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SPECIAL REPORT

WORK SMARTER, WORK HAPPIER
Be more productive, creative and collaborative

HOW VACATIONS BOOST YOUR BRAIN

THE SCIENCE OF HOW WE LEARN

COVER PHOTOILLUSTRATION AND THIS PAGE: AARON GOODMAN

I love my job, but research suggests I'm in the minority. A 2015 survey by the nonprofit Conference Board found that only 48.3 percent of Americans are satisfied at work. This has not always been the case. In the late 1980s and mid-1990s, job satisfaction hovered around 60 percent. To make matters worse, Americans spend an awful lot of time at their less than joyful jobs: according to Gallup, an average of 47 hours a week for full-time workers—nearly a full day beyond the 40-hour week. What does it take to find more fulfillment, less stress and greater productivity on the job? That's the question we set out to answer in our special report, "Work Smarter, Work Happier," which begins on page 31.

Many modern employees worry that robots and artificial intelligence threaten their livelihood. Computer scientist Sandy Pentland of M.I.T. turns this idea on its head by showing how technological devices can actually foster the most human part of labor: the social connections essential to teamwork and innovation. "In the laboratory and in real life, we have found that these aids can help coworkers communicate better, find greater success and enjoy work more," he writes in "Betting on People Power."

In "No Workplace Like Home," journalist Rachel Nuwer explores the growing trend of telecommuting, examining research that shows how distance workers can exceed their office-bound peers in both productivity and job satisfaction. And in "Give Me a Break," contributing editor Ferris Jabr looks at solutions to what may be the single biggest stressor for the modern desk jockey: the failure to unplug from the always on, always connected workplace.

As much time as we invest on the job, we spend even more hours sleeping. Or trying to sleep. This is an active area of research for brain scientists, and both our Consciousness Redux column by neuroscientist Christof Koch (*page 22*) and the opening stories in Head Lines (*pages 7–9*) look at fascinating new findings.

Finally, as the country lurches toward Election Day, we bring you several articles that are relevant to voting. Starting on page 50, British psychologist Kevin Dutton examines the intriguing—and alarming—overlap of personality traits found in politicians and psychopaths. Don't miss his assessment of the current presidential candidates. On page 20, behavioral scientist Supriya Syal and behavioral economist Dan Ariely extract lessons from research on how to improve voter turnout. And on page 16, our inimitable advice columnist, Sunny Sea Gold, offers practical wisdom on how to be a more responsible, informed voter. It's worthwhile reading, whatever your politics.

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SCIENTIFIC AMERICAN
MIND CONTENTS

LETTERS MAY/JUNE 2016 ISSUE

DANGEROUS BELIEFS

In "Fueling Extremes," Stephen D. Reicher and S. Alexander Haslam repeatedly lay blame on the victims, as in, for instance: "counterterrorism efforts in many countries give little consideration to how our responses may be upping the ante."

Unfortunately, pacifism will not work with the Islamic extremists who believe that it is their mission to establish a Muslim caliphate on earth and that all nonbelievers must be killed. All of the love and understanding that the authors would like us to bring to these folks will not deter them, for one moment, from committing horrific acts that they believe advance the caliphate.

Edward Graf
Alexandria, Va.

I was disappointed that your three articles about terrorism focused only on the actions of groups such as ISIS and did not acknowledge the greater threat of other sources of terrorism. Overwhelmingly, those who have committed terrorist attacks in the U.S. and Europe are not Muslims. You should have mentioned all of the homegrown terrorists in the U.S.—for instance, the recent terrorist acts in Colorado Springs, in which a Planned Parenthood clinic was attacked.

You had the opportunity to make a more scientific statement about who the terrorists that really threaten us are, and instead you chose to reinforce the fear that is expressed in our national news media about Muslims.

Virginia McAfee
Boulder County, Colorado

THE TROUBLE WITH SHAME

In "For Shame," Diana Kwon mentions a teenager posting "raunchy photographs to the Web." There is a lot of inherent bias in the choice of that adjective! Raunchy? Sexual or provocative, perhaps—and perhaps not at all a turn-on to countless people.

I have a Ph.D. in human sexuality, and I have lectured internationally on sex education and behaviors. Unfortunately, slut shaming, fat shaming and other slams are still rampant, even in our more accepting times. Raunchy—or was it artistic and beautiful? Is the self-awareness of the girl who knowingly posted her pictures simply not okay for the author?

Safe, sane and consensual sex is okay. It should not be the object of shame, guilt or someone else passing judgment.

Robert Berend
Beverly Hills, Calif.

Kwon's article seems to confuse shame and humiliation. Shame is a basic and primary human emotion—we are born with it. Humiliation is what you feel when someone has "shamed" you, publicly, but it's a different emotion than basic shame or a version of shame with the added negative emotions of anger (at being disrespected) and/or fear (of social rejection).

In cases where shame leads to a positive outcome, it is because shame has arisen on its own after the person has had time alone to process and reflect. In situations where shame leads to defensive digging in, despair or even suicide, it is because someone else has tried to make the person feel shame.

Shame cannot be commanded or demanded—because then it is humiliation instead, and humiliation is toxic. Trying to control someone else's behavior by manipulating his or her emotions almost never leads to anything positive or constructive. An obvious analogy: I cannot make you love me. Most of us get that

FOR SHAME

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

ILLUSTRATIONS BY NOMA BAR

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one. Well, I cannot make you feel shame either, and when I try, just like when I try to make you love me, it usually backfires and may actually result in the opposite of what I'm trying to make happen.

Publicly shaming someone is no different than bullying, harassment or other forms of interpersonal violence. Please make this distinction clear.

Rebecca Stanwyck
Castro Valley and Pleasanton, Calif.

WHAT ABOUT COUNSELING?

I found Carol W. Berman's careful observations regarding her patient's symptoms and emotions in "The Black Spot" [Cases] to be interesting and educational, but I was dismayed by her stated chain of logic regarding treatment. As she acknowledged, cognitive-behavioral therapy (CBT) has proved to be effective for many people with obsessive-compulsive disorder (OCD), and this seems particularly true when provided in combination with some medications. And yet she apparently decided that she would only prescribe massive doses of Zoloft. Her reasoning was that "we needed to act quickly." I don't consider 30 or more days to be quick, personally. Why not begin immediate psychological counseling in conjunction with drugs? At the very least, the man's anxiety may have been assuaged while awaiting the effectiveness of Berman's pending psychotropic

cocktail. And at best, the pharmaceuticals may not have been needed at all, at least not in such massive dosages.

Terry A. Rogers
Santa Cruz, Calif.

BERMAN REPLIES: If you read carefully, you'll notice at the beginning of the article that I'm engaged in a specific dialogue with my patient, which was psychotherapeutic in nature. Because psychopharmacology is my specialty in psychiatry, I naturally wanted to give him medication for his OCD. Although studies in the past have shown that CBT and pharmacotherapy may be considered equally effective for OCD, a recent article in the May 2016 issue of the American Journal of Psychiatry *suggested otherwise. I personally have found medication to be highly effective.*

KIDS AND ANTIDEPRESSANTS

In "The Hidden Harms of Antidepressants" [Head Lines], Diana Kwon highlights the efforts to suppress adverse effects of antidepressants in youths. Possibly more important is the dramatic lack of demonstrated advantage in using these drugs to "treat" our struggling children and teens.

The evidence base for this intervention rests on studies such as the 2004 Treatment of Adolescents with Depression Study. In this study of 439 youths, 109 were given fluoxetine (Prozac). Study conclusions reveal that in the short term, combined treatment of CBT and fluox-

etine resulted in the greatest advantage, followed by fluoxetine alone. But after the conclusion of the study (at 36 weeks), a one-year naturalistic follow-up shows the advantage of medication disappeared: participants from all arms of treatment were in a virtual dead heat of progress on depression scores.

Even more stunning than this deteriorating benefit are the efforts in substantiating SNRI medications, such as duloxetine (Cymbalta) or venlafaxine (Effexor). In a primary duloxetine study reported in the Cymbalta package literature, researchers found that efficacy in treating major depression was not demonstrated in patients aged seven to 17: neither Cymbalta nor an SSRI was superior to a placebo. In a major study of Effexor, the drug failed to outperform a placebo in two placebo-controlled trials of a total of 766 youths.

