she and Wiseheart hope educators and policy makers will take note of this research and keep music in classrooms. As Kraus says, "We want to improve human communication by harnessing the brain's ability to change."

Julia Calderone is a freelance science writer and former Mind *intern.*



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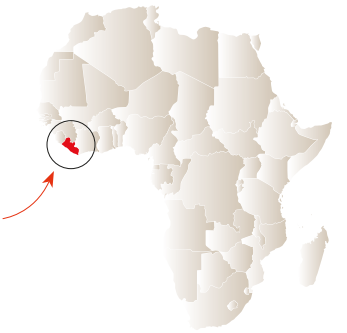
STANDING UP TO EBOLA

AN AMERICAN WOMAN RISKS HER LIFE TO OFFER HOPE AND A HOME TO CHILDREN IN LIBERIA

BY MOLLY KNIGHT RASKIN

PHOTOGRAPHS BY KATIE MEYLER



Katie Meyler (*below*), an American, founded a school for destitute children in a slum called West Point in Liberia (*right*). The school later became a home for children orphaned by the Ebola epidemic.

Before Katie Meyler came to West Point, Liberia, the children living there had little hope for the future. The crowded township, which lies on a peninsula that juts into the Atlantic Ocean at the northern end of Monrovia, Liberia's capital, is the worst slum in the country. Less than two square miles in size, West Point is home to more than 75,000 people crammed into decaying tin shanties without electricity, running water or sanitation.

"It's no place for a child," says the 32-year-old Meyler, a native of Bernardsville, N.J. "But the kids who live there don't have a choice. West Point is their home."

For decades, West Point has been a blight on an already battered Liberia, a small, impoverished country that suffered 14 years of civil war. A walk through its congested, meandering mud passageways is like a visual assault; indelible images of abject poverty and crime appear at every turn. Visitors to Liberia are cautioned to avoid West Point altogether, and those who do venture there are hard-pressed to forget the barely clothed children who wander aimlessly in search of food or clean water or the residents who defecate on the public beaches next to swelling, fetid mounds of garbage.

But the same community that can make even the steeliest aid worker blanch tugged at Meyler when she first traveled to Liberia as a college student with Samaritan's Purse, an international Christian relief organization, in 2006. "I was completely drawn to it," recalls Meyler, who speaks and gesticulates with the bubbly enthusiasm of a teenager. "Where other people saw suffering, I saw beauty and resilience."

Liberians' resilience would be sorely tested, however, when their country faced its worst-ever public health battle in 2014, one that tore a path of death and destruction through a community that Meyler and others had been tirelessly trying to rebuild. The crisis would force Meyler to change course and face the terror head-on and, in its wake, combat a mental health crisis marked by widespread depression, post-traumatic stress disorder and fear.

Learning to Heal

Meyler's nearly instant connection with Liberia rose out of her own upbringing. Raised by a single mother, Joann, who worked two jobs to support her family of three, Meyler grew up in the clutch of poverty. The family would have gone hungry without food stamps, and the kids depended on charitable neighbors in their mostly affluent town to drop garbage bags filled with clothing on their doorstep. Meyler, in turn, devoted herself to community service. As a high school student, she spent her summers traveling with faith-based aid organizations to developing countries and logged more than 500 hours as a volunteer, which earned her a college scholarship.

After graduating from North Central University in Minneapolis, Meyler found herself back in Liberia—first with Samaritan's Purse, then with the Shine Foundation, which assigned her to West Point to develop a mentoring program for ex-combatants and an educational program for 150 youngsters who lacked access to school. Working in the squalid community, Meyler grew incensed at the violence against young girls and their lack of opportunity. Although the country boasts the first democratically elected female president in Africa, Ellen John-

FAST FACTS

THE IMPOSSIBLE FIGHT

1. In early January, Save the Children estimated that as many as 10,000 children had lost one or both parents to Ebola.
2. As with children of war, many of those who survive the virus will be abandoned and be without access to education or health care.
3. Even before the Ebola crisis, 44 percent of people in Liberia met the clinical criteria for post-traumatic stress disorder and 40 percent for major depressive disorder.
4. Liberia has just one practicing psychiatrist, one small psychiatric hospital, and fewer than 100 clinicians working in neurology or mental health.

MOLLY RASKIN (*portrait of Katie Meyler*); ISTOCKPHOTO (*map*)

Lacking a sewage system or organized trash collection, West Point, a township in Liberia's capital of Monrovia, is infested with waste and garbage.

son Sirleaf, violence against women and girls remains alarmingly high. Rape is one of the most frequently reported crimes in Liberia, with most victims between eight and 18. Many of the girls in the country's ghettos, including West Point, are forced into prostitution in exchange for basic needs. "I had to do something," Meyler says.

Meyler befriended dozens of girls in West Point, posing a question to them that no one had ever cared enough to ask: If you could have anything in the world, what would it be? Their unanimous answer took Meyler by surprise: an education. Although the law mandates free primary education for all Liberian children, most schools charge fees for operating costs, books and teacher salaries—fees most Liberians cannot afford. "They could have asked for so many things, like clean drinking water or food," Meyler says. "I wasn't a good student and didn't like school much. But to these girls, an education meant a chance at life."

Before leaving Liberia in 2007, Meyler promised the girls she would get them into school. Yet when she returned to the U.S., she realized she had no idea how. "I didn't have any of the things I thought I needed to start a nonprofit—no celebrity status, no Ivy League education, no trust fund," Meyler says. One day, as she continued to agonize over her lack of credentials, a friend offered the following advice: "It's not about you, Katie."

In 2008 Meyler filed the paperwork for the Liberia-based nonprofit More Than Me foundation, with the goal of getting girls off the streets of West Point and into school, where they would be protected from the endemic violence and learn the skills necessary to get jobs. In 2010 she launched More Than Me on a shoestring budget of grants, individual donations and prize money from a few charitable contests, which she used to

BY THE END OF 2011, MORE THAN ME WAS FUNDING TUITION FOR MORE THAN 50 AT-RISK GIRLS AND HAD STARTED CONSTRUCTION ON A SCHOOL, RENOVATING A WAR-DAMAGED BUILDING.

send more than two dozen at-risk Liberian girls to schools in Monrovia. Traveling back and forth between Liberia and the U.S., Meyler and her staff of 13 volunteers also began planning for a school of their own. In between hastily organized fundraisers, Meyler juggled several jobs, including waitressing and cleaning gutters for a roofing company.

Meyler was on a mission to provide something even scarcer than education to the children of Liberia: hope.

THE AUTHOR

MOLLY KNIGHT RASKIN is a freelance journalist, author and producer who reports frequently on mental and global health. She is a regular contributor to *The NewsHour* on PBS and producer of a documentary film—*Still We Rise*—about trauma and resilience in Liberia.

Hope is hard to come by in Liberia, where the war took the lives of more than 250,000, displaced millions and destroyed the country's infrastructure. In the years since the conflict ended in 2003, Liberians have continued to struggle, crippled by grief, poverty and lack of access to basic needs such as food, running water, electricity and paved roads. In a survey of 1,600 adults published in 2008, physician Kirsten Johnson of McGill University and Harvard University's Humanitarian Initiative and colleagues found that 44 percent of the country's four million people met the clinical criteria for post-traumatic stress disorder (PTSD), reporting symptoms such as nightmares, feelings of hopelessness, anger and self-destructive behavior. Forty percent qualified for a diagnosis of major depressive disorder; indeed, more than 10 percent of those Johnson surveyed said they had contemplated suicide. News reports and at least one scientific paper, as well as my own interviews with police and civilians, suggest that Liberia also has a major problem with substance abuse, particularly among former child combatants.

And yet despite the lingering physical and psychological wounds, the population has virtually no recourse for healing. In addition to the damaged education infrastructure, the country's health care system remains fragmented and heavily dependent on international donors. Mental health care barely exists. The country has just one practicing psychiatrist—University of Liberia professor Benjamin Harris—one small psychiatric hospital, in Monrovia, and fewer than 100 clinicians working in neurology or mental health.

In 2009 the Liberian Ministry of Health and Social Welfare made an effort to address the country's dire need for psychiatric care by passing a National Mental Health Policy, but without adequate clinicians or drugs, the new measure could not effectively deliver treatment. In 2010 the Atlanta-based Carter Center began a five-year initiative to train 150 nurses and physician's assistants to be mental health clinicians in a six-month intensive crash course in Monrovia. After graduat-

Left to right: **Neighborhood kids helped to repaint the gates of the house for the staff of the More Than Me Academy in Liberia. In addition to educating children, the academy was designed to offer an even rarer commodity: hope. In February 2014 students played in the academy's courtyard and sang in a classroom.**

ing from the program, the clinicians fanned out across the country to deliver basic mental health services such as psychotherapy, counseling for addiction and support for PTSD. By spring 2013, when the fourth class graduated, all 15 counties in Liberia had access to at least one locally trained and credentialed mental health clinician.

Meanwhile, by the end of 2011, More Than Me was funding tuition for more than 50 at-risk girls and had started construction on a school of its own, renovating a war-damaged building donated by the president. Then, in 2012, the organization won the coveted Chase Community Giving grant of $250,000.

On September 7, 2013—Meyler's 31st birthday—the More Than Me Academy opened to 120 girls between the ages of five and 17, with a ribbon-cutting ceremony attended by President Sirleaf. The curriculum included health care, an after-school program and two meals a day. "This whole thing feels like a crazy dream but a really beautiful one," Meyler told me then. More Than Me made waves among global charities. A check came from Microsoft Corporate Giving, and U2 front man Bono, who co-founded the ONE Campaign to end extreme poverty, dropped by for a visit. Residents of West Point begged Meyler to enroll their daughters, and the girls in the school begged Meyler not to send them home at the end of the day.

A visit to the school in February of last year was marked by the sound of children laughing and singing, their voices echoing through the brightly painted hallways of the once decrepit cement

MOLLY RASKIN (*photographs of schoolgirls*)

Meyler's mission changed with the arrival of Ebola. The More Than Me Academy, which began as a school, became headquarters for the Ebola Free Coalition. The academy's library shelves stock Ebola supplies (*left*) and coalition members work at its desks (*center*). Meyler regularly visits the Ebola treatment unit. Before leaving the unit, she steps into a bucket of bleach as a disinfection measure (*right*).

Two children likely to be infected with Ebola are escorted to the More Than Me ambulance. Because Ebola treatment units only accept patients who arrive in an ambulance, the acquisition of the ambulance meant that sick West Point residents could be picked up within half an hour rather than waiting three to four days to be transported to the clinic.

"I'D NEVER EVEN HEARD OF EBOLA," MEYLER SAYS. "I REMEMBER THINKING IT SOUNDED WEIRD AND SCARY, BUT AT THE TIME, I DIDN'T THINK IT COULD DESTABILIZE AN ENTIRE COUNTRY."

building just outside the border of the township. The girls hugged visitors, beckoning them into their classrooms. "They love to be held," Meyler said, as a gaggle of girls, some as old as 18, clung to various pieces of her flowing skirt like babies to a mother duck. Outside, on a three-story whitewashed wall facing the school, someone had used bright-red paint to write the word "HOPE."

Some mornings Meyler's students arrived sleep-deprived and bruised—marks of abuse—but they came and completed their work, and they seemed inspired to learn. Meyler appeared ebullient. "I believe in miracles," she said. "We're growing so fast, and we have so many plans for the future."

Promise Not to Touch

In late March 2014 news broke worldwide that citizens of a neighboring country, Guinea, were dying from a mysterious illness with symptoms resembling those of both malaria and cholera: fever, vomiting and aching joints. There were also reports of cases in Sierra Leone and Liberia, which both share porous, highly trafficked borders with Guinea.

Médecins Sans Frontières responded immediately, sending blood samples to the Pasteur Institute in Lyon, France, to identify the cause of the affliction. Results confirmed the worst: the infectious organism was *Zaire Ebola virus*. This highly contagious and deadly agent had killed 70 percent of its victims when it struck Sudan and the Democratic Republic of the Congo (formerly Zaire) in 1976, leaving 431 people dead. In the late stages, after organ failure, symptoms can include profuse bleeding from the nose and mouth.

The first medical teams, under the umbrella of the World Health Organization (WHO), were on the ground by the end of the month. Initially the disease moved slowly in Liberia; between March and April only six cases were recorded, followed by six weeks of none at all. By the end of May, however, Ebola arrived in Monrovia, where it quickly took hold and spread like brushfire. Still, Meyler says she was not overly concerned. "I'd never even heard of Ebola," she says. "I remember thinking it sounded weird and scary, but at the time I didn't think it could destabilize an entire country."

In July she flew to the U.S. to spend several months fundraising and meeting with More Than Me donors, advisers and board members. Later that month an American lawyer named Patrick Sawyer died of the disease in Lagos, Nigeria, the stopover for his flight home from Liberia, where he had been caring for his sick sister. Reacting to the death of an American, the Peace Corps pulled all its volunteers from Liberia, Guinea and Sierra Leone, and the U. S. Centers for Disease Control and Prevention warned against all "nonessential" travel. The WHO declared an international health emergency. The Carter Center put the breaks on its mental health program, redirecting all in-country resources to the Liberian government's campaign to contain the disease.

In Liberia, the Ebola epidemic has left many children without families to care for them. These babies were abandoned by Ebola-stricken family members. Only one of them (*right*) survived. That child was reunited with her mother in an Ebola treatment unit.