Rather than subjecting the developing nervous system to these medications, clinicians should carefully reconsider their support for such interventions.

Robert Foltz
Chicago School
of Professional Psychology

I am 15 years old, I take antidepressants, and if I didn't take them, I would be a different person. Without them, I go into a downward spiral, with no end until I take my medication again. I have ADHD, I'm on the autism spectrum and I am depressed. Every day is a challenge. Antidepressants don't make me more aggressive and depressed—they help me stay regulated. I don't think that it is fair to say that doctors need to stop this trend of constantly prescribing these drugs without also including the experience of youth like me who benefit from them.

K. Marion
via e-mail

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Head Lines

A USER'S GUIDE TO THE BRAIN
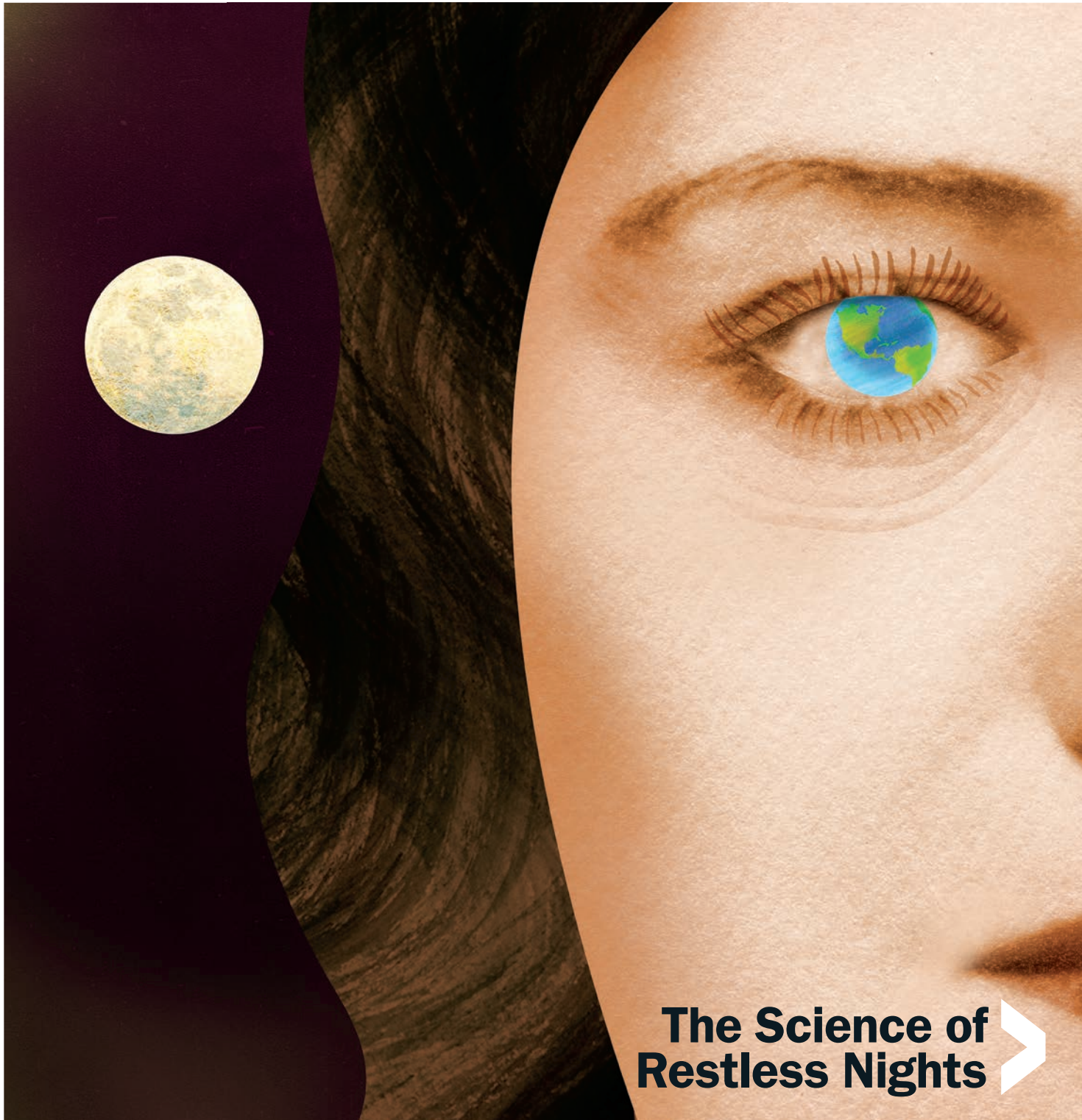
The Science of Restless Nights

Trouble Sleeping?

You're not alone. Sleep deprivation is rampant around the world. New studies help to explain why we have so much trouble getting enough shut-eye—and they also warn of serious consequences if we don't figure out how to get more.

The Hidden Risks of Poor Sleep in Women

Shift work and problems such as apnea may cause more trouble for women than men

The science of sleep is woefully incomplete, not least because research on the topic has long ignored half of the population. For decades, sleep studies mostly enrolled men. Now, as sleep researchers are making a more concerted effort to study women, they are uncovering important differences between the sexes.

Hormones are a major factor. Estrogen, progesterone and testosterone can influence the chemical systems in the brain that regulate sleep and arousal. Moreover, recent studies indicate that during times of hormonal change—such as puberty, pregnancy and menopause—women are at an increased risk for sleep disorders such as obstructive sleep apnea, restless legs syndrome and insomnia. Women also tend to report that they have more trouble sleeping before and during their menstrual periods.

And when women do sleep poorly, they may have a harder time focusing than sleep-deprived men do. In one recent study, researchers shifted the sleep-wake cycles of 16 men and 18 women for 10 days. Volunteers were put on a 28-hour daily cycle involving nearly 19 hours of awake time followed by a little more than nine hours of sleep. During the sleep-shifted period, the women in the group performed much less accurately than the men on cognitive tests. The findings, published in April of this year in the *Proceedings of the National Academy of Sciences USA,* may help explain why women are more likely than men to get injured working graveyard shifts. In addition, a study conducted in 2015 in teenagers reported that weekday sleep deprivation affects cognitive ability more in girls than in boys.

And yet despite the fact that sleep issues may affect women disproportionately, they may also be underrecognized in women. Statistics suggest that men are more than twice as likely to be diagnosed in youth or middle age with obstructive sleep apnea—a disorder characterized by periodic stops and starts in breathing during sleep. This may be in part because the diagnostic criteria are skewed toward men. "We discovered the disease in a specific sex, so of course it's going to be more typically catered to the features seen in that sex," explains Christine Won, director of the Women's Sleep Health Program at the Yale School of Medicine. Men are often flagged for possible apnea after reporting to their doctor that they snore or gasp awake during the night, but a study earlier this year found that women with sleep apnea have different symptoms, such as daytime sleepiness, which their doctors may not recognize as apnea-related.

Even when women do undergo sleep testing, they still may not be properly diagnosed. Apnea tends to cluster during the rapid eye movement (REM) stage of sleep in women, whereas male apnea is not as stage-specific, Won explains. Because apnea is diagnosed by calculating an average index of breathing issues during a total night's sleep—an approach that was, again, built on studies involving men—the severity of women's REM-focused apnea often gets diluted, which is especially worrying considering the results of a 2015 study that found that women with sleep apnea are at an increased risk for heart failure and death as compared with men. "We have overrelied on screening instruments, devices and pharmacological agents that were designed for men that may not be applicable to women," explains Monica Mallampalli, vice president of Scientific Affairs at the nonprofit Society for Women's Health Research in Washington, D.C. The balance is finally shifting, but it may take decades for scientists to uncover all the sex differences related to sleep and update the diagnostic criteria, statistics and treatments to reflect them. —*Melinda Wenner Moyer*

Why We Toss and Turn in an Unfamiliar Bed

Half the brain stays more alert the first night in a new location

When we bed down in a new locale, our sleep often suffers. A recent study finds that this so-called first-night effect may be the result of partial wakefulness in one side of the brain—as if the brain is keeping watch.

Researchers at Brown University and the Georgia Institute of Technology used neuroimaging and a brain wave–tracking approach called polysomnography to record activity in four brain networks in 11 individuals as they slept on two nights about a week apart. The subjects nodded off at their normal bedtimes, and their brain was scanned for about two hours—the length of a sleep cycle.

As participants slept, right hemisphere regions showed consistent slow-wave activity regardless of the night. Yet average slow-wave activity was shallower in their left hemisphere during the first night—an asymmetry that was enhanced in those who took longer to fall asleep. [For more details about this study, turn to page 22.]

The results, published in May in *Current Biology,* suggest systems in one side of the brain remain active as people venture into unfamiliar sleep situations—an apparent survival strategy reminiscent of the unihemispheric sleep reported in certain animals.

Because the results represent just one sleep cycle, however, it is unclear whether the left side of the brain is always tasked with maintaining attentiveness, explains the study's senior author Yuka Sasaki, a cognitive, linguistic and psychological sciences researcher at Brown. It is possible the right hemisphere takes over guard dog duties at some point in the night.

Based on anatomical sites with muted slow-wave activity, the researchers suspect the first-night effect involves the default-mode network, a system of interacting brain regions involved in daydreaming and spontaneous thoughts. That network is usually focused inward, though; nighttime watchfulness would be an odd task for it to take, says Massachusetts General Hospital psychiatry researcher Dara Manoach, who was not involved in the study. Still, she says, the differences in left brain activity "link us to the rest of the animal kingdom," offering an

"evolutionarily sensible" scenario that explains the first-night effect.

—*Andrea Anderson*

Who Gets the Most Sleep?

Researchers at the University of Michigan used a free smartphone app to collect bedtime and wake-time data from 8,000 people in 128 countries. No big surprise: most people fail to get the solid eight hours that experts often recommend. Folks in Singapore average the least sleep, and the Dutch get the most. Other findings:

- Women average 30 minutes more snooze time than men.
- Middle-aged men get the least shut-eye.
- Bedtime, not wake time, makes the biggest difference in how much sleep you ultimately get.

	AVERAGE BEDTIME	AVERAGE SLEEP DURATION
Australia		8.0223
New Zealand		8.0667
Belgium		8.0217
U.S.		7.8686
Canada		7.9712
Denmark		7.8116
Netherlands *(most amount of sleep)*		8.087
Switzerland		7.8358
U.K.		7.898
France		8.0531
Germany		7.6957
Japan		7.5085
Mexico		7.7917
Hong Kong		7.7708
Brazil		7.5686
China		7.8582
U.A.E.		7.9474
Italy		7.878
Singapore *(least amount of sleep)*		7.3962
Spain		7.8406

10:00   11:00   12:00

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Head Lines

Can Newborns Imitate Adults?
Some research says yes, but a new study raises questions

There is nothing cuter than a newborn sticking out its tongue in response to you doing the same. Now research suggests that such mimicry might be just a coincidence, at least in the youngest babies. The study challenges the prevailing notion in developmental psychology that imitation is ingrained at birth.

Psychologists Janine Oostenbroek, Virginia Slaughter and their colleagues at the University of Queensland in Australia tested 64 infants at one, three, six and nine weeks old for their ability to imitate nine gestures and facial expressions that previous studies have suggested infants can mimic. They hoped to link individual babies' mimicry to their cognitive development, but instead they could not find that babies imitated at all.

"Babies do increase their activity when they're in face-to-face contact with an adult, but they don't specifically match what the adult is doing," Slaughter says.

The study, published in May in *Current Biology,* rekindles a 40-year-old controversy, which raged after newborn imitation was first documented in 1977. After that initial paper, findings went back and forth for decades. Then in the 1990s, publications skewed to only positive results, perhaps indicating a systemic bias. The authors say they have heard from colleagues who could not get papers published when they did not find imitation. "I hope our study does help some of the negative results to be aired," Oostenbroek says.

Critics of the new study point out that the researchers did find an effect when comparing tongue protrusion with mouth opening, a classic test used in many studies with positive results. The babies were indeed more likely to stick out their tongue when researchers did than when the researchers opened their mouth—but crucially, they were also just as likely to stick out their tongue in response to the other seven gestures. If the babies had truly been imitating, they should do so across all conditions, the investigators explain.

Newborn imitation is often used as evidence for the idea that human mirror neurons are engaged at birth. These results suggest the reality may be more complicated. The finding does not mean, however, that aping adults is not a fundamental part of early communication and learning, says evolutionary psychologist David Bjorklund of Florida Atlantic University, who was not involved with the study. Mimicry probably just takes a few months to develop. —*Meredith Knight*

Selfie-Indulgence
Maybe you should hand your phone to a friend

People regularly see themselves as more attractive and talented than others see them. Now the rise of selfies has deepened the hue of this rose-tinted mirror. According to new research, people who take frequent self-portraits think these pics put them in the best light, even when others see selfies as, frankly, unflattering.

For this study, published online in April in *Social Psychological and Personality Science,* college students were asked to take a selfie in the laboratory, and a researcher took a nearly identical picture of them. Then the students and a group of online participants of all ages rated the images.

The researchers found that people who regularly take selfies thought that they looked more attractive and likable in their selfies than in the photographs taken by an experimenter. Other observers, however, rated them as less likable and more narcissistic in their selfies as compared with the nonselfies. For students who do not usually take selfies, it was a triple whammy: in addition to being seen as less likable and more narcissistic, their selfies were also judged to be less attractive.

People who do not regularly take selfies did not have the same bias about their own snaps as did regular selfie takers, perhaps because the selfie-indulgent have internalized positive feedback for their shots on social media, the researchers theorize. They suggest that selfie takers may also enjoy knowing they were the photographer because they have positive illusions about their photography skills, too.

"Exercise some caution when posting a selfie," says Daniel Re, a researcher at the University of Toronto and the paper's primary author. "It might not be perceived the way you intend." —*Matthew Hutson*

GETTY IMAGES

Mom, I'm Joey, not Jennie!

Why we call our nearest and dearest by the wrong name

If you were like most children, you probably got upset when your mother called you by a sibling's name. How could she not know you? Did it mean she loved you less?

Probably not. According to the first research to tackle this topic head-on, misnaming the most familiar people in our life is a common cognitive glitch that has to do with how our memories classify and store familiar names.

The study, published online in April in the journal *Memory and Cognition,* found that the "wrong" name is not random but is invariably fished out from the same relationship pond: children, siblings, friends. It did not plumb the possibility of deep psychological significance to the mistake, says Duke University psychologist David C. Rubin, a co-author, "but it does tell us who's in and who's out of the group."

The study also found that within that group, misnamings occurred where the names shared initial or internal sounds, like Jimmy and Joanie or John and Bob. Physical resemblance between people was not a factor. Nor was gender.

The researchers conducted five separate surveys of more than 1,700 people. Some of the surveys included only college students; others were done with a mixed-age population. Some asked subjects about incidents where someone close to them—family, friend or "other"—had called them by another person's name. The other surveys asked about times when subjects had themselves called someone close to them by the wrong name. All the surveys found that people mixed up names within relationship groups such as grandchildren, friends and siblings but hardly ever crossed these boundaries.

The mechanism behind the misnaming, says lead author Samantha Deffler, also a psychologist at Duke, is probably that related concepts "prime" one another. "If I mention a spoon," she says, "I might activate a related concept, and you might be likely to think of a fork." In the same way, she suggests, if Mom wants to call her daughter, the concept of daughter is also linked to her son. So she may call her daughter by her son's name.

In general, the study found that undergraduates were almost as likely as old people to make this mistake and men as likely as women. Older people and women made the mistake slightly more often, Deffler says, but that may be because grandparents have more grandchildren to mix up than parents have children. Also, mothers may call on their children more often than fathers, given traditional gender norms. There was no evidence that errors occurred more when the misnamer was frustrated, tired or angry.

The authors gleaned no data on the standard rom-com plot device of calling a lover by another's name. Possibly, the survey subjects may have identified such mistakes in the "friend" or "other" category—or not admitted it at all. Deffler does recall one young man who called his girlfriend by his sister's name. "Probably a bad sign," she opines.