Meyler watched the news in horror. "The more I heard, the more I began to freak out," she says. During one weekend, Friday, August 1, to Monday, August 4, 45 additional cases cropped up in the region, most of them health workers, according to a WHO report. In response, President Sirleaf declared a 90-day state of emergency in Liberia and ordered the indefinite closure of all schools, including More Than Me. Meyler called for the evacuation of all the school's foreign volunteers from the country, then booked herself a ticket on the next flight back to Liberia. "Just because you can escape, it doesn't mean you should," she says. On the plane, Meyler drafted a living will.

Meyler returned to a country trapped in dread heaped on poverty. Health workers dressed in head-to-toe protective gear trolled villages and city streets for the infected and the dead. The screams of those who had lost loved ones to Ebola echoed in the streets. "It's worse than the war," Quendi Appleton, a nurse trained in mental health at SOS Children's Clinic in Monrovia told me at the time. "People are terrified to go out of their homes. They feel lonely, scared, confused. It's like a nightmare."

On August 20 the Liberian government put the residents of West Point under quarantine to stop Ebola's spread, encircling the slum with barbed wire and armed troops. Home from Liberia in California, Janessa Wells, a More Than Me teacher, ran across newspaper photographs of angry, frightened West Point residents, some of whom were her students. "My heart filled with dread," Wells recalls. "Even if they didn't get the virus, I knew they'd be impacted—physically, emotionally and psychologically." Wells booked a flight back to Liberia.

More Than Me staff pushed their way into the slum to track down every one of their 124 students. All the kids had clean bills of health. The team took them bottles of chlorine bleach and began to organize grassroots Ebola awareness and education efforts in the township. Meyler and Wells made the girls promise not to touch anyone and to wash their hands often. They stood with them, resisting the urge to embrace them tightly, and assured them that everything

JOHN MOORE Getty Images (*young boy on bucket*)

In August 2014 residents of West Point gathered in an alley around a very sick 10-year-old boy after the child was denied treatment at a local clinic. The boy's mother and six-year-old brother had already died from suspected Ebola infection.

"POLKA-DOTTED SHEETS CAN'T BRING BACK ESTHER'S MOTHER, FATHER, AUNT, UNCLE AND FOUR COUSINS, BUT THEY SURE WILL MAKE HER SLEEPING ROOM BRIGHTER."

would be okay. "I craved a sense of normalcy, the ability to give a hug to an old friend or a sad child," Wells says. "The very first thing I did was put my hands behind my back or cross my arms to restrain the urge to pull them close."

Restrictions on physical contact is yet another punishing aspect of the Ebola crisis. Culturally, West Africans are gregarious and physically demonstrative, quick to embrace or shake hands. In Liberia, the customary greeting is an elaborate handshake culminating in the "finger snap," which involves the two people clicking their fingers together. "In a culture where touch and physicality is not just a nicety but a way of life, [the lack of physical contact] seems like the cruelest type of message," Wells says.

For those who have lost family members to Ebola, the constraint on touch is especially harsh, robbing them of a powerful source of comfort during the mandatory 21-day quarantine. According to a number of studies, some led by behavioral scientist Michael Meaney of McGill, children deprived of physical contact from a parent or caregiver in a time of stress can suffer long-term psychological and developmental damage that makes them prone to depression and anxiety.

Some of this damage involves an alteration of the stress response. In a study published in 1997 neurobiologist Mary Carlson and child psychiatrist Felton Earls of Harvard and their colleagues found that children in a Romanian orphanage who had been deprived of touch and attention by their caregivers developed abnormally high levels of the stress hormone cortisol, which led to long-term developmental and cognitive challenges.

"There are significant effects on kids when they go even a few days without the physical affection of a parent," says developmental psychologist Tiffany Field of the University of Miami School of Medicine. "I can't imagine the impact after 21 days. It's an extreme situation, and I predict these kids are going to need real help." Ironically, she adds, the protective quarantine for suspected Ebola cases, and the resulting physical separation from caregivers, could ultimately boost a child's vulnerability to the virus (and other infections) because impairment of the ability to regulate stress can also suppress immunity.

To manage their own stress and fear, Meyler and Wells say they swam in a hotel pool, wrote in their journals and, when they returned home at night, watched funny movies and television shows.

Despite having no background in medicine, disease or disaster aid, Meyler found herself leading the township's assault on Ebola. The Liberian Ministry of Health and Social Welfare recruited her to head a coalition to end Ebola in West Point; aid workers trained her to wear gloves and protective gear and to wash her hands in bleach, which she did up to 15 times a day. Her team acquired an ambulance and set out to retrieve scores of Ebola victims who were dying in their homes and take them to a hastily constructed emergency unit at the nearby Redemp-

The parents of these six siblings (*far left*) died from Ebola. More Than Me supplied the children with clothes and food at an interim child care center, where they were living. Ice cream for the orphans (*left*) helps to lift their spirits.

tion Hospital. She helped to transform the More Than Me school building into a warehouse for food and medical supplies and a training facility for the coalition of volunteers working to stamp out Ebola in the slum.

It was the one-year anniversary of the More Than Me Academy, but no one was celebrating. Meyler says, "I felt like the world left Liberia to die."

Orphaned by Ebola

Throughout August and September, Ebola continued to spread in Liberia. At Redemption Hospital many of the patients were already dead, lying in pools of their own blood, vomit or feces. Small children—some confirmed Ebola patients, others suspected—lay on cots next to the deceased, their vacant stares and slumping bodies bearing all the signs of trauma. Some were on the verge of death themselves, too young to understand what was happening and too terrified to utter a sound. More were dying outside the hospital's doors. The emergency unit was full, as were all the other government-run units in the country, leaving many of the sick with nowhere to go. A hotline set up by the health ministry in June for reporting suspected cases and locating treatment centers was by August receiving too many calls to answer.

Whenever Meyler visited the units, she sat with every child, offering comforting words no matter their truth. "I would tell them that their parents had sent me to say how much they are loved," she told me. One day she purchased $500 worth of toys and candy, which she handed out to critically ill kids in the treatment centers.

At one point, Meyler walked outside the hospital and began to vomit. Within minutes she had convinced herself she had Ebola. She tested negative, only to return for another test weeks later when she again began vomiting unexpectedly. It was not until later that she realized the true cause of her sickness—her own trauma. "This was my body's way of dealing with the fact that I was seeing people die every day," she says.

Meyler used her blog—Racing Heart—to put a human face on the crisis. In one post, she described the moment she spotted Berlinda, age three, wearing a pink dress, sitting in the back of an ambulance watching her mother die. She was free of Ebola, but no one would take in the toddler for fear of contagion. Meyler brought her home. Then came Miatta, age six, who was found alone, screaming and crying because everyone in her family had died. Then she rescued Esther, age 10, who had lost her mother, father and entire extended family. Meyler chronicled her efforts to care for them—and herself:

> **Polka-dotted sheets** can't bring back Esther's mother, father, aunt, uncle and four cousins, but they sure will make her sleeping room brighter.
> **Grace's mom** is fighting #ebola—let's pray she makes it. Grace didn't want to leave her side, but she had no choice. Ice cream isn't helping.
> **Rule #1** when fighting #ebola: stop every so often to act ridiculous in order to sustain yourself for the long run.

In early January the WHO reported that Ebola had killed at least 8,000 people in Guinea, Liberia and Sierra Leone. According to Save the Children, as many as 10,000 children had lost one or both parents to the disease. UNICEF is helping those governments train mental health and social workers, in addition to recruiting more than 2,000 Ebola survivors, now immune to the disease, to care for the children.

When one Good Samaritan heard that More Than Me was caring for Ebola orphans, the anonymous individual showed up at the converted school in a taxi with a stack of mattresses tied to its roof.

In October the Liberian government fast-tracked Meyler's request to register More Than Me as a holding home for children orphaned by Ebola. As more children were admitted, Meyler and her staff greeted them, as she puts it, with "love, candy, Disney movies and psychosocial support." And so More Than Me officially shifted its focus to a new generation of Liberian orphans.

Youngsters orphaned by Ebola present a complex psychological challenge. The source of their trauma seems fathomless: the grief of witnessing the gruesome death of a parent or their entire family; the terror of being carried from their homes to an isolation-treatment unit by a faceless aid worker wearing what looks like a space suit. For children who test negative, after going through the ordeal of quarantine, most will not be able to return to their communities. They are outcasts, forever associated with the deadly disease. Even relatives and close family friends shun them out of an unfounded fear that they are still contagious.

So as with children of war, many of those who survive Ebola will be abandoned, without access to education or health care. "Kids need structure, routines and security," says psychologist Theresa S. Betancourt, who directs a research program on children and global adversity at Harvard's T. H. Chan School of Public Health. "Right now we're seeing kids sleeping on the streets, rejected and orphaned. If we want these countries to build back better, we have to think long term and also focus on the psychosocial issues because right now they are exploding."

"Of Course, I Could Die"

To tackle this psychological burden, Betancourt is working with the Catholic aid organization CARITAS Freetown to launch an emergency Ebola relief program modeled on her work with youth affected by war in Sierra Leone and families by HIV/AIDS in Rwanda. Called the Family Strengthening Intervention, the program is rooted in research showing that in the aftermath of war or deadly disease, the most effective way to help children is to support their caregivers. To do so, Betancourt will send local health workers to coach caregivers on how to communicate with children and discourage the use of harsh punishment.

Such low-cost, easy-to-implement local mental health interventions can ease the burden of depression and anxiety in developing countries. In Uganda, a nonprofit organization called StrongMinds is recruiting local health workers such as physician's assistants, nurses and social workers to conduct group psychotherapy sessions for women with depression in the slums of Kampala. To date, the organization has treated 244 women in 16-week sessions run by four community facilitators. A week after the sessions ended, 94 percent of the women had been relieved of the symptoms of their depression, self-reporting better sleep, higher energy levels, increased productivity and an overall sense of hope. Such a strategy could work in Liberia, too. "This model can be quickly scaled to counter the anticipated depression epidemic that will follow Ebola," says StrongMinds founder Sean Mayberry.

To sharpen their tactics, Betancourt and her team are conducting a longitudinal study in the Freetown area of Sierra Leone to investigate the contributions of stigma, social distrust and patterns of disease on distress and other mental health problems. Such ripples may continue to spread even after Liberia is Ebola-free. Betancourt's findings may be useful to Meyler then, as she seeks help from the Liberian government and aid organizations to find homes for the children orphaned by the disease. In the years to come, Meyler plans to

After losing their parents and grandparents to Ebola, these siblings passed the 21-day observation period in good health. Their big sister beat the virus. "They were stoked!" wrote Meyler, their then caretaker, on Instagram.

expand More Than Me into a campus that includes health care, a boarding house and psychosocial support.

Meanwhile Meyler has more than 200 children in her care, some of them anxiously awaiting the results of their Ebola tests. She also faces the knowledge that one small mistake could make her the next victim of the virus. "Yes, of course, I could die," she says matter-of-factly. "But if I did, it would be worth it. It would be a sign to the world to wake up." And she adds, "There's a saying that if you haven't felt something worth dying for, it's not worth living. And I would die for these kids." M

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All Together Now

Harvard Business School's Linda A. Hill explains how to unleash an organization's collective genius and innovation

Interview by Gareth Cook

What allows a creative enterprise—a film studio, a design firm, a start-up—to flourish? It's an old question but one that has become increasingly relevant as we transition to an economy built on the exchange of knowledge and information. Linda A. Hill, a professor of business administration at Harvard Business School, has studied how creative teams come together and how certain leadership qualities build these collectives. Recently Hill pooled her knowledge with colleagues from Pixar, the Massachusetts Institute of Technology and other institutions to co-author *Collective Genius,* which offers insight into innovative groups. In an interview with *Scientific American Mind* contributing editor Gareth Cook, Hill describes how certain key principles, such as embracing debate, open-minded leadership and active experimentation, can allow creative organizations to thrive.

FAST FACTS
IN CREATIVE COMPANY

1. Three factors appear to aid organizations in finding novel solutions: creative abrasion, creative agility and creative resolution.
2. These strategies allow people to pursue multiple ideas and to test them against one another in ways that encourage further experimentation, debate and problem solving.
3. This approach requires a leader who is flexible and open-minded, finding ways to recombine different solutions as opposed to simply selecting one over another.

SCIENTIFIC AMERICAN MIND: In your research, you and your colleagues have identified three abilities that truly innovative organizations share. Can you describe each?

HILL: Whether we were looking at an Islamic bank in Dubai, a luxury goods retailer in Korea or the global marketing division of a German automaker, my coauthors and I found that innovative organizations are communities that have mastered three capabilities critical to innovation: creative abrasion, creative agility and creative resolution.

Creative abrasion refers to the ability to generate a marketplace of ideas through discourse and debate. Innovative organizations know how to amplify rather than minimize differences. We're not just talking about brainstorming,

Photography by Jared Leeds

which asks people to suspend their judgment and to share their ideas no matter how "off the wall" or "half-baked." Creative abrasion is about having heated yet healthy arguments to generate a portfolio of alternatives. People in innovative organizations have learned how to inquire, actively listen and advocate for their point of view. They understand that you rarely get innovation without diversity of thought and conflict.

Creative agility is the ability to test and refine ideas through quick pursuit, reflection and adjustment. It is about knowing how to do the kind of discovery-driven learning used by scientists and designers, for example, to solve problems—an interesting mix of the scientific method and the artistic process. Creative agility is about acting your way, as opposed to planning your way, to a solution. One could think of it as running a series of experiments, not pilot studies. In research, pilot studies are often about being right—when they don't work, something or someone is to blame. Experiments, in contrast, are about learning—and a negative outcome can provide important insights.

The third capability, creative resolution, is the ability to do integrative decision making so that diverse ideas, even opposable ones, can be combined or reconfigured to create a new solution. In innovative organizations, people are not willing to go along to get along. They do not allow one individual or group to dominate—not the bosses, not the experts. They do not compromise or take the path of least resistance. This approach allows leaders to combine multiple ideas as opposed to selecting only one option.

How does a group put these principles into practice? And how does a leader participate in this process?

Think about what it takes to create a film at Pixar. No solitary genius, no flash of inspiration, produces these movies. It takes about 250 people working diligently for four to five years to make one film.

Throughout the making of a Pixar film, the story evolves. Different shots move through the production pipeline at different speeds and not in order. Some scenes take months or longer because they represent unprecedented artistic or technical challenges. Ten seconds of film (such as in the movie *Up* when the boy hands the chocolate to the big bird) can take even the most gifted animator six months to perfect.

In addition, at Pixar no part of a movie is considered finished until the entire movie is done. Halfway through the making of one movie, an animator gave a character a slightly arched eyebrow, suggesting a mischievous side. The director saw this moment in a daily review of the work in progress and said, "No, no. That's out of character. Nicely done, but lose it."

A few weeks later the director came back with a different reaction. He'd been thinking about those few seconds of film and concluded they should put it in. Because an animator added his personal take—what we call his "slice of genius"—the director was able to reconceive the character in a subtle but important way and improve the story.

This is an example of the power of collaboration and creative resolution. The director combined ideas instead of seeing one idea as right and another as wrong.

Great innovation leaders see their role not as visionaries but as social architects. Their job is to set the stage, not to perform on it.

The unavoidable paradox at the heart of innovation is the need to unleash the talents of individuals and harness those talents in the form of a solution that is useful to the organization. Creative workers need a leader who understands the power of collaboration, someone who will create an environment in which everyone is willing and able to share and refine ideas together. Innovation is a journey, a collaborative problem-solving process—most often among people with diverse perspectives and expertise.

That example illustrates creative resolution in action, showing how a leader integrates different visions. Can you give an example of creative abrasion and creative agility in context?

The infrastructure group at Google is the group responsible for keeping Google's search engine and applications up and running 24/7. You can imagine what a wicked set of problems that presents.

When Google was preparing to introduce Gmail and integrate YouTube, they knew their data storage system at the time was inadequate. Bill Coughran (then senior vice president of engineering) and the infrastructure group were charged with tackling this mission-critical task.

THE AUTHOR

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Instead of picking a team, Bill elected to let small project teams emerge and organize "spontaneously around different solutions," as he puts it. Two separate groups soon coalesced around promising alternatives. One group, Big Table, proposed an evolutionary approach building on the current system. The other, Build It from Scratch, thought it was time to build a brand-new system.

Separately, both teams were allowed to work full-time on their ideas. Even with everyone working at breakneck speeds, the process took two years. In periodic engineering reviews, Bill and his leadership team worked to "drive debate" and "inject honesty" (to use their words) into each team's thinking. This is creative abrasion. The friction created as people present, defend and critique ideas propels the project forward.

Both teams were encouraged to build prototypes so they could bump up against reality and discover for themselves the pluses and minuses of their proposed solutions. The Build It from Scratch team shared their prototype with the operations group whose beepers would go off in the middle of the night if a problem arose with the Web site. They heard loud and clear about the limitations of their design. In other words, they used creative agility, actively testing ideas to assess each approach.

As the evidence came in, it became clear that the Big Table system was the better alternative for the time being—frankly, the need for a solution was becoming urgent. But to ensure that the knowledge gained by the Build It from Scratch team was retained, Bill asked members of that team to join a new team that was emerging to take on the next big infrastructure challenge.

Putting these principles into practice and running parallel experiments may seem inefficient. By the end of the process at Google, one engineer who was initially skeptical told us that he saw the wisdom of letting smart people play out their particular passions. If people had been forced onto one big team, their focus might have been about winning and proving whose solution was right rather than learning and discovering the best solution.

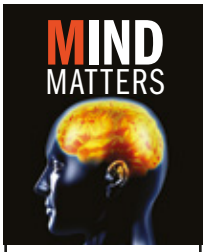
Bill at Google and the leaders at Pixar all understood that most innovations are the result of bottom-up, not top-down initiatives [projects that are not dictated by management]. As Bill told us, "Talented, passionate people don't want to follow you to create a better future; they want to co-create it with you." So he intervened in a top-down way only when necessary. He explained to us that finding the right balance between patience and urgency wasn't easy. His dilemma was to give the two teams the time they needed to develop and test their ideas, all the while urging them forward as quickly as possible to meet Google's bold ambitions and pressing needs.

What do you think are the biggest misunderstandings that people have about what it takes to lead a creative effort?

Many people believe in the myth that innovation happens when a solo genius has an aha! moment, but that is usually not the way. In fact, most innovations happen through collaboration, with many false starts and missteps along the way. Often innovations result from combinations of many ideas, even old ideas being combined in new ways or being applied to new circumstances.

Think about it this way: when we are trying to do something truly new—when we are far out on the cutting edge—we cannot know, by definition, where to go or maybe even how to get there. Instead we have to act and learn our way forward, to discover what that new future is going to be.

Great innovation leaders see their role not as visionaries but as social architects. This does not mean they lack vision. To the contrary, many are quite visionary. But because they understand how innovation really happens, they reject that leadership ideal. They understand that their job is to set the stage, not to perform on it.



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 in Boston.

You have written and lectured extensively on the need for strong leadership and its connection to creativity. Why is this so important?

I became a professor of business because without economic development, none of us can have the livelihoods or lives to which we aspire. And I became interested in innovation, in part, because we have so many complex problems and opportunities out there in the world, both in business and in society at large, that need innovative solutions.

We need a lot of new thinking and new ways of doing things to address them. That is why I am interested in business and, particularly, in what leaders of businesses do that makes the difference. If we can build organizations that are willing and able to innovate time and again, then I believe that we can create better societies. That is what drives me personally. M

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DEBUNKING

MIDLIFE MYTHS

Psychological studies suggest that midlife crises are real, but the stereotypes are not

By Hanna Drimalla

A fortysomething middle manager quits his day job, buys a sports car and abandons his wife for a younger woman. Diagnosis? Midlife crisis. Lester Burnham in *American Beauty,* Walter White in *Breaking Bad*—examples of these desperate characters abound in popular culture, and the concept is entrenched in our collective psyche. But are people of a certain age really more likely to launch a total life reboot?

FAST FACTS

NOT SO BAD AFTER ALL

1. Genuine midlife breakdowns affect no more than a quarter of the population.
2. Studies show that happiness does hit a lifetime low in middle age. The biology and psychology of aging may contribute to that finding, along with life events.
3. Despite the trough in happiness, midlife for most people is marked by stability, especially in their relationships.

It would seem so, according to scientists. Some hallmarks of midlife—increased self-reflection, aging, career and family changes—can seed deep dissatisfaction. And studies indicate that our sense of well-being naturally wanes during this stretch of adulthood. But research also shows that many common beliefs about the quintessential fortysomething meltdown are untrue. In fact, malaise can commence at almost any age, men are not more susceptible to dissatisfaction than women, and midlife crises are far from inevitable.

At some point between age 40 and 60, most people will face significant stress in one form or another, but not everyone reacts by chasing after fading youth or, worse, succumbs to depression or substance abuse. Genuine midlife breakdowns appear to be less common than many think, affecting only 10 percent of the population, according to a review in the early 1990s, or 26 percent, according to a 2000 study. For some of that group, these upheavals lead not to ruin but to a welcome second act. And the reasons certain people do fall victim may have more to do with personality and cultural expectations than age.

A Life Half-Empty

If the midlife crisis seems to defy precise definition, consider that midlife itself is a nebulous concept.

Illustrations by **PATRIC SANDRI**

In 2011 researchers at Florida State University analyzed a questionnaire given to several thousand Americans in the 1990s and found that most participants defined midlife as running from age 44 to 59. Ten years later the same participants described midlife as age 46 to 62. The older the respondents—women in particular—the later they envisioned the debut of their dotage.

Our notion of midlife may be a moving target, but once it starts, our perspective on time shifts. Instead of counting the years from our birth, we begin guessing at how many years we have left. Psychologist Laura Carstensen, founding director of the Center on Longevity at Stanford University, has shown that this subjective sense of a life half-empty influences our goals. The fewer years we think we have, the less expansive our plans become. Instead some individuals focus on family and friends—just as young and old alike seek familiar comforts when epidemics or terrorist attacks remind us of how finite life is.

When older people were asked what age they would like to be again, the majority chose their mid-40s.

Other people, though, begin to take stock of their lives and revisit unrealized dreams. "We retrieve our youthful goals from 20 years before and check off, one by one, what we have achieved," explains Alexandra Freund, a professor of applied psychology at the University of Zurich. She has found that older people typically try to maintain what they have now to avoid future losses and that they focus less on their careers. During this transition, our sense that the demands of work exceed our ability to cope can increase. Occupational psychologist Amanda Griffiths and her colleagues at the University of Nottingham in England have reported that this perceived job stress peaks between the ages of 50 and 55.

Such changes in focus and aspiration may render us less satisfied with life. In 2008 labor economists David G. Blanchflower of Dartmouth College and Andrew J. Oswald of the University of Warwick in England reviewed data about well-being collected from half a million people of various ages in 72 countries. They concluded that the happiness level throughout an individual's life span frequently follows a U-shaped curve, bottoming out in the early to mid-40s. In some locations, this emotional nadir did not appear in the raw data but emerged once Blanchflower and Oswald reanalyzed the numbers to consider the potentially confounding contributions of marital status, income, education and other factors on contentment.

Complicating the picture, other researchers have noted the presence of peaks and plateaus of happiness within the midlife period. In 2012 economist John Haisken-DeNew of the University of Melbourne reviewed life satisfaction among Germans using data from the German Socio-Economic Panel, a 30-year-old longitudinal study that surveys some 30,000 people annually. The length of the study allowed Haisken-DeNew to account for individual differences in optimism. For instance, a happiness score of 6 out of 10 might represent an all-time high for a confirmed misanthrope but a crash for a starry-eyed romantic. Haisken-DeNew observed that happiness levels drop continuously, if slightly, throughout adulthood until the early 60s, after which they increase until age 75 and then plummet.

Wrinkles in Time

Still, the subject of much debate is whether the cause of midlife strife lies in our creaturely selves or in our stars. Some researchers argue that life events are most important. In a study published in 2000 sociologist Elaine Wethington of Cornell University conducted a telephone survey of 724 American adults between the ages of 28 and 78 and found that more than a quarter of her respondents—men and women almost equally—admitted to having had a midlife crisis. The majority attributed these spells to upsetting life events such as losing a job or parent and not to age, leading Wethington to conclude that midlife crises are not a natural part of aging.

Yet research into the biology of middle age suggests that at least part of our vulnerability is built in. In 2012 psychologist Alexander Weiss and his colleagues at the University of Edinburgh reviewed accounts from zookeepers, volunteers, researchers and caretakers, who reported that middle-aged chimpanzees and orangutans showed definite signs of disgruntlement, compared with younger and older apes. These observations were subjective; the animal keepers knew the ages of the animals and may have been interpreting their behavior based on expectations. Nevertheless, Weiss's team concluded that the biology we share with our fellow great apes could underpin our midlife doldrums.

Gray hair and wrinkles aside, many adjustments associated with aging can cause psychological distress. The rates of cancer and cardiovascular disease, among other illnesses, increase, along with the risk of depression. A 2012 report from the Central Research Institute of Ambulatory Health Care in Berlin revealed that depression cases climb almost linearly until one's late 50s and peak again at around 85 for women and 90 for men. In the U.S., statistics from the Centers for Disease Control and Prevention reveal that the highest rates of depression among men and women fall between the ages of 40 and 59.

Physically, too, the brain begins to degrade more quickly after age 40. In 2010 neuroscientist Antonio Giorgio of the University of Siena in Italy, then working with colleagues at the

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University of Oxford, tested 66 subjects between the ages of 23 and 81 using MRI and diffusion-tensor imaging. Their results were consistent with earlier studies: The brain's white matter volume increased continuously up to the early 40s and then decreased rather rapidly. The volume of gray matter declined steadily over the entire period in most brain regions.

Older brains can usually compensate for these deficits, offsetting lost firepower with greater experience and knowledge. But the effects of hormonal attrition are more unsettling. When male andropause sets in after about age 40, testosterone levels start to decline, and both sexual interest and performance can suffer. For women, the decline of estrogen levels in the 40s leads to menopause, usually in the 50s, and a host of sometimes upsetting symptoms, including insomnia, memory problems and depression.