The biggest surprise to the researchers was that family members sometimes called one another by the family dog's name. With cats, such slipups did not happen—perhaps because cats do not generally respond as much to their names as dogs do, Deffler suggests, so people call them less often. This result, she says, affirms the special relationship people have with their dogs, which are truly thought of as members of their family. —*Francine Russo*

TIFFANY BEUCHER

What Science Really Says about Spanking

Does this punishment cause behavioral problems, or are troubled kids more likely to be spanked?

To spank or not to spank? This age-old parenting question elicits fierce debate among parents, psychologists and pediatricians. Surveys suggest that nearly half of U.S. parents have spanked their children as a disciplinary tactic, but many experts argue that this form of punishment—hitting a child on the bottom with an open hand—increases the risk that kids will develop emotional and behavioral problems. Other scientists counter that research on the issue is fraught with problems, making it impossible to draw definitive conclusions. A new meta-analysis speaks to several of the most contentious points in the debate and concludes that spanking does pose risks, but differences of opinion persist.

In the meta-analysis, researchers Elizabeth Gershoff and Andrew Grogan-Kaylor of the University of Texas at Austin and the University of Michigan, respectively, evaluated 75 published studies on the relation between spanking by parents and various behavioral, emotional, cognitive and physical outcomes among their kids. They found that spanking was associated with 13 out of a total of 17 negative outcomes they assessed, including increased aggression, behavioral and mental health problems, and reduced cognitive ability and self-esteem.

This was not simply an attempt to synthesize studies—Gershoff and Grogan-Kaylor also wanted to address two concerns often raised about the body of research linking spanking to childhood problems. The first is that much of it has evaluated the effects of physical punishment in general, without homing in on the effects of spanking specifically—and because physical punishment can include tactics such as hitting with objects, pinching and biting, this "lumping problem" may ultimately exaggerate spanking's risks. The second concern is that many published studies are "cross sectional," which means that they evaluate the effects of spanking by collecting data at a single point in time, making determinations of cause and effect difficult. A cross-sectional study might, for instance, find that aggressive 10-year-olds were more likely than docile 10-year-olds to have been spanked as toddlers, but that does not mean that spanking made them aggressive. They may have been spanked because they were acting out back then, too.

To confront these issues, Gershoff and Grogan-Kaylor did several things. First, they limited their meta-analysis to studies that evaluated the effects of spanking, slapping and hitting children without the use of objects and found that spanking is still associated with negative outcomes. They also compared the results from cross-sectional studies with results from longitudinal studies, which track the kids' behavior over time and are better able to tease out cause and effect. Gershoff and Grogan-Kaylor found that spanking is associated with negative outcomes in both types of studies, which strengthens the argument that spanking poses risks.

Yet some researchers remain skeptical. Studies suggest, for instance, that the effects of spanking can differ depending on the circumstances. Two studies have found no associations between spanking and mental health problems among kids who were spanked less than once or twice a month; other research has shown that spanking has much less of a negative effect on preschool kids than on infants and adolescents. So the conclusion from the meta-analysis that spanking itself is dangerous might be overly simplistic. "I think it's irresponsible to make exclusive statements one way or another," says Christopher Ferguson, a psychologist at Stetson University in Florida.

And then there is the chicken-or-egg question: Are kids spanked because they act out, or do they act out because they are spanked—or both? Ferguson tried to control for the effects of preexisting child behavior in a 2013 meta-analysis he published of the longitudinal studies on this issue; when he did, the relation between spanking and mental health problems was much smaller than it had appeared without these controls in place. As a further demonstration of the importance of careful statistical controls, Robert Larzelere, a psychologist at Oklahoma State University, and his colleagues reported in a 2010 study that grounding and also psychotherapy are linked just as strongly to bad behavior as spanking is but that all the associations disappear once controls are used.

Still, a number of individual studies have found associations between spanking and negative outcomes, even after controlling for preexisting behaviors. Thus, Gershoff says that in spite of the lingering controversy, the safest approach parents can take is not to spank their kids. "Studies continue to find that spanking predicts negative behavior changes—there are no studies showing that kids improve," she says. In other words, not a shred of data suggests spanking actually helps kids become better adjusted—and with the large body of work suggesting it might do harm, why take the chance?

—Melinda Wenner Moyer

Does City Life Pose a Risk to Mental Health?

Exploring the link between urban living and psychosis

Life in the city can be taxing. For years studies have consistently linked urban living to a higher risk of schizophrenia—but researchers are only beginning to understand why this association exists. A number of factors, including elements of the social environment (such as inequality and isolation) and physical stressors (such as pollution and noise) could explain how the city erodes well-being. Conversely, people predisposed to mental illness may simply be more likely to move into urban locales. Two papers published in May suggest both scenarios could be involved.

Although most investigations have focused on adults, new evidence indicates that exposure to urban environments early in life—being born or growing up in a city—matters most. To look more closely at this critical stage of life, a group led by Helen Fisher, a psychiatrist at King's College London, and Candice Odgers, a psychologist at Duke University, conducted a longitudinal study involving 2,232 twin children in the U.K. when they were ages five and 12. Half the kids at each age lived in cities. The investigators measured psychotic symptoms by conducting in-depth interviews with the children at age 12 to determine whether they had experienced hallucinations or delusions.

Their analysis revealed that growing up in the city nearly doubled the likelihood of psychotic symptoms at age 12 and that exposure to crime, along with low social cohesion (that is, a lack of closeness and supportiveness among neighbors), were the biggest risk factors. Although most kids who have psychotic symptoms will not develop schizophrenia as adults, psychotic incidents can predict a wide range of mental health problems, including depression, post-traumatic stress disorder and substance abuse.

Complicating the matter, schizophrenia is a highly heritable disorder, meaning genetic factors may also contribute. One process that might be occurring is social drift, whereby people with mental illness tend to move into poor city neighborhoods with substandard health care. In a recent study, published in May in *Translational Psychiatry,* a team led by researchers at the University of Oxford assessed genetic and environmental influences in three different cohorts of Swedish individuals: more than two million siblings, 1,355 twin pairs, and molecular genetic data collected from blood samples in another group of twins. They found that the risk of living in a deprived neighborhood in adulthood was heritable and associated with an increased genetic risk for schizophrenia. The authors believe previous studies failed to account enough for this familial confounding—although other experts disagree. One point of contention is that the new study looked at adults, whereas much existing work has shown that the city's influence in early life makes the biggest impact.

Scientists will likely need to combine the hereditary and environmental factors to understand how city life truly affects mental health. "Emphasizing the role of genes over the environment—or vice versa—is an overly reductionist approach to the science and ignores the fact that both sets of factors are relevant to psychosis onset," says James Kirkbride, a psychiatric epidemiologist at University College London who was not involved in the new studies. "No one is denying genetic factors, overall, contribute a greater extent to risk, but of the two, only environmental influences can be ameliorated currently." According to Kirkbride, the science confirms that efforts to reduce the negative impact of urban living should focus on disadvantaged neighborhoods, where the cycle of poor mental health may persist across generations. —*Diana Kwon*
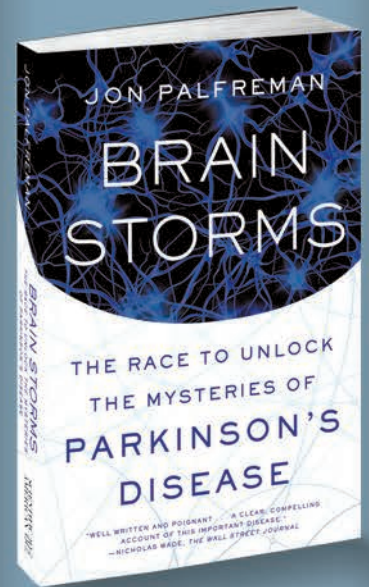
GETTY IMAGES

Harsh Parents Raise Bullies—and Their Victims

Overly permissive parenting may lead to the same problems

The consensus is clear: mean parents make mean kids—*and* the victims of mean kids. Several recent studies confirm an association between strict parenting styles and children's likelihood of both being a bully and being bullied. Some work also points to a more surprising association—permissive or neglectful parenting might create bullies, too.