To Every Season

But whatever its source, midlife stress does not foredoom us to a life out of control, especially in our relationships. A 2011 Kinsey Institute study of more than 1,000 couples in Germany, Spain, the U.S., Japan and Brazil found that middle-aged men and women rate their relationships and sex lives higher the longer they have been married and that people entering middle age with a long-term partner have a good chance of staying together, citing earlier estimates that more than half of marriages in the U.S. and 92 percent in Spain will last more than 20 years. Of the marriages that do break down, the husband is not typically the one to walk out. According to the National Marriage Project at the University of Virginia, women instigate two thirds of all divorces—most likely not because they are having midlife crises but because their husbands are behaving badly.

The empty-nest syndrome appears to be a myth, too. Pasqualina Perrig-Chiello, a professor of developmental psychology at the University of Bern in Switzerland, found in a 2001 study of 260 middle-aged subjects that mothers frequently view their children's departure optimistically. Fathers more often have mixed feelings, perhaps wishing that they had spent more time with their children. In a 2009 study, sociologist Barbara A. Mitchell of Simon Fraser University in British Columbia asked more than 300 parents from different cultural backgrounds about their children's departure from home. Only a minority—younger parents with health problems and fewer children—reported emotional suffering. Overall, most parents reported positive feelings, such as pride at having been successful in raising their children so that they could move out.

Perhaps the biggest misconception of all is that the outlook at 40 is grim. The John D. and Catherine T. MacArthur Foundation Research Network on Successful Midlife Development, a Harvard University–based interdisciplinary project run by 13 scholars, surveyed more than 7,000 people in the U.S. between the ages of 25 and 74 on aspects of middle age. The results, which have spawned multiple books and scores of research papers, reveal midlife to be largely a period of calm and stability: most relationships hold together, most people stay healthy and many enjoy financial security.

And when Zurich's Freund asked older people what age they would most like to be again, the majority chose their mid-40s. In some cultures, such as Japan, India, Kenya and Samoa, the concept of the midlife crisis is entirely imported. Maybe knowing that our misgivings about midlife are usually exaggerated—and temporary—can make the passage to late maturity just a bit more manageable. **M**

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PLAYED BY A PARASITE

Toxoplasma gondii, an insidious and common unicellular parasite, controls its rodent host's brain—and may be manipulating our own behavior as well

By Gustavo Arrizabalaga and Bill Sullivan

Imagine a world without fear. It might be empowering to go about your daily life uninhibited by everyday distresses. You could cross highways with confidence, take on all kinds of daredevilry and watch horror flicks without flinching. Yet consider the prospect a little more deeply, and the possibilities become darker, even deadly. Our fears, after all, can protect us.

The basic aversion that a mouse has for a cat, for instance, keeps the rodent out of death's jaws. But unfortunately for mice everywhere, there is a second enemy with which to contend, one

Illustration by **BORIS SÉMÉNIAKO**

that may prevent them from experiencing that fear in the first place. A unicellular organism (a protozoan), *Toxoplasma gondii,* can override a rodent's most basic survival instincts. The result is a rodent that does not race away from a cat but is instead strangely attracted to it.

Toxoplasma's reach extends far beyond the world of cat and mouse. It may have a special relationship with rodent and feline hosts, but this parasite also infects the brains of billions of animals on land, at sea and in the air. Humans are no exception. Worldwide, scientists estimate that as many as three billion people may be carrying *Toxoplasma*. In the U.S., there is a one-in-five chance that *Toxoplasma* parasites are lodged in your neural circuits, and infection rates are as high as 95 percent in other countries.

For most people, this infection appears asymptomatic, but recent evidence shows that *Toxoplasma* actively remodels the molecular landscape of mammalian brain cells. Now some researchers have begun to speculate that this tiny single-celled organism may be tweaking human health and personalities in stealthy, subtle ways.

What the Cat Dragged In

Researchers first discovered *T. gondii* in 1908, and by the end of the 20th century they had a good grasp on how people could pick up this parasite. The story starts with cats: for reasons that scientists have yet to unravel, *Toxoplasma* can sexually reproduce only in the feline gut. The parasite breeds within its feline host and is released from the feline's tail end. Cats are such obsessive groomers that it is rarely found in their fur. Instead people can become infected from kitty litter or by ingesting it in contaminated water or food [*see box on page 66*].

Within a new host the parasite begins dividing asexually and spreading throughout the host's body. During this initial stage of the infection, *Toxoplasma* can cause the disease toxoplasmosis in immunocompromised or otherwise susceptible hosts, leading to extensive tissue damage. Pregnant women are particularly at risk. If a woman is infected with *Toxoplasma* for the first time during pregnancy, the parasite may invade the developing fetus, cutting through tissues and organs as it spreads from cell to cell. Infection early in pregnancy can result in miscarriage or birth defects.

In otherwise healthy individuals, however, the only symptoms during this period are brief, flulike discomforts such as chills, fever and body ache. Within days the immune system gets the parasite under control, and *Toxoplasma* retreats into a dormant state. It conceals itself within a hardened wall in the host's cells, a structure called a tissue cyst.

This stage of the infection has no other discernible symptoms, but individuals with dormant infections who develop compromised immune systems—because of AIDS, an organ transplant or chemotherapy—may experience severe complications. With the body's defense systems weakened, *Toxoplasma* can reactivate and grow uncontrollably.

Once infected, a person will remain a carrier for life. Our immune system is apparently incapable of eliminating the tissue cysts, nor can any known drug. Nevertheless, the infection, detectable with a blood test, has long been viewed as relatively benign. After all, many people carry this parasite with no obvious ill effects. Only recently have scientists begun reexamining this belief.

After infection, neural activity shifts from the defensive to the reproductive pathway. Instead of danger, the rats smell love.

Eat Me, Mr. Kitty

In the 1980s researchers noticed unusual behaviors in *Toxoplasma*-infected mice. The rodents became hyperactive and groomed less. In 1994 epidemiologist Joanne Webster, then at the University of Oxford, observed that rats harboring tissue cysts behaved differently from their uninfected counterparts. Instead of fleeing from cats, the infected rodents moved toward them—making them easier prey.

Webster suspected that this "fatal feline attraction," as she called it, was a crafty way for the parasite to get back into a cat's belly to complete the sexual stage of its life cycle. In the years to follow, this idea gained ground: a large body of work now shows that the parasite can indeed manipulate rodents' behavior by altering neural activity and gene expression.

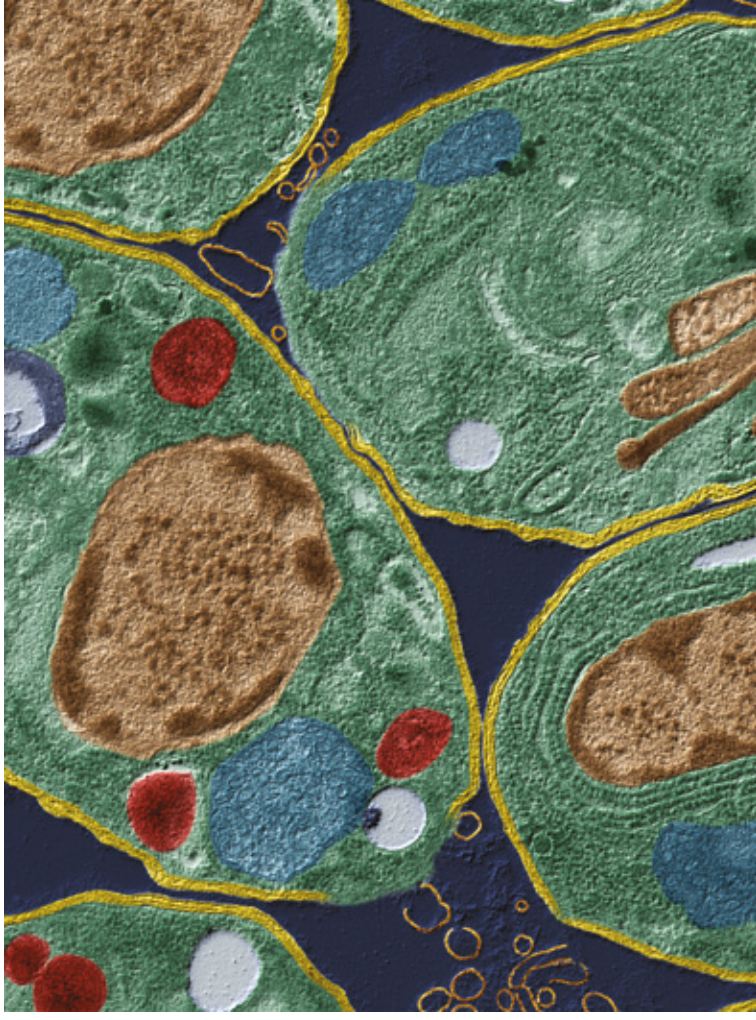
Several well-controlled experiments have shown that although uninfected rodents avoid areas that have been infused with cat stench, infected rodents do not seem to mind. Even more bizarre, in 2011 neuroendocrinologist Robert Sapolsky of Stanford University, molecular biologist Ajai Vyas of Nanyang Technological University in Singapore and their colleagues found that—at least in terms of neural activity—infected rats appeared to be *sexually* attracted to cat scent.

In the mammalian brain, the "defensive" and "reproductive" neuronal pathways run in parallel. These pathways start at the olfactory bulb, involved in odor detection, and ter-

FAST FACTS
PERSUASIVE PROTOZOAN

1. A feline parasite, *Toxoplasma gondii,* may inhabit the brains of as many as three billion people worldwide.
2. New molecular and cellular evidence suggests that the parasite has widespread and lasting effects on its host.
3. *Toxoplasma* has the power to modify its rodent host's brain and behavior, but to what extent this manipulation occurs in humans is still unclear.

minate at the limbic system, an area critical to basic reactions such as fear and arousal. Their proximity may partially explain how the parasite manipulates rodent behavior.



With powerful magnification, a colored transmission electron micrograph image reveals *Toxoplasma gondii* cells.

Working with 18 infected and 18 uninfected male rats, Sapolsky and his colleagues studied the rodents' behavior when they were exposed to either the odor of female rats or cat urine. Then they sacrificed the animals and looked at their brains. The researchers found a slight enrichment of parasite cysts in the limbic system compared with other brain areas.

They also assessed which parts of the brain had been operating during exposure to odors by staining the cells with a solution that revealed c-Fos, a protein expressed when neurons are active. The Stanford researchers discovered that infected rodents had high levels of engagement in their brain's reproductive pathway in response to the odor of both female rats and felines. In addition, the team found that infected rodents exposed to cat urine showed activation in the reproductive pathway similar to what uninfected rodents showed for the scent of a female rat. These results suggest that in infected rats, neural activity shifts from the defensive to the nearby reproductive pathway. Instead of smelling danger, the rats smell love.

Scientists are not sure how exactly the parasite elicits this fatal attraction, but one clue surfaced in 2014 in Vyas's laboratory. Vyas and his colleagues showed that *Toxoplasma* increases its host's levels of a neurotransmitter involved in social and sexual behavior. To accomplish this task, the parasite alters DNA methylation. Methylated genes are silent, blocked by a molecular cap. *Toxoplasma* uncaps a group of genes that spurs the creation of the sex-promoting neurotransmitter. Vyas and his team discovered this trick by performing the process in reverse: when they administered a chemical compound to the infected rats that silences the associated genes, the rats' peculiar attraction to feline odor vanished.

Kiss and Spit

With evidence mounting that *Toxoplasma* can influence its host's brain, other scientists set out to understand the parasite's effects at a much smaller scale: within each host cell. Their findings suggest that this microbe is particularly insidious—the changes it makes may be permanent.

To replicate, *Toxoplasma* must invade a cell. Stanford parasitologist John C. Boothroyd has dubbed this process "kiss and spit." The parasite first attaches to the host cell (the kiss) and then releases an arsenal of foreign proteins into that cell (the spit). *Toxoplasma* then enters the host cell, and the injected proteins help it redecorate its new home.

The parasite's first act is establishing a protective bubble in which it can divide in peace without attacks from host cell proteins. (Later, during the infection's dormant stage, these bubbles thicken to become tissue cysts.) The parasite then moves the mitochondria, which serve as the cell's powerhouses, to be adjacent to the protective bubble. It also acts on the cell's DNA, inhibiting the expression of some host genes while activating others. Finally, *Toxoplasma* modifies host proteins to alter their function and inhibit the immune response.

Altogether, these modifications ensure that the host cell will live a long time and supply energy to the parasite, without alerting immune cells that a parasite has moved in. Although these findings have principally been made with rodents, work with human cell cultures suggests that the same changes probably take place in the human body. In our labs, we are studying how *Toxoplasma* replicates and interacts with its host in an effort to develop new drugs to treat this infection.

Remarkably, a study that Boothroyd's group published in 2012 showed that *Toxoplasma* not only spits into the cells it invades but also spits into cells that it does not infect. This behavior—spitting proteins in passing without lingering in the cells—is a recent discovery in the microbial world. Consequently, cells

THE AUTHORS

GUSTAVO ARRIZABALAGA and **BILL SULLIVAN** are professors of pharmacology and toxicology and of microbiology and immunology at the Indiana University School of Medicine. Each runs an independent research laboratory focused on the cellular and molecular biology of *Toxoplasma gondii.*

SCOTT CAMAZINE *Science Source*

Even if the parasite can be removed from the body, behavioral changes may persist. The infection leaves a mark, like a permanent, parasite-given tattoo.

that are not harboring *Toxoplasma* contain parasite proteins that can co-opt and reprogram that cell. In the brains of infected mice, cells that have been spat into but not invaded are even more common than ones containing parasites. This widespread scattering of proteins means *Toxoplasma* can affect its host at a global level, making it easier to imagine how the parasite might manipulate the activity of an entire animal.