In one such study, researchers at the University of Washington and Arizona State University conducted a retrospective study of 419 college students and found that parental authoritativeness—in which parents are warm and caring but set rules for the sake of their child's safety—lowered kids' risk of being bullied. Both permissive and authoritarian (strict) parenting styles, on the other hand, were positively correlated with bullying other kids, according to the results published in January in *Substance Use and Misuse.* Both approaches can result in a lack of respect for rules and the rights of others.

A 2012 study in the *Journal of Cybertherapy and Rehabilitation* also pointed to lackadaisical parenting as a problem. Researchers investigated online bullying in a sample of college students and found that those with permissive parents had engaged in more bullying behaviors than participants with authoritarian and authoritative parents. Neglectful parenting was associated with the most bullying.

Most research on parents' influence on bullying, however, has focused on harsh, punitive parenting styles—in which the parents are essentially modeling bullying behavior for their children. One such study, published in January in *Child Abuse and Neglect,* assessed bullying involvement, parenting styles and disciplinary practices in a sample of 2,060 Spanish high school students. Results indicate that abusive discipline increased teenagers' risk of abusing peers or being abused by them. For girls, the risk of being a bully was more closely connected to physical punishment, whereas for boys it was linked primarily to psychologically aggressive parental discipline. For both boys and girls, there was a direct correlation between falling victim to a bully and psychological aggression from parents.

Taken together, the studies indicate that the best parenting tactics probably fall in the middle of the spectrum. Indeed, studies have shown that a protective factor against being bullied or becoming a bully is having parents who are facilitative, meaning warm and responsive to their children and encouraging of appropriate levels of autonomy (rather than being either controlling or overly permissive). A 2015 study of 215 grade school children, reported in the *Journal of Child and Family Studies,* found that bullied children were consistently rated by teachers as having less facilitative parenting than nonbullied children. A 2016 study from the *Journal of Child Psychology and Psychiatry* followed kids for five years and found that those whose parents supported autonomy when the kids were four or five years old bullied less over time than those whose parents showed less support for autonomy.

The bottom line? "If you do not wish to raise a bully, do not bully your own kids," says Julie A. Patock-Peckham, a psychology professor at Arizona State. "An authoritative parenting style, on the other hand, is protective against so many negative psychological outcomes that people who wish to become better parents should take classes on how to be more authoritative with their children." —*Tori Rodriguez*

Trying to Forget May Cause Amnesia

Suppressing unwanted memories impairs the brain's ability to retain new information

What do you do when, say, a friendly conversation accidentally triggers a bitter memory? You probably try to put the dark thoughts out of your mind and carry on with the chat. Now a recent study in *Nature Communications* suggests that trying to banish that memory may cause you to forget the details of your conversation more quickly than you would have otherwise.

In the study, participants started by memorizing a number of word pairs. Researchers then showed them one word from the pair. The participants had to either retrieve or suppress the other. In between some retrieval/suppression tasks, the researchers showed the subjects unrelated pictures of objects in an unexpected setting (say, a peacock in a parking lot). Later the team surprised the participants with a memory test in which they were shown each background setting and asked to recall the associated object. The participants were 42 percent less likely to recollect the object correctly if it had been presented between suppression tasks as opposed to recall tasks.

In another experiment described in the same paper, the researchers used functional MRI to look at participants' brain activity during retrieval and suppression. They discovered that suppression subdued activity in their hippocampus, a brain area responsible for both forming new memories and recalling old ones. This dampening may hinder the ability to register new experiences occurring at that moment. "This area of the brain doesn't have a quick on or off switch that you can simply toggle back and forth," explains lead author Justin Hulbert, a cognitive psychologist at Bard College. "It takes some time to ramp up and down. In that process, other information that you'd like to remember later may get lost as well."
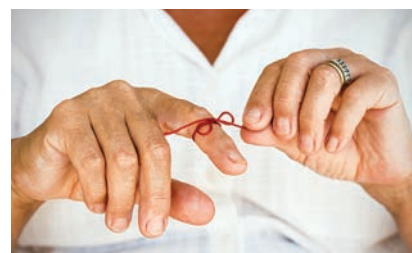
Jesse Rissman, assistant professor in the department of psychology at the University of California, Los Angeles, says he is fascinated by the results of the study, yet he adds that it would be hard to test its real-world implications.

The findings could explain why some people report learning issues after a traumatic experience—if they often try to suppress bad memories, they might hinder their brain's ability to form new ones. —*Dinsa Sachan*

You Smell Sick

Scientists are racing to create tests that can identify illness via odors in patients' sweat, breath and urine

Being alive is a smelly business. Our bodies constantly release by-products of the processes that go on inside us—and it is more than just a curiosity or a cause for dismay. A growing amount of research suggests that it might one day be possible to sniff someone's breath, skin or bodily fluids to help diagnose a disease.

For years researchers have investigated the idea that animals, especially dogs, might be able to tell sick people from healthy individuals by smell. For some diseases, trained animals can be surprisingly good at it. Devices that detect volatile compounds can also pick up subtle differences between diseased and healthy tissue samples, breath or other substances. The list of illnesses studied this way is long—cancers of the stomach, lung, breast and pancreas, cirrhosis, tuberculosis, and many more. Researchers have even reported on a Scottish woman who is capable of identifying people who have Parkinson's disease by their scent—in one case, months before the diagnosis was made.

One recent paper in *Chemical Senses* suggests that traumatic brain injury causes a change in the urine of mice that other mice can be trained to sniff out. "Not only was there an odor change, but it lasts for quite a while," says study author Gary Beauchamp of the Monell Chemical Senses Center, which suggests the smell may be the result of a process involved in the brain's response. The researchers are interested in developing a quick, noninvasive test to aid in detecting whether children playing contact sports have received brain injuries. Nothing like that currently exists, and a smell test, should it transfer to humans, could be very useful.

But just recognizing a change in smell is one thing. Figuring out exactly what molecules are different and why that is the case is another. There are good arguments for taking that second step before a test ever leaves the laboratory. If you do not know exactly what has been altered, you cannot be sure how good a marker of disease an odor really is.

For example, Raed Dweik, a physician and professor at the Cleveland Clinic, had what looked like a thrilling find several years ago: a signal that showed up in the breath of every hospitalized patient with a certain disease and in none of the healthy control subjects. The team thought it might have discovered something really important. "But on further analyses," Dweik says, "what we found was one of the volatile compounds in the cleaning solution in the hospital." Every patient had indeed exhaled it—but it had nothing directly to do with the illness.

Car exhaust also shows up in people's breath, it turns out. And other factors can muddy the waters: microbes that live in the mouth and gut, oral hygiene, and whether the sample is from the beginning of a breath or its tail end. Also, a breath or other odor-based test has to meet the same rigorous criteria as a blood test while being better at its job in some way than existing assays.

Given these challenges, the most appealing targets for sniff tests are covert diseases for which there is no existing blood test or method of early detection. George Preti, a researcher at the Monell Center, is investigating using a sniffer tool to detect ovarian cancer, which tends to be diagnosed when the disease has already advanced.

Although many potential odor tests are still primarily the domain of research scientists, there is one that has made it into the clinic: a measure of nitric oxide, which is released by inflamed airways, in the breath. Exhaled nitric oxide levels are much higher in people with asthma, and after two decades of careful development, a handheld detection device was approved by the FDA some years ago. It is now widely used by doctors to help make a diagnosis. Dweik says that a similar technology for personal use might eventually be available to enable patients to monitor the effects of their medication and give advance warning of attacks. The new sensor he is developing with collaborators would plug into a cell phone and use an app to report on nitric oxide levels. "Your phone," Dweik says, "would become the device. That's the future." —*Veronique Greenwood*

A GUIDE TO MASTERING YOUR WORLD

How to Be a Better *voter*

Some pundits say that this election has turned everything we thought we knew about U.S. politics on its head. I tend to agree more with those who note that divisiveness and bombastic attacks have always been a part of presidential races. Consider the election of 1800, when the campaigns of John Adams and Thomas Jefferson traded accusations that one had a "hideous hermaphroditical character" and the other was "the son of a half-breed Indian squaw, sired by a Virginia mulatto father." What does feel different this election cycle is the level of emotion stirred up among voters. Violence at rallies; protests galore; families at one another's throats on Facebook. (Or is that just my family?) Strong emotion doesn't always make for good decisions. It's time to take a deep breath, clear our heads and learn how to cast our votes *well.*

#1 Don't just go with your gut.
Voting well means making your choice from a standpoint of informed consideration and with an eye toward the common good, says Jason Brennan, a political philosopher at Georgetown University and author of *The Ethics of Voting.* "Suppose you go to a doctor and ask for advice about an illness—you'd expect the doctor to have your interests at heart and to think rationally about your symptoms," he says. "Voters owe the same thing to each other and the electorate. Vote for everyone's best interest, and when you're forming your political beliefs, form them based on information and learning, not on the basis of quick thinking, anger or bias." That can be tough to do, however, because a good politician knows exactly how to push our emotional buttons, says Leslie Shore, a communications expert who teaches effective listening at St. Mary's University of Minnesota: "Word choice can be very specifically used to induce a response in the listener." Strong emotion, however, can interfere with our ability to think critically.