In 2013 biologist Michael Eisen of the University of California, Berkeley, and his colleagues found that a rodent's strange attraction to cat odors may be permanent, even if there are no longer signs of infection. In one study, Eisen exposed mice to a mutant strain of the parasite that does not appear to form brain cysts. Four months later the infected mice had no detectable parasites in the brain, yet they were still attracted to cat odors instead of repelled. This finding suggests that even if the parasite can be removed from the body, behavioral changes may persist. The infection leaves a mark, like a permanent parasite-given tattoo.

The Human Connection

The fact that people do not throw themselves into the lion cage at the zoo strongly argues that *Toxoplasma* does not affect humans in the way it transforms mice. Mammalian brains are not all the same, and *Toxoplasma*'s tricks are most likely specially suited for rodents. The parasite has little to gain, in evolutionary terms, by adapting to control the human brain. We are, after all, a "dead-end" host—the parasites within us are unlikely to return to the cat gut for breeding. Nevertheless,

How *Toxoplasma* Conquered the Animal Kingdom

Toxoplasma gondii is the most widespread parasite on earth, found across all continents and in a staggering variety of habitats. We have only recently discovered how many different animals it infects. To the surprise of many, University of British Columbia scientists found the parasite in beluga whales in the Arctic in 2014. Off the California coast, *Toxoplasma* infection has been revealed to be responsible for sea otter deaths formerly attributed to sharks or boats.

The wily intruder owes its success in part to a high rate of expansion. A cat newly infected with *Toxoplasma* can excrete up to 800 million packets containing the parasite—called oocysts—in the span of about seven to 14 days. Once released, an oocyst can persist in soil or water for years. Inhaling or ingesting just one oocyst is enough to establish infection, which virtually guarantees that the parasite will find its way into a variety of new hosts.

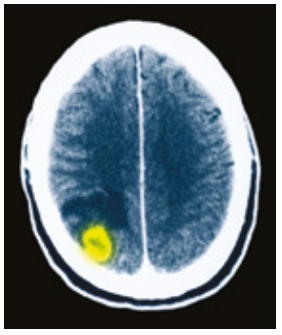
But house cats may have unfairly gotten a bad reputation from their link to *Toxoplasma*. Pet owners may indeed accidentally ingest an oocyst if they fail to wash up after tending to kitty litter, but scientists believe an individual cat will shed oocysts only once in a lifetime.

In contrast to housebound felines, wild and feral cats can spread oocysts in gardens, farms and water reservoirs, meaning they are likely to be greater contributors to *Toxoplasma*'s spread. Oocysts are commonly found in dirty water or on unwashed fruits and vegetables. The parasite does not infect plants, but its oocysts can remain on their surface unless they are carefully cleaned.

Moreover, many animals—including humans—are likely to become infected by eating raw or undercooked meat. Any animal infected by *Toxoplasma* will harbor tissue cysts for the rest of its life. When that tissue is eaten in, for instance, steak tartare, the parasite spreads into its new host. These clever methods of entering new hosts have allowed *Toxoplasma* to disseminate across the globe.

—*G.A. and B.S.*

LAUREN PUSCHAVER *Corbis*



Toxoplasmosis (*site of infection seen in yellow*) can cause serious complications in immunocompromised patients, such as this HIV-positive individual.

these cysts lodged in our brains could be manipulating us in subtle, unexpected ways.

A large body of research, mostly conducted by parasitologist Jaroslav Flegr of Charles University in Prague, supports the idea that *Toxoplasma* harbors the potential to change human behavior. In a series of personality assessments spanning more than a decade and involving nearly 2,500 individuals, Flegr and his colleagues found that certain traits often coincide with a *Toxoplasma* infection. For example, infected men tend to be introverted, suspicious and rebellious, whereas infected women tend to be extraverted, trusting and obedient.

Using a simple reaction time test, Flegr has also found that infected individuals are slower to respond than uninfected peers. This lag may relate to another correlation he has identified. In a 2009 analysis of 3,890 military conscripts in the Czech Republic, those with latent toxoplasmosis who also had a negative blood type, meaning they lacked the protein RhD, were six times more likely to be in a fender bender than those who were *Toxoplasma*-free or who had a positive blood type. The function of RhD is unknown. Flegr's results suggest RhD somehow protects people against *Toxoplasma*'s effects, but how it does so remains a mystery.

More recently, Flegr and his colleagues found that some of the changes that occur in mice also exist in humans—albeit in a gender-specific manner. In 2011 the researchers asked 34 *Toxoplasma*-infected students and 134 noninfected students to rate the intensity and pleasantness of urine samples from different animals. Curiously, infected men found cat urine odor more pleasant than uninfected men; in women, the opposite occurred.

Another line of research has focused on a potential link between toxoplasmosis and schizophrenia. In 2001 psychiatrist E. Fuller Torrey of the Stanley Medical Research Institute and neurovirologist Robert Yolken of the Johns Hopkins University School of Medicine reported significantly more antibodies associated with *Toxoplasma* in patients experiencing their first schizophrenic episode as compared with healthy peers. Although this initial study was limited to only 38 people, additional studies in the ensuing years have largely supported this link.

Fascinating and attention-grabbing as these studies may be, they come with several caveats. The sample sizes are relatively small, meaning the findings are preliminary. They do not definitively demonstrate that *Toxoplasma* causes behavior changes in humans. In the case of schizophrenia, it is important to note that the condition is complex and may involve many triggers. The parasite may be one contributor, but it is also possible that people with schizophrenia may simply behave in ways that make them more likely to pick up an infection. No hard evidence has emerged to date that directly implicates the parasite as a cause for any psychosis, including schizophrenia.

Ultimately these provocative findings probably reflect a complex exchange among various factors. Certain genetic predispositions, for example, or even an interaction between *Toxoplasma* and another infectious agent could mean that some people are more susceptible to the parasite's persuasion. Only larger studies from multiple research groups will determine precisely what this parasite may do to the people it infects.

An Accidental Meddler

As researchers continue to uncover the astonishing effects that *Toxoplasma* has kept secret for so long, many scientists are beginning to think that *Toxoplasma*'s impressive cellular and molecular tricks make it capable of causing disruptions in a human host. At the very least, the findings from human surveys beg for further clarification.

If you are curious whether you carry the parasite, you can get a blood test. In the meantime, you can increase your odds of staying *Toxoplasma*-free by maintaining good hygiene for you and your feline friends. If cats wander through your yard, the Centers for Disease Control and Prevention recommends wearing gloves and a mask when gardening and keeping any sandboxes closed up when not in use. Other basic health tips—cleaning fruits and vegetables, thoroughly cooking meats and washing hands regularly—are also important for avoiding an infection.

The notion that *Toxoplasma* could radically reorient the brain and behavior is certainly disturbing. But perhaps these findings are a reminder of a more basic truth. Each person is actually a rich ecosystem. For every human cell in the body, there are 10 more bacterial cells that influence physiology, metabolism and health. The protozoan *Toxoplasma* is just another stowaway within the system and one that warrants further study. After all, we will never fully understand ourselves without learning about our microbial companions. **M**

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SCIENCE SOURCE

FIRST AID FOR MENTAL HEALTH

Could an eight-hour class prevent tragedies triggered by psychiatric disorders?

By Aliyah Baruchin

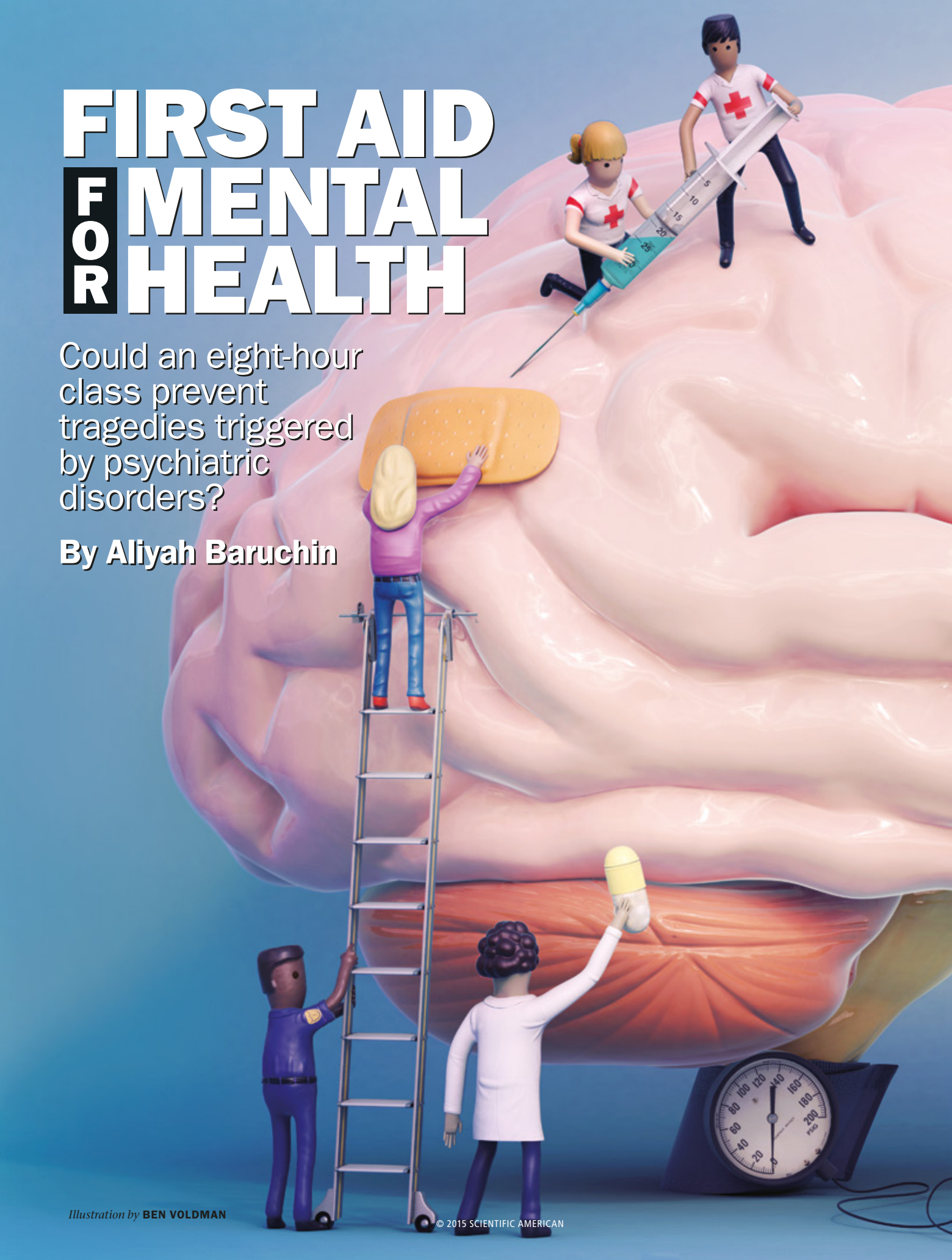


Illustration by **BEN VOLDMAN**

On the morning of September 16, 2013, a 34-year-old U.S. Navy technology contractor named Aaron Alexis shot and killed 12 people inside the Washington, D.C., Navy Yard before being killed by police. The media barrage that followed the shooting focused largely on Alexis's credentialed access to a government facility and on the military's process for vetting contractors.

Less publicized was the fact that a month before, in the early hours of August 7, Alexis had picked up the telephone in a hotel room in Newport, R.I., and called the police for help. He was hallucinating and had changed hotels three times during the night. He claimed that a stranger with whom he had recently and briefly argued had sent three people to follow him, and they were bombarding him with microwaves to keep him from sleeping. The responding officers came to the hotel, spoke with Alexis, called a supervisor and took a report. Then they left.

Those officers fulfilled their legal obligations: Alexis was alone, declined treatment, and stated that he was not thinking of hurting or killing himself. Thus, he failed to meet the legal criterion of posing "an imminent likelihood of serious harm" to himself or others that would have allowed police to take him to the hospital involuntarily for a psychiatric examination.

The Navy Yard incident joined a string of mass shootings by mentally ill individuals in the U.S. in the past three years, including the Sandy Hook Elementary School shooting in Newtown, Conn., that claimed the lives of 26 children and teachers in late 2012 and the 2011 shooting in Tucson that killed six people and wounded 13, one of them Representative Gabrielle Giffords of Arizona.

On a smaller scale, troubling scenarios involving people with mental illness play out across the country every day in homes, schools, workplaces, subways and restaurants. A professor watches a student's classroom behavior become more and more erratic; a father calls police for help when his adult son threatens other family members; a restaurant owner observes a customer melt down in front of other patrons. According to the Substance Abuse and Mental Health Services Administration (SAMHSA), nearly 20 percent of adults in the U.S. struggle with mental illness in any given year.

No one holds the magic formula for preventing the distress or violence that mental illness can cause, but one recent strategy aims to make the masses part of the solution. A program called Mental Health First Aid (MHFA) trains citizens to recognize early symptoms of mental illness or the signs of a mental health crisis and to guide distressed people to the right kind of assistance. According to the program, effective intervention by citizens requires neither simple compassion nor good cheer but rather a set of skills that emphasize the ability to listen actively, offer reassurance and helpful information, and gauge when someone has become dangerously unstable.

Recent studies in several countries show that the program succeeds in arming people with the knowledge and confidence they need to deescalate crises and provide help. As a result, MHFA is now included in SAMHSA's National Registry of Evidence-Based Programs and Practices. Also, as part of the Obama administration's Now Is the Time plan to increase school safety, 120 state and local school districts received funding for MHFA training in September 2014.

Community Response

Mental illness can be hugely debilitating, especially because much of it goes untreated. One in five U.S. adults has a mental disorder, yet fewer than half of these people receive treatment. And many of those who do take years to find help. For example, half of individuals diagnosed with depression have delayed seeking help for eight years or more. The result, according to the World Health Organization, is a combined rate of disability and premature death in the U.S. that is exceeded only by those of heart disease and cancer.

Originally developed in Australia in 2000 by a husband-and-wife team and now adapted for use in 23 countries, MHFA

FAST FACTS

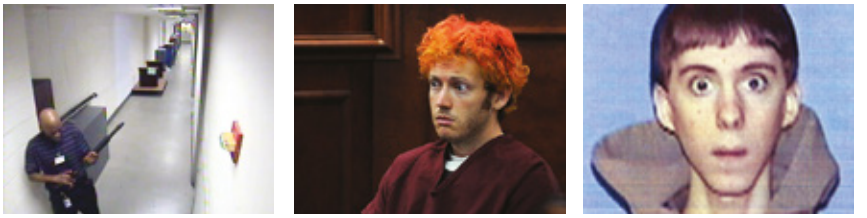
DEFUSING DISTRESS

1. A program called Mental Health First Aid (MHFA) trains laypeople, from cops to parents, to recognize symptoms of mental illness and guide the afflicted to appropriate care.
2. To intervene effectively, citizens need a set of skills that emphasize active listening, providing reassurance and information, and gauging when to call for help in a crisis.
3. Across the U.S., 280,000 people have completed MHFA training; classes are available in every state.

has the dual goals of catching mental illness early on and keeping people safe in the event of a full-blown crisis. Betty Kitchener, one of MHFA's founders, herself suffered from depression. "It struck me: Why doesn't regular first aid teach about mental illness?" she told LIFE Communications, an Australian suicide prevention project. "Across our lifetime most of us aren't going to come across someone who's had a cardiac arrest. We're much more likely to come across somebody who is troubled by mental health problems."

About 280,000 people have completed the eight-hour MHFA training in the U.S.; classes are available in every state. Some trainees work in social services and want to be better prepared to help the mentally ill people they encounter at their jobs. Others have lost relatives or friends to suicide and hope that MHFA training might save someone else's life. Among those who have taken the course are police in dozens of jurisdictions; public safety officials such as campus officers, sheriffs, and corrections and court staff; and doctors, teachers and clergy members. Specialized modules exist for rural communities and for people who work primarily with children. One version debuted in April 2014 for those in military service, veterans and their families.

The neighbor offers Brian neither friendship nor a skilled clinical assessment. Instead she blends concern with a level of objectivity that lets her listen nonjudgmentally.



Washington Navy Yard gunman Aaron Alexis (*left*), Colorado movie-theater killer James E. Holmes (*center*) and Sandy Hook shooter Adam Lanza (*right*) all suffered psychiatric problems before they fired their weapons.

In Philadelphia's MHFA program, the largest in the country, 7,000 residents are currently prepared to help people in distress and connect them to appropriate services. "We wanted to move away from a more passive approach, where people experiencing mental health issues come in for treatment, to an approach that would let us educate the community about mental illness and intervene earlier," says Arthur C. Evans, Jr., commissioner of Philadelphia's Department of Behavioral Health and Intellectual disAbility Services.

"That Must Be Very Scary"

The man in the video hears the knocking at the door, but the last thing he wants to do is answer. He pulls aside a curtain to peer at the two women—his neighbors—who are calling to him from his front porch, asking to talk. His gaze darts from left to right; his fear and agitation are almost palpable.

The women persist, and when a few minutes later he does respond, the older woman begins speaking to him in a calm voice. "Brian, why don't you come outside for a minute and stand here on the porch, and we can talk here?" she asks. "If you feel uncomfortable, you can go back inside. We'll leave the door open. I won't ask you to go anywhere that isn't safe."

The woman tells Brian that she has been concerned about him for some time, and she asks him specific questions. She is kind but frank and a little detached. As the conversation unfolds, Brian discloses that he believes someone is following him and that he thinks he is in danger. "That must be very scary," the woman says. He also admits that he has stopped taking his medication and that he does not want a crisis team to visit, because they will force him to take the drugs again. "Well, that's possible," the woman says, "but they may just want to talk with you first and see what's going on." Ultimately Brian agrees to let them call a crisis team.

The neighbor in this instructional video has been trained in MHFA. She offers Brian neither simple friendship nor a skilled clinical assessment. Instead she blends concern with a level of objectivity that lets her listen nonjudgmentally. She also prepares him for what will happen next. Other elements covered by the course include assessing people for risk of suicide or self-injury—by, say, looking for signs of physical harm or extreme distress—and encouraging individuals to get professional help [*see box on next page*]. The process requires a high degree of empathy, good listening skills and the ability to keep calm, but trainers say virtually anyone can master it.

In addition to instructional videos, MHFA trainees receive basic information about mental illness to allay the fear and helplessness many feel when encountering someone in distress. They learn the symptoms of conditions such as psychosis, anxiety, depression and substance abuse, and they discover that the most intimidating conditions are rare (schizophrenia affects 1.1 percent of adults in the U.S.; anxiety more than 18 percent). Trainees also engage in role-playing. In one exercise, designed to give an idea of what living with auditory hallucinations is like, a trainee must maintain a lucid conversation while anoth-

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AP PHOTO

Deliver Mental Health First Aid in Five Steps

MHFA includes a five-step method for helping someone showing signs of mental illness:

1. **Assess the person for risk of suicide or harm.** Are there signs of injury to his or her body? Is the person in extreme distress? Has the person become aggressive or lost touch with reality? If the person is suicidal, always call for professional help.
2. **Listen nonjudgmentally.** Be patient and understanding; listen carefully before offering help. Let the person know he or she can talk freely without being criticized.
3. **Give reassurance and information.** Empathize and express hope; offer practical help and relevant information. Respond truthfully to any concerns.
4. **Encourage seeking professional help.** Describe treatment options for the distressed person and sources of support for family members.
5. **Recommend other forms of assistance.** Suggest accepting help from family members, friends or those who have had their own mental health problems.

er trainee whispers urgently in his or her ear the entire time.

These methods seem to be effective. In their 2014 meta-analysis of 15 papers assessing MHFA training programs, researchers at the Karolinska Institute in Stockholm found that MHFA training increases mental health literacy, decreases negative attitudes about mental illness and bolsters confidence about assisting a mentally ill person.

"Tell Me More about the Wiring"

It was close to 1:00 A.M. the first time Warwick, R.I., police officer Joshua Myer arrived at the home of a schizophrenic man in his 20s. Relatives had called police for help when the man became agitated and violent, and although no weapon was involved, tensions quickly escalated. "He met us at the door ready to fight," Myer remembers. The man lunged at Myer's partner. The two officers subdued him, handcuffed him and took him to the department for booking; only after several hours was he transported to the hospital for a psychiatric exam.

Although 10 percent of the Warwick Police Department's calls involved behavioral health issues, including mental illness and substance abuse, the training for such situations had been lacking. Education existed for encounters with so-called emotionally disturbed persons. Yet those sessions, Warwick police captain Joseph Coffey says, were more about "how to deal with 'crazy' or 'psychotic' people," such as the man who takes hostages and barricades himself in a room, and not how to talk to people living with depression, post-traumatic stress disorder or anxiety—in other words, the nonviolent majority of mentally ill people.

By the time Myer saw the man with schizophrenia again, just over two years later, Myer had taken MHFA. "He wasn't ready to fight, but he was still charged up. He'd broken things in the house already," Myer recalls. "I tried to keep his attention on us. That actually is a big deal when you're hearing voices." Myer kept repeating the man's name and told him they were there to make sure he got help, not to hurt or arrest him. Myer's approach worked: within half an hour the officers were able to take the man to the hospital. "The training made a huge difference," Myer says.

MHFA training is now part of the curriculum at one of Rhode Island's three police academies and is one of the most popular in-service programs at precincts. Coffey, also a national MHFA trainer, says its key benefit is enabling officers to recognize symptoms of mental illness and act accordingly: "The appropriate response may not be an arrest. Can we give the person a summons and get him to the hospital?"

MHFA can be particularly helpful with people who are in the early stages of a psychiatric illness, when symptoms can be easy to miss: someone may seem withdrawn, unusually quiet or disinterested in his or her typical activities. In such cases, being able to recognize warning signs can help prevent a crisis. Robert Davison, executive director of the Mental Health Association of Essex County in New Jersey, remembers receiving a call from a mother concerned about her 20-year-old son. The young man seemed troubled and was spending an unusual amount of time alone, the mother said. Then she mentioned that her son had stripped the wiring out of his bedroom walls. "I said, 'Take a step back and tell me more about the wiring,'" Davison recalls. The son later admitted that he thought he was receiving radio transmissions through the wires. "She didn't know that that was a distinct symptom of psychosis," Davison says. "Had she known, she might have contacted me earlier."

Alexis, the naval contractor, had had run-ins with police over the years, and some of his friends said they had seen him change in the weeks before the Navy Yard shooting, becoming more isolated and withdrawn. With more specific knowledge, one of these people might have brought him into care long before the red flag on that August night in Newport. M

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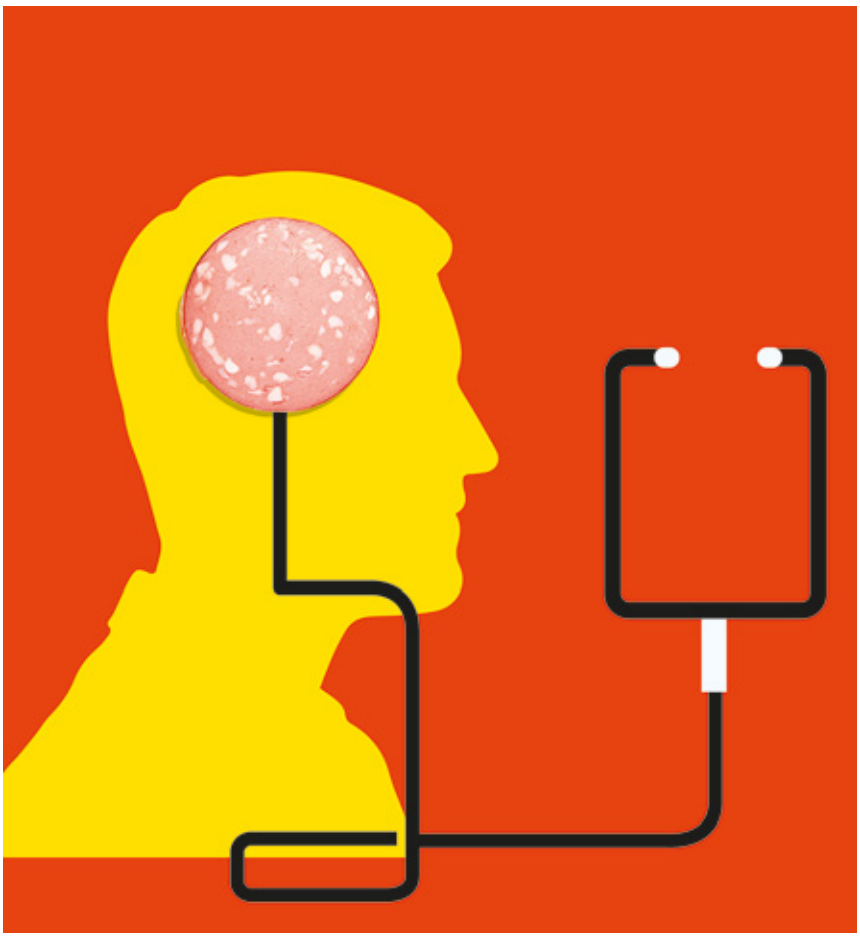
THE LAST WORD

A Reader's Guide to Baloney Detection

Sensationalist coverage and our brains can feed us false facts about mental illness



OLIVER MUNDAY (*illustration*); SEAN McCABE (*Lilienfeld and Arkowitz*)

As the saying goes, all good things must come to an end. For more than eight years, we have authored this column on facts and fictions in mental health, an opportunity for which we are profoundly grateful. Nevertheless, because of growing commitments and other pursuits, we have decided that this will be our last column.

We have written these articles for a simple reason: we live in a world in which mental health literacy is more important than ever. According to survey data published in 2010 by psychiatrist Mark Olfson of Columbia University and psychologist Steven Marcus of the University of Pennsylvania, about 3 percent of Americans are in psychotherapy, with most of them also receiving medication. Moreover, as psychiatrist Thomas Insel, director of the National Institute of Mental Health, observed in a 2014 strategic plan, the incidence of a number of mental health conditions, including autism spectrum disorder and major depression, has soared in recent years, although the significance of these rising rates remains a matter of controversy.