#2 Don't get all your news from social media. Most of us have unfollowed, unfriended or muted contacts on Facebook, Twitter and other networks because their political views make us mad.

Doing so can give rise to narrowed political views and groupthink, Shore warns. "Most of our social media networks are full of people who agree with us, so they create an automatic validation of everything that you're already thinking," she says. "If no one challenges you, there's no opportunity to rethink or ask important questions." Try broadening your news sources by tuning to channels or sites, papers or magazines that have a different slant than you do. "If you have a news app on your smartphone or tablet, specifically add a publication to your feed that you know tends to lean the opposite way, and then do yourself a favor and actually read what they're saying," Shore says.

#3 Watch the next debate with your eyes closed. A recent study by Joan Y. Chiao, then at Northwestern University, a founder of the new field of cultural neuroscience, found that voters perceive male candidates as more competent and dominant than female ones, based on facial features alone. What's more, voters of both genders tend to prefer physically attractive female candidates, whereas attractiveness doesn't matter for male ones. Most of us like to think that we won't let outdated gender stereotypes affect our vote, but it's worth a self-check anyhow.

#4 Know when to abstain. I have a confession to make: I didn't vote in the presidential primaries. I'm not used to the mail-in ballots in my adopted home state of Oregon, and I sent mine in too late to be counted. Looking back, I think perhaps it was for the best: I'd been waffling for months about which candidate to choose and hadn't taken the time to firmly ground my choice in facts and information. "We've found that having more information changes people's policy preferences," Brennan says. "We can specifically predict what the American public likely *would* choose if it were better informed." But political science studies have found that a majority of Americans are ignorant of some pretty basic political knowledge such as actual trends in crime or unemployment or whether the economy is doing well or not. You can think of casting a "bad" vote as being a bit like air pollution, he says. "If you drive an inefficient car and pollute a lot, your individual contribution isn't that big of a deal. But if we all do that, it *is.*" Not everyone may agree with the idea that a good citizen should abstain from voting if he or she can't cast a "good" vote, but it resonates with me. Here's hoping we take our responsibility to heart and endeavor to do our civic duty well. —*Sunny Sea Gold*

The Brain's Meaning Map
Semantic information lives all over the cortex

Listening to speech is so easy for most of us that it is difficult to grasp the neural complexity involved. Previous studies have revealed several brain regions, collectively called the semantic system, that process meaning. Yet such studies have typically focused on specific distinctions, such as abstract versus concrete words, or found discrete areas responsive to groups of related words, such as tools or food. Now a team of neuroscientists in Jack Gallant's laboratory at the University of California, Berkeley, led by Alexander Huth, has generated a comprehensive "atlas" of where different meanings are represented in the human brain.

The researchers played two hours of stories from the *Moth Radio Hour,* a public broadcast show, to seven participants while recording their brain activity in a functional MRI scanner. They then analyzed the activity in the roughly 50,000 voxels (three-dimensional pixels) that make up the entire brain, creating detailed maps of where different meanings are represented in each individual. This approach contrasts with standard studies, where activity is averaged across many participants to look at similarities across a group while ignoring variations among individuals.
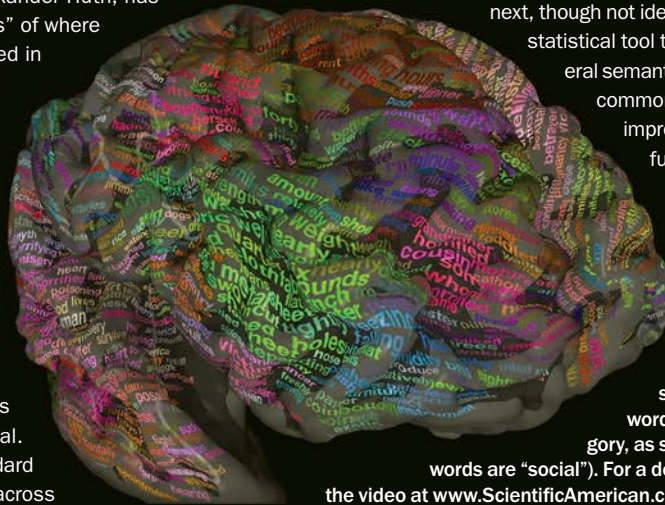
The maps cover much of the cortex, the outermost brain regions controlling higher cognitive functions, extending beyond areas traditionally thought of as language centers. Every meaning appears in multiple locations, and every location contains a cluster of related meanings. Some areas selectively respond to words related to people, for instance, whereas others respond to places or numbers. "This is way more information, and probably way more generalizable to natural narrative comprehension, than any previous study," Gallant says.

The maps were remarkably similar from one participant to the next, though not identical. The researchers developed a statistical tool that enabled them to produce a general semantic "atlas," by finding functional areas common to all participants. This technique, improved and extended to other cognitive functions, could ultimately be useful for mapping brain function so as to minimize the impact of surgery or other invasive treatments.
—Simon Makin

This word map shows which parts of the brain responded as a single subject listened to a storyteller. The words tend to cluster by semantic category, as shown by color (for example, pink words are "social"). For a deeper exploration of the map, watch the video at www.ScientificAmerican.com/video/the-brain-dictionary

Laugh Lots, Live Longer
A robust sense of humor may protect against mortality

"Funny or die" has a whole new meaning, thanks to a large study published in April in *Psychosomatic Medicine.* Women with a strong sense of humor were found to live longer in spite of illness, especially cardiovascular disease and infection. Mirthful men seem to be protected against infection.

Norwegian researchers reported findings from a 15-year study on the link between sense of humor and mortality among 53,556 women and men in their country. The team assessed the cognitive, social and affective components of humor using a validated questionnaire, and examined death from specific conditions: heart disease, infection, cancer and chronic obstructive pulmonary disease.

The findings show that for women, high scores on humor's cognitive component were associated with 48 percent less risk of death from all causes, a 73 percent lower risk of death from heart disease and an 83 percent lower risk of death from infection. In men, a link was found only for the risk of death from infection—those with high humor scores had a 74 percent reduced risk. The gender differences could be due to a slight decline in humor scores as the men aged, the authors suggest. No association was found for the social and affective components of humor.

The cognitive component is a fairly stable aspect of personality and may influence the way individuals attribute meaning to everyday experiences, says study co-author Sven Svebak, a professor emeritus of neuromedicine at the Norwegian University of Science and Technology. In this way, it may buffer against conflict in social interactions and overall stress, preventing the escalation of stress hormones, Svebak says. When these hormones, such as cortisol, are chronically elevated, they suppress immune functions.

Although there is a genetic component that determines sense of humor, it is also developed through socialization. "I expect that children who lack adult models for the use of humor as a coping resource in the face of challenges are less likely to activate their sense of humor to cope with everyday life when they grow up," he says. But if you had a humorless childhood, never fear—studies show people can learn to embrace the absurdity of life at any age. *—Tori Rodriguez*

Folk Illusions

What schoolyard tricks reveal about young minds

Our son, Iago, currently in fourth grade at a public school in Brooklyn, N.Y., learned a new game at recess recently. One evening, after entertaining the family with his ever expanding repertoire of knock-knock jokes, he turned to one of us (Susana) and pointed his index finger at her arm, stopping just half an inch from her skin. She looked at her arm, intrigued, and then at Iago.