Despite its pervasiveness, many people are woefully misinformed about mental illness. This fact is worrisome because inaccurate notions about mental illness can be harmful. For example, the erroneous belief that people with schizophrenia are prone to violence can lead to unjustified stigma [see "Deranged and Dangerous?"; July/August 2011]. And the unsupported assumption that antidepressants are more effective than cognitive-behavior therapy for the long-term treatment of depression can dissuade individuals from seeking the most beneficial interventions for their illness [see "The Best Medicine?"; October/November 2007].

In this concluding column, we look back at our past contributions and extract some of their most important lessons. We hope to leave readers with a user-friendly kit for sorting fact from fiction about mental health and illness.

A Misunderstanding Mind

Several common errors of reasoning make all of us susceptible to certain misconceptions about psychological health. For instance, the availability heuristic is a mental shortcut by which we gauge the frequency of an event by the extent to

BY SCOTT O. LILIENFELD AND HAL ARKOWITZ

Scott O. Lilienfeld and Hal Arkowitz serve on the board of advisers for *Scientific American Mind*. Lilienfeld is a psychology professor at Emory University, and Arkowitz is an associate professor of psychology at the University of Arizona.

which it is fresh in our mind. For example, the mistaken belief that most children of divorced parents display poor psychological adjustment probably stems from the fact that when a child experiences serious problems after a divorce, we often hear about it. Conversely, when a child adapts well to a divorce—as most do—his or her resilience is almost never discussed. As a result, we may think of divorce as more closely tied to psychological problems than it actually is [see "Is Divorce Bad for Children?"; March/April 2013].

Another common logical error is post hoc, ergo propter hoc, meaning "after this, therefore because of this." Our minds are continually on the lookout for connections between incidents, which may lead us to conclude that an event preceding the emergence of a psychological condition caused the condition. For instance, many people continue to believe that childhood vaccines (especially those containing the preservative thimerosal) cause autism because the usual time for vaccinating children—soon after they turn one—comes just before the first signs of autism typically become evident. This connection in time is apparently more persuasive to many than the multiple, large epidemiological studies that have debunked the link [see "Autism: An Epidemic?"; April/May 2007].

In addition, many misconceptions about mental illness contain a kernel of truth that can lead us to false conclusions. For example, just because dogs, horses and some other domesticated animals provide emotional warmth that can temporarily relieve anguish does not mean that animal-assisted therapy alleviates the main symptoms of major mental disorders such as autism, schizophrenia and anorexia nervosa [see "Can Animals Aid Therapy?"; June/July 2008].

Misled by the Messenger

As information becomes increasingly abundant and accessible, the ability to evaluate articles, books and Web sites grows more crucial. About 3,500 self-help books appear every year, but few are based on research or are subjected to scientific scrutiny [see "Do Self-Help Books Help?"; October/November 2006]. Likewise, many psychology Web sites are replete with misinformation. In a 2012 survey of the sites of eight national autism associations, special education professor Jennifer Stephenson and her co-authors at Macquarie University in Australia found that most of them provided misleading information about the effectiveness of interventions. For example, of 33 autism treatments suggested on these sites, solid empirical support exists for only three. (Those three are grounded in the principles of behavior modification, a technique that reinforces adaptive activities.)

The mainstream media can also spread distortions, whether because of mistakes rising from deadline pressure, misunderstanding of source material or an overzealous desire to appeal to the public. As psychologist Thomas Gilovich of Cornell University observed in his 1991 book, *How We Know What Isn't So,* reporters almost always sharpen the central point of an article and leave out peripheral details. They also routinely exaggerate claims in the service of a good story. On October 7, 2013, the front page of *The Sun,* a popular British tabloid, trumpeted: "1,200 killed by mental patients." The headline implied that psychiatric patients had murdered 1,200 people in the U.K. Yet that figure included not only patients in the mental health system but also individuals who were judged retrospectively by researchers to be experiencing symptoms of mental illness, a judgment that is highly subjective.

Even when a story is more nuanced, the headline may still hold sway in people's minds. Psychologist Ullrich Ecker of the University of Western Australia and his colleagues collected data last year showing that deceptive headlines, such as "Fears of Fluoride in Drinking Water" (which topped an article emphasizing the safety of fluoride in water), can provoke biased inferences about the story, leading to misconceptions. Thus, readers must not only continue past the headline but must also carefully encode any details in a story that contradict or add nuance to its title. We should beware, too, of misguided attempts to create balance in stories. Journalists sometimes feel obligated to present both sides of an issue even when the scientific consensus is clearly on one side.

We hope that this column and the more than 50 that came before it have helped educate readers about psychological health in ways that matter for both individuals and society. The tips and analyses we have offered over the years are hardly panaceas, but they can serve as a guide through the increasingly complicated maze of claims about mental health. M

MANY MISCONCEPTIONS ABOUT MENTAL ILLNESS CONTAIN A KERNEL OF TRUTH THAT **CAN LEAD US TO FALSE CONCLUSIONS.**

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HEAD VS. HEART

On Romantic Love

by Berit Brogaard. Oxford University Press, 2015 ($21.95)

In spite of what you may have heard, love—at least the healthy kind—is actually pretty simple. If you have strong positive feelings for someone, want to protect him or her, and want to be with him or her, you are feeling love. If you also feel, at least sometimes, that you want to be physically intimate with that person, you have crossed over into the world of romantic love.

Unrequited, intense and baseless love has, over the centuries, inspired thousands of poems and works of art—perhaps millions, if we include the ones that ended up in the trash—not to mention more than a few suicides, murders and wars.

Enter Brogaard, a philosopher at the University of Miami, with a largely upbeat message about what we can do when love is going wrong. Drawing on analyses of real romantic mishaps and assertions she makes (mainly speculative) about how the brain and mind process emotions, Brogaard argues that we can exercise some degree of rational control over the love we feel, even when it is driven by unconscious processes. In so doing, we can learn to flee from harmful relationships before too much damage is done, heal more quickly after painful breakups, and, more important, use our head and not just our heart to manage love relationships worth keeping.

On the downside, Brogaard sometimes gets lost in tedious debates, such as one about whether love is really an emotion (she says it is), and seems unaware of the hundreds of experimental studies conducted in recent decades on how emotional bonds are formed. She even overlooks some of the most basic contemporary theories of love, focusing instead on ideas that are sometimes a century old.

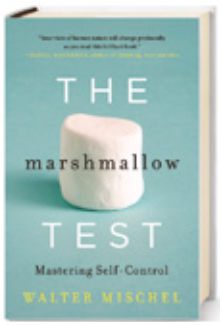
Brogaard makes her case mainly by surveying a variety of modern therapy techniques that alter how people think and feel. Even simple acts such as moving things around in your house can release you from the hold that sour feelings have on you after a breakup, she says. She is persuasive, but her advice is easier said than done when the madness of imperfect love actually hits.

—Robert Epstein

WAITING GAME

The Marshmallow Test: Mastering Self-Control

by Walter Mischel. Little, Brown, 2014 ($29)



Fifty years ago Mischel, a psychologist, presented preschoolers with a difficult choice. The youngsters could opt for immediate enjoyment of a single delectable treat—a marshmallow—or they could wait up to 20 minutes and get two of them. Over time Mischel found that kids who could hold out for greater rewards had better social and cognitive development, self-worth and SAT scores later in life.

These curious correlations are at the heart of *The Marshmallow Test,* which surveys dozens of studies that document the power of self-control. Along the way, Mischel reveals the techniques that separate highly disciplined kids from their peers, tricks that anyone can use to sidestep the snares of temptation.

The choice between instant or delayed rewards pits two factions within the brain against each other. One side, the "hot" limbic system, which includes the emotionally reactive amygdala, focuses on the mouthwatering marshmallow and urges us to enjoy it now. The other side, the "cool" prefrontal cortex, which oversees planning and problem solving, reasons that greater pleasure is worth the wait.

Each child will respond differently to this mental tug-of-war, and factors such as genetics, parenting and environment can shape the reaction. For example, kids raised in unstable homes with unreliable adults are more apt to take their rewards right away. Experience has taught them to distrust the promise of future treats. Stress can also tip the balance toward hot thinking, which can explain why otherwise even-tempered adults will still succumb to inappropriate enticements when under duress.

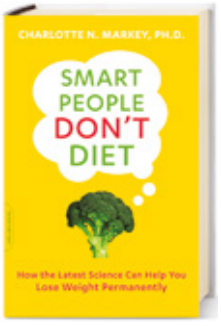
Fortunately, anyone can learn to delay gratification. Mischel's observations have revealed that people can study their lapses in self-control and develop personal coping strategies. Distraction, for example, can shift focus away from the siren call of a sweet snack or the lure of a cigarette. Cognitive reappraisal—in which we reinterpret our emotional response to something—can help us think of our greatest temptation as a toxin rather than a treat. And imagining how our future self would assess our decisions can keep shortsighted desires in check.

The Marshmallow Test is a wonderfully rich treat in itself, laden with advice and detailed research. Mischel presents all his conclusions with nuance, reminding readers of the wide variation in human behavior. He also acknowledges that the occasional lapse in self-control could be good. A life spent working and waiting can be just as deleterious as one spent giving in to every reward or vice. Still, in most cases, the science of self-control is clear: good things really do come to those who wait. *—Daisy Yuhas*

WEIGHT LOSS FOR NONDUMMIES

Smart People Don't Diet

by Charlotte N. Markey. Da Capo Press, 2014 ($16.99)



Though not perfect, this is possibly the best book on weight loss ever written. Markey, a psychology professor who teaches a course called "The Psychology of Eating" at Rutgers University–Camden, is a true expert who has done what experts seldom do well. She has translated good science on eating and dieting into clear, friendly, informal language that virtually anyone with concerns about weight will find both interesting and helpful. Even more important, Markey has organized myriad findings about eating and dieting into a highly organized, practical format. If supersizing is on your mind, the only thing better than reading this book would be, I imagine, to sneak into her classroom.

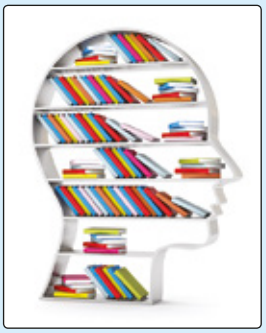
What makes her book strong, alas—and as a researcher myself and co-author of a fitness book, I cannot overstate how strong it is—also makes it frustrating. The hitch is that the volumes of research she is digesting for us sup-

port ideas that most well-informed people are already familiar with. If you want to control your weight, no crash diets, please; slow and steady wins the race. Get a good night's sleep and don't forget to exercise. Eat a good breakfast, cut down on snacks and sugar, keep a food diary (at least for a while), weigh yourself (but not every day), refrain from emotional eating, cut back on condiments, and avoid drive-through restaurants and high-calorie drinks. Most important of all, be mindful of the food you eat.

These are the lessons of decades of recent research—but we knew that. Probably most frustrating is when Markey gives us the kind of advice that is virtually impossible to follow: form good eating habits, she says, and "develop a taste for healthy food."

If only it were that simple. It isn't, and Markey knows this better than just about anyone on the planet. Her candid acknowledgment of complexity is what makes this book so especially compelling and credible. She knows how difficult weight loss can be in a culture that encourages people to shovel unhealthful food down their throats from morning until night. She knows that no matter how high one's motivation, no matter how great one's needs, no matter how well intentioned one's plan, weight loss in an affluent, consumer-oriented society is hard to achieve and even more difficult to maintain. Markey understands the challenges, sympathizing with the reader on every page while staying the course—teaching, informing, and, yes, sometimes only reminding us about what works and what doesn't. What more can an honest author do? *—R.E.*

On Our Shelf



Anatomy of an Epidemic

by Robert Whitaker. Crown, 2010

Whitaker, a longtime medical journalist, builds a disturbing and enthralling case that long-term prescriptions for psychiatric medications damage the brain and are directly responsible for the rising rates of mental illness in the U.S.

—Karen Schrock Simring, contributing editor

Creativity, Inc.: Overcoming the Unseen Forces That Stand in the Way of True Inspiration

by Ed Catmull, with Amy Wallace. Random House, 2014

As a child, Catmull, a co-founder of Pixar Animation Studios, had two heroes: Walt Disney and Albert Einstein. His dual passions for artistry and technical wizardry were integral to Pixar's founding. Yet the company's growth from scrappy little studio to Hollywood mainstay kept threatening to throttle workers' creativity. In this book, Catmull shares the lessons he learned about inspiring employees to think freely even as a company grows. *—Sandra Upson, contributing editor*

Ha! The Science of When We Laugh and Why

by Scott Weems. Basic Books, 2014

Ever wonder what happens in your brain when you decipher the punch line of a joke? In *Ha!,* cognitive neuroscientist Weems divulges the answer to this question, along with many other scientifically backed factoids on the nature of humor. I discovered, for example, that the duck is the funniest animal in the English language and that my response to a joke could reveal personality traits. And best of all, *Ha!* left me with a score of groan-worthy wisecracks for amusing friends and family.