"Am I touching you?" he asked.

"No," she replied. His finger was clearly not in contact with her arm.

"Look!" he said, delighted, pointing to his other hand, which was resting on her knee.

Because Susana was so focused on her arm, she had failed to notice Iago touching a different part of her body. The trick reminded us of the tactics used by theat-

MISSING THE BEND

Recently neuropsychologist Peter Brugger and his then student Rebekka Meier of University Hospital Zurich investigated a curious game children play at Swiss playgrounds. Brugger first learned about it in 2002 from his daughter, Hazel, who was nine years old at the time. One kid—"the director," in Barker and Rice's parlance—asks a friend, "the actor," to close his or her eyes and extend one arm with the palm up. The director slowly slides his or her finger from the wrist toward the crook of the actor's elbow. The actor, with eyes still closed, shouts, "Stop!" when he or she feels that the director's finger has reached the crook. On opening his or her eyes, the actor sees the error: many people will say stop one inch or more short of the bend in their arm.

Both actor and director delight in the mistake—a reaction that is commonplace with these games, Barker and Rice say: "There are many questions left around folk illusions that we hope to find answers for. But one thing that we are absolutely certain of is that the kids love to play them, and that's because they have so much fun."

Brugger and Meier tested this elbow illusion in 90 adult participants and found that it was stronger in the nondominant arm and more striking in men (supporting previous observations that women have greater sensitivity to touch). They proposed that the phenomenon might be partially explained by the late firing, or "afterdischarge," of cortical somatosensory neurons in response to specific signals from skin mechanoreceptors that are driven by slow-moving tactile stimuli.

rical pickpockets such as Apollo Robbins, with whom we collaborated on a study of misdirection in magic. To steal spectators' belongings during his act, Apollo gets people to pay attention to a specific location (say, their front pocket) while he pilfers an object from somewhere else (such as a watch from their wrist). Iago's version was far less sophisticated, but it demonstrated the same basic principle: the best way to divert someone's attention from an object or place is to get him or her to focus elsewhere.

Iago's prank is an example of a novel but quickly growing genre of perceptual and cognitive ruses that Indiana Univer-

sity Bloomington folklorist K. Brandon Barker and University of Louisiana at Lafayette English professor Claiborne Rice have dubbed "folk illusions." These playful misperceptions are shared and taught, from child to child, generation after generation, at playgrounds, schoolyards, sleepovers and summer camps. Every reader will remember at least a few such tricks from his or her childhood. Some of the earliest records date back to the 1600s (see, for example, the famous diary of English Parliamentarian and naval administrator Samuel Pepys). Today's schoolchildren still play very similar—even identical—games.

BY SUSANA MARTINEZ-CONDE AND STEPHEN L. MACKNIK

Susana Martinez-Conde and Stephen L. Macknik are professors of ophthalmology, neurology, physiology and pharmacology at SUNY Downstate Medical Center in Brooklyn, N.Y. They are the authors of *Sleights of Mind,* with Sandra Blakeslee, winner of a Prisma Prize for best science book of the year (http://sleightsofmind.com).

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ILLUSTRATIONS BY STEVEN HARRINGTON; SEAN McCABE (*Martinez-Conde and Macknik*)

Just as brothers Jacob and Wilhelm Grimm—recognized by some academics as the first folklorists—collected children's tales in 19th-century Germany, Barker and Rice have been compiling contemporary folk illusions in the U.S. Their collection is expanding through the painstaking process of recording children's reports and adult recollections and making direct observations of kids' interactions. Barker and Rice's future research plans include documenting folk illusions from non-Western cultures.

So far Barker and Rice have identified more than 70 types of folk illusions, starting with games such as "steal your nose" among toddlers and progressing to more sophisticated tricks throughout the school years into adulthood. Their categorization makes it clear that age affects the games we play. And this observation in turn offers a fascinating window into the brain's perceptions and thinking processes during development.

Readers are welcome to share their childhood games with Barker and Rice at shareyourillusions@folkillusions. org. Here we review some historical and current folk illusions and explain their neural bases. **M**

FLOATING ARMS

One of the most popular illusions from child lore is the "floating arms" trick. In one common variant, the child director stands behind another child, the actor, holding the actor's arms close to the sides of his or her body while the actor tries to lift them up. The two remain at odds—one pushing up and the other down—for approximately 30 seconds. And when the director releases his or her hold, the actor's arms appear to float up by themselves, without the actor's conscious intent.

At work is the Kohnstamm effect, named after the German neurologist who first described it in 1915. Scientists believe it results from neural aftereffects that follow sustained muscle contractions. The trick most likely invokes the brain's motor and somatosensory areas, as well as the cerebellum (a hub for the coordination of movement).

Children will often incorporate complex narratives to go along with the illusion. In one of Barker's favorites, the director turns an imaginary crank in front of the actor's chest as his or her arms start to rise, declaring that the actor is Frankenstein's monster.

CHURCH BELLS

Barker and Rice found an early reference to this game—still played today—in a text from the early 1600s. Different variants involve either a wire coat hanger or a metal oven rack, which produces a more powerful effect. To play, cut two pieces of string, tie them to the metal and then wrap the loose string ends several times around your index fingers. Put your index fingers in your ears and have a partner strike the rack. You will hear the sound of a church bell. The illusion relies on the mechanical transmission of the vibration from the metal to the strings, then to the hands and skull bones, and finally to the fluid inside the cochlea in the inner ear. "Even when you anticipate that it is going to work," Rice says, "it is still so surprising when it does happen."

MORE TO EXPLORE

■ **Folk Illusions: An Unrecognized Genre of Folklore.** K. Brandon Barker and Claiborne Rice in *Journal of American Folklore,* Vol. 125, No. 498, pages 444–473; Fall 2012.

■ **A New Illusion at Your Elbow.** Peter Brugger and Rebekka Meier in *Perception,* Vol. 44, No. 2, pages 219–221; February 2015.

■ **Folk Illusions and the Social Activation of Embodiment: Ping Pong, Olive Juice, and Elephant Shoes.** K. B. Barker and C. Rice in *Journal of Folklore Research,* Vol. 53, No. 2, pages 63–85; May/August 2016.

Getting Out the Vote

Behavioral research offers several proven strategies for boosting turnout on Election Day

By Supriya Syal and Dan Ariely

Only about half of the people who could vote in the 2012 U.S. presidential election actually did so (53.6 percent of the voting-age population). This puts turnout in the U.S. among the worst in developed countries. By way of contrast, 87.2 percent of Belgians, 80.5 percent of Australians and 73.1 percent of Finns voted in their last elections. In a nation quick to defend democracy both within its borders and beyond, why are more Americans not exercising what is arguably their biggest democratic right?

Certainly there are political and mechanical obstacles within the American voting climate that make it difficult for people to even get to the polls, such as onerous voter ID laws or a shortage of polling stations in some locales. The absence of automatic voter registration (as in Finland) or mandatory registration (as in Australia) also limits turnout.

But beyond these structural hurdles, most theories that examine the mindset of those who do not vote speak to disengagement from electoral politics or disbelief in government's ability to affect progress. Solutions that aim to address these problems typically inform people about the importance of their vote in electing a government that works for them. Yet this tactic does not appear to sway many. Despite such efforts, turnout has consistently hovered around 50 percent for the past nine U.S. presidential elections—the highest being 56.9 percent in 2008.
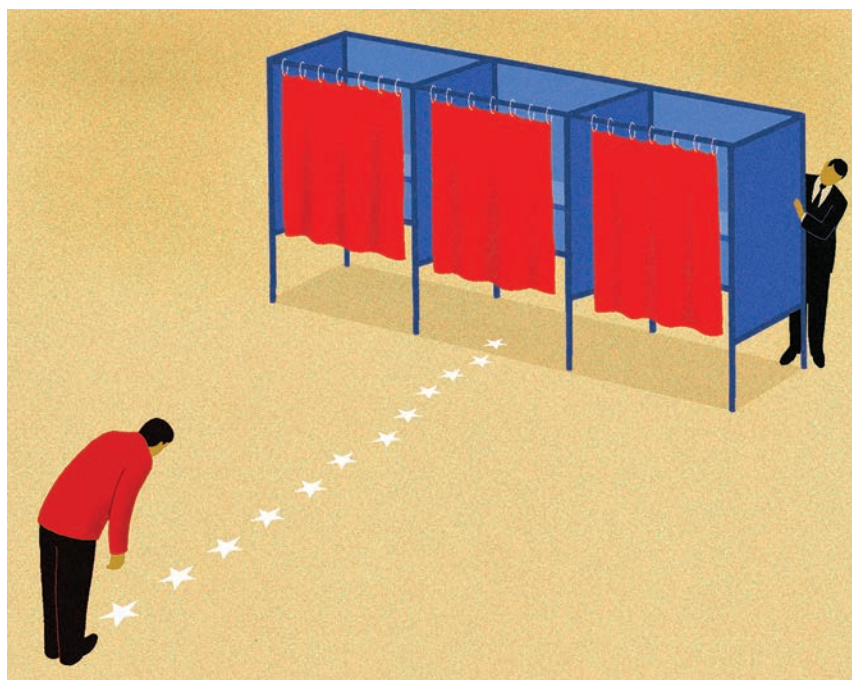
Behavioral science might explain why these informational interventions fall short. A substantive body of evidence indicates that the environment in which we make decisions can fundamentally alter them. For example, what we think others are doing, how voting makes us feel about ourselves, and what we need to do to vote all affect whether or not we participate on Election Day. So instead of simply telling Americans to vote, the science suggests we need to think about the context in which citizens decide to cast their ballots.

Always Have a Plan

A number of traditional mobilization efforts are directed at getting citizens to agree they will vote come election time. But just as many of us intend to exercise, eat healthy and save for retirement, people often fail to act on their intentions. As a 2015 review by researchers at Harvard University and the University of Pennsylvania concluded, making concrete plans can help people translate goals into actions across a number of domains.

In a field experiment conducted among 287,000 would-be voters in Pennsylvania during the 2008 Democratic primary election, researchers tried to see if voter turnout could be increased by helping people make a concrete plan to implement their intentions. One to three days before the November 2008 election, behavioral scientists David Nickerson, now at Temple University, and Todd Rogers of Harvard asked one group of would-be voters about their intentions to vote and a second group about their intentions and also about *when, where* and *how* they would accomplish the goal of voting.

Voter records showed that making a plan was more than twice as effective as simply asking people about their intentions. Overall there was a 4.1 percentage point increase in the likelihood of voting

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by making a plan relative to people who did not receive a phone call. (The average effectiveness of commercial phone banks, assessed from dozens of studies, is about one percentage point.)

Everyone Else Is Doing It

Conventional wisdom (and practice) suggests that we could convince people to vote by stressing that their particular ballot is very important because *not many other people* are voting. Yet findings in behavioral science indicate that most of us are motivated by the desire to conform to the social norm—meaning we are more likely to do what *most people* are doing.

Two get-out-the-vote field experiments during the 2005 general election in New Jersey and the 2006 primary election in California tested these hypotheses. They found that individuals were much more motivated to vote when they believed lots of other people were voting compared with when they thought relatively few others were voting.

In another field experiment run by researchers at Yale University and the University of Northern Iowa during the 2006 primary election in Michigan, potential voters received direct mail noting that both they and their neighbors would be informed of who had voted after the election. Amazingly, this led to an 8.1 percent increase in turnout—one of the most successful get-out-the-vote tactics studied to date. Conventional direct-mail reminders, in contrast, yield just a 0.162 percent increase in turnout on average, according to a 2013 estimate based on 110 studies.

If most of us vote, then being part of the truant few who do not feels like we are shirking a social contract. Publicizing voting records may therefore increase the salience of this social obligation and possibly bring shame on nonvoters. Following through, however, allows them to maintain their self-identity as contributing members of society.

All about Identity

Some of the largest-ever experimental effects on voter turnout come from

an experiment that used people's desire to shape or conform to a worthy self-identity, that is, the identity of "someone who votes."

In a study published in 2011, psychologists at Stanford University and Harvard presented would-be voters in the 2008 presidential election in California and in the 2009 gubernatorial election in New Jersey with a preelection survey that framed voting as either an

expression of self-identity ("How important is it to you to be a voter?") or simply an activity ("How important is it to you to vote?"). In both cases, participants completed the survey the day before or the morning of the election.

Being "a voter," one might argue, is about who you are as an upstanding citizen—a part of your identity that feels good to embrace and act on. The act of voting is simply that, an action, and one that anyone can, in principle, take. The results showed a remarkable 10.9 percentage point increase in turnout among people in the "voter" identity condition.

Such an increase nationally could have historic consequences. Indeed, it would bring American voter turnout up to 64.5 percent—ahead of both Canada and the U.K., lifting the nation

from 31st to 19th place out of 34 developed countries in a Pew Research Center analysis.

To Vote or Not to Vote

Although tackling political barriers to voting remains critical, the great strength of these behavioral interventions lies in their ability to overwhelm obstacles by catalyzing citizen motivation. And for people who do not vote because they believe one person's ballot cannot change election outcomes, behavioral science also offers a reason why voting is important for individuals.

Research has found that in addition to signaling who we are to others, our actions tell *us* something about ourselves—shaping our own preferences and beliefs. From this perspective, people who do not vote are not merely abstaining from the democratic process in one instance. They are also "telling" themselves: "I don't care about politics." Moving forward, they may also become less interested in civic rights, local governance, foreign affairs, and so on. And for those who do vote, participation is not just an expression of interest in current politics but also a seed that could grow into an active political life. **M**

> ## PROMPTING VOTERS TO PLAN WHEN, WHERE AND HOW THEY WOULD GET TO A POLLING PLACE IS FAR **MORE EFFECTIVE THAN A GENERIC REMINDER.**

MORE TO EXPLORE

■ **If They Were to Vote, They Would Vote for Us.** Namkje Koudenburg, Tom Postmes and Ernestine H. Gordijn in *Psychological Science,* Vol. 22, No. 12, pages 1506–1510; December 2011.

■ **Academic "Dream Team" Helped Obama's Effort.** Benedict Carey in *New York Times;* November 13, 2012.

■ Todd Rogers on "Turning Mass Intention into Action" at TEDxCambridge, 2013: **www.tedx cambridge.com/portfolio-item/todd-rogers**

■ **U.S. Voter Turnout Trails Most Developed Countries.** Drew Desilver. Pew Research Center. Published online May 6, 2015.

■ **Beyond Good Intentions: Prompting People to Make Plans Improves Follow-Through on Important Tasks.** Todd Rogers, Katherine L. Milkman, Leslie K. John and Michael I. Norton in *Behavioral Science & Policy,* Vol. 1, No. 2, pages 33–41; December 2015.

"The repose of the night does not belong to us. It is not the possession of our being. Sleep opens within us an inn for phantoms. In the morning we must sweep out the shadows."
—Gaston Bachelard, French philosopher, 1960

PHYSIOLOGY

To Sleep with Half a Brain

Sleep and wakefulness are not all-or-none states of mind. When we sleep, one side of our brain can be awake

BY CHRISTOF KOCH

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

Flies, birds, mice, dogs, monkeys and people all need to sleep. That is, they show daily periods of relative immobility and lack of response to external stimuli, such as light, sound or touch. This reduced sensitivity to external events distinguishes sleep from quiet resting, whereas the capacity to awaken from slumber distinguishes sleep from coma. Why sleep should be such a prominent feature of daily life across the animal kingdom, despite the fact that it leaves the sleeper unable to confront potential threats, remains mysterious.

Still, much progress in characterizing the physiology and capabilities of the sleeping brain has occurred over the past century, driven by the ability to record electrical activity of the brain (via electroencephalography, or EEG, on the surface of the skull), of the eyes (via electro-

| Awake | Early NREM | Late NREM | REM Sleep |

1 sec
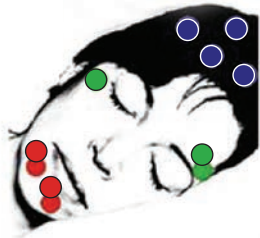