—Daisy Yuhas, associate editor

MOBILE APP

Concussion Coach

For iPhone and Android (free; Android version pending)

First, let's get something straight: concussions are miserable. Despite having edited countless stories on traumatic brain injury, I never fully grasped how painful, frustrating and debilitating the recovery from a concussion can be. One rollerblading accident later, I'm singing a new tune: for nearly six weeks, I have been plagued by persistent headaches, fatigue, dizziness and difficulty concentrating. Lucky for me, just before my accident, the U.S. Department of Veterans Affairs released a smartphone app called Concussion Coach to help manage these symptoms. (The app was developed in collaboration with the department's National Center for PTSD; the team was led by Julia Hoffman.)

Concussion Coach was designed with military veterans in mind because many soldiers suffer brain injuries from blasts or physical trauma. The app is useful to anyone who suspects they might have a concussion, however; it is packed with information about diagnoses and symptoms to help patients understand what their brain is going through and, more important, describe their symptoms accurately to their doctor. An easy-to-use, surveylike symptom tracker helps to log trends over time.

By far the best and most surprising part of the app, however, is the coach. That's what I call her, anyway. Her calm, warm voice is hidden behind the Manage This Moment tab, which aims to help relieve symptoms in real time. You simply choose what is bothering you—headache? dizziness? irritability? worries?—and the app suggests a particular exercise that targets the symptom. Click "start," and the coach's tranquil voice guides you through a five- to 10-minute regimen of soothing mental or physical exercises. The techniques, such as muscle relaxation, deep breathing and emotional acceptance therapy, are based on well-established psychotherapeutic strategies.

Incredibly, most of these exercises work. The first time I tried one for a killer headache—turning to the app in desperation after weeks of skeptical avoidance—I was so relieved to find my pain lessened at the end of the mindfulness regimen that I cried. Out the window flew my plans to write a snarky review pointing out the irony of offering smartphone-based therapy to people whose condition often makes it painful to look at glowing screens; a few seconds of seasickness as I navigate to the coach is a small price to pay for sweet relief. Even when I am no longer recovering from a concussion, I will still open this app when I have a headache or feel stressed or sad. The techniques within are that powerful—and they speak to the potential of guided home remedies for all kinds of mental maladies. The future of therapy has arrived. *—Karen Schrock Simring*

COURTESY OF DEPARTMENT OF VETERANS AFFAIRS NATIONAL CENTER FOR PTSD (*icon*); ISTOCKPHOTO (*bookshelf*)

Is it possible to get so inebriated that you don't remember your actions?

—**Eleine Ng,** Singapore

Charles F. Zorumski, head of the department of psychiatry at the Washington University School of Medicine in St. Louis, answers:

It is indeed possible for a person to get intoxicated and not remember what she or he did. This state is called a "blackout" or, more precisely, a "memory blackout." During a blackout a person is intoxicated but awake and interacting with the environment in seemingly meaningful ways, such as holding a conversation or driving a car. After the period of intoxication, usually the next day, the person has no or, at best, vague recall for events that occurred while inebriated. At times, being in this state can have disastrous consequences, such as waking up in an unknown or unsafe place, losing personal possessions or participating in risky behaviors.

On the neural level, a blackout is a period of anterograde amnesia. That is, a person's ability to form new memories becomes impaired. Although a person does not lose previously learned information, he or she may also find it more difficult to recall certain facts while intoxicated. Yet once a person sobers up, his or her memory and ability to learn new information are not permanently affected.

How alcohol, or ethanol, produces a memory blackout is not completely understood. It is clear, however, that alcohol can impair a process in brain cells called long-term potentiation (LTP), a cellular mechanism thought to underlie memory formation, particularly in the hippocampus.

The amount of alcohol required to impair LTP and learning, and potentially cause a blackout, can vary. Important factors include the type and amount of alcohol consumed—high-potency drinks are worse—and the rate at which alcohol is consumed, with rapid consumption being more problematic. These factors affect how quickly alcohol levels rise in the brain and impair memory formation.

In our studies in rodents, blocking LTP in the hippocampus requires dangerously high concentrations of alcohol, about three times the level necessary to get a person drunk. It is important to note, however, that drugs other than alcohol can affect LTP. And when combined with alcohol, these drugs can cause blackouts at lower concentrations of alcohol. Common sedatives such as the benzodiazepines Xanax and Valium and drugs that act similarly on the brain, including the popular sleeping aid Ambien, can even induce a blackout on their own.

Given the dangers associated with blackouts, the best strategy to avoid having one is to abstain from heavy consumption and from combining alcohol with other neuroactive drugs.

Can people's personality change for the better after a stroke? If so, why?

—**Jenna Owen,** England

Jon Stone, a consultant neurologist and honorary senior lecturer at the University of Edinburgh, replies:

Strokes are areas of damage in the brain caused by blocked blood vessels or bleeding. They can set off a host of problems, including paralysis or impaired vision. Cognitive and behavioral changes after stroke are common yet often overlooked because the effects may be subtle.

Friends and relatives may report a personality change that is hard to pin down. Some of these changes, such as low mood and anxiety, are more likely to be related to a person's feelings about having a stroke than to any harm to the brain. A genuine shift may occur, however, when the frontal lobes sustain damage. The frontal lobes play an essential role in regulating emotion, decision making and judgment. Strokes that affect the frontal lobes can lead to a range of problems, such as apathy or emotionalism (an overflow of emotion without necessarily feeling that emotion).

A stroke that hits the cerebellum can also trigger a personality shift. This brain region is vital to many aspects of executive function. Damage here can bring about disinhibition, which often manifests as inappropriate behavior. Other "negative" personality changes include poor decision making, aggression and irritability.

Less common are cases of "positive" personality changes, in which people reportedly become happier and even nicer. Surveys suggest such changes occur rarely, but the frequency may be underreported. They might arise if a person has experienced a mild frontal lobe impairment that has led to a small increase in apathy and less anxiety. A slight loss of inhibition may also explain why a stroke victim might begin to experience more positive emotions.

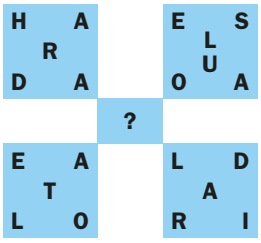
Yet personality changes after a stroke could have nothing to do with afflicted brain areas. Serious illness often leads people to reevaluate their priorities in life and change their attitudes toward others. For example, British television broadcaster Andrew Marr, who suffered a stroke, said that his stroke made him a "nicer and happier person" and less "self-absorbed."

Clinicians understandably tend to focus on the negative aspects of stroke and other brain diseases, but positive personality change is a reality for some patients and deserves further study. **M**

JAMIE CARROLL *iStockphoto*

1 MISSING LINK

What one letter, indicated by the question mark, combines with the letters in each box to form a common word?



2 WORD WHEEL

An eight-letter word is spelled out in the box below. Find it by beginning with the correct letter and moving clockwise or counterclockwise around the box, using each letter only once.

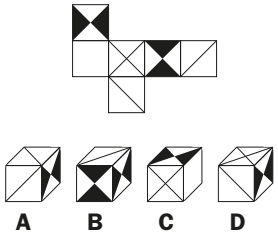
3 TIMES TEASER

The digits from 0 to 9 are used once each in the multiplication equation below. Fill in the missing numbers.

```
  ???
×  ?5
-----
?????
```

4 SPATIAL SENSE

Which of the four cubes below cannot be made from the unfolded cube above them?



5 FAUX QUOTE

First unscramble the letters in each word at the right, then unscramble the word order to find a statement that could have been made by Queen Elizabeth I of England:

RPULEP OT YORLA YM DSSERHRAIER YM NTSAW DRE HTIS WLAUF IAHR TBU I TNWA YLALRE YDE

6 A REAL HEAD-SCRATCHER

A question is coiled in the grid at the right. To spell it out, start with the "A" in the upper right corner and move to an adjacent letter in any direction. All the letters will be used exactly once. (Hint: The enumeration is 3, 1, 4, 6, 3, 1, 3, 6, 9 ?)

L	N	A	H	E	A
A	C	C	T	A	R
C	E	F	A	S	L
I	I	A	D	M	I
T	D	N	A	C	H
N	E	E	C	N	A

7 CONFOUNDING COMPOUNDING

Place a word between the pair of words on each line to form an entirely new word or a phrase with each of them (example: SCHOOL *BOOK* BAG). In this case, one four-letter word will fit in all three pairs below. What is it?

BACK	_____	**SOME**
LEFT	_____	**WORK**
FORE	_____	**SHAKE**

8 PLAYING WITH BLOCKS

How many different combinations of blocks below form the word COLD? You can use each block more than once.

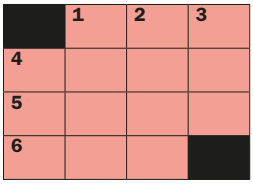
9 MINI CROSSWORD

Across

1. Busy airport
4. Madcap
5. Assistant
6. Old hand

Down

1. Narrow margin
2. Ruin
3. "See ya!"
4. Microwave



10 WORD MORPH

Go from PINK to ROSE in only four steps, changing one letter at a time and making a common English word at each step.

PINK

_____

_____

_____

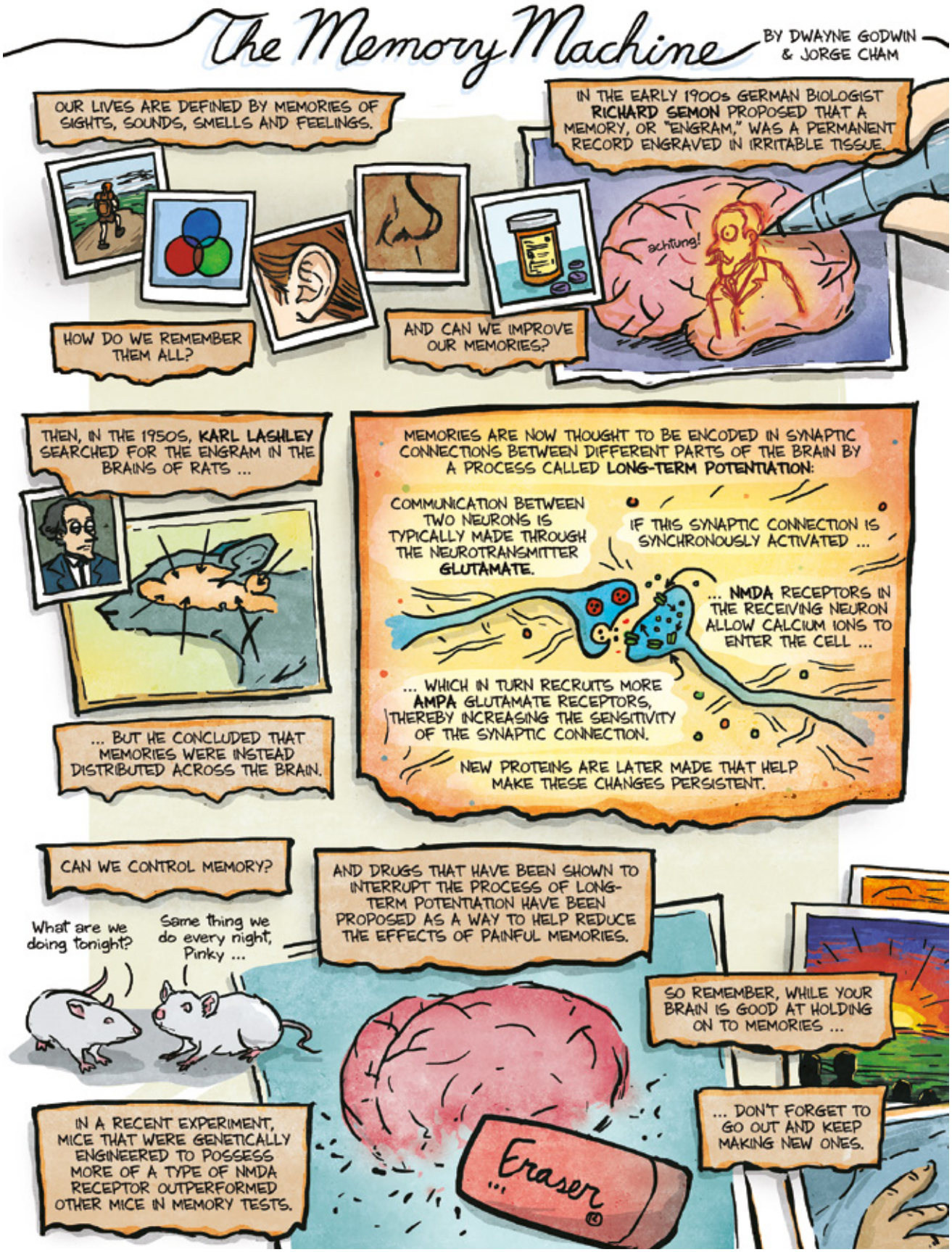
ROSE

Answers

1. Z: HAZARD, ZEALOUS, LIZARD, ZEALOT.
2. REPRISAL.
3. 396 × 45 = 17,820
4. Cubes A and C cannot be made.
5. My hairdresser wants to dye my hair this awful red, but I really want royal purple.
6. Are a slim chance and a fat chance identical?
7. HAND.
8. 12 different combinations.
9.

P	R	O	
A	I	D	E
Z	A	N	Y
	H	U	B

10. Here's one solution: PINK, PINE, PONE, POSE, ROSE.



Dwayne Godwin is a neuroscientist at the Wake Forest University School of Medicine.
Jorge Cham draws the comic strip *Piled Higher and Deeper* at www.phdcomics.com.

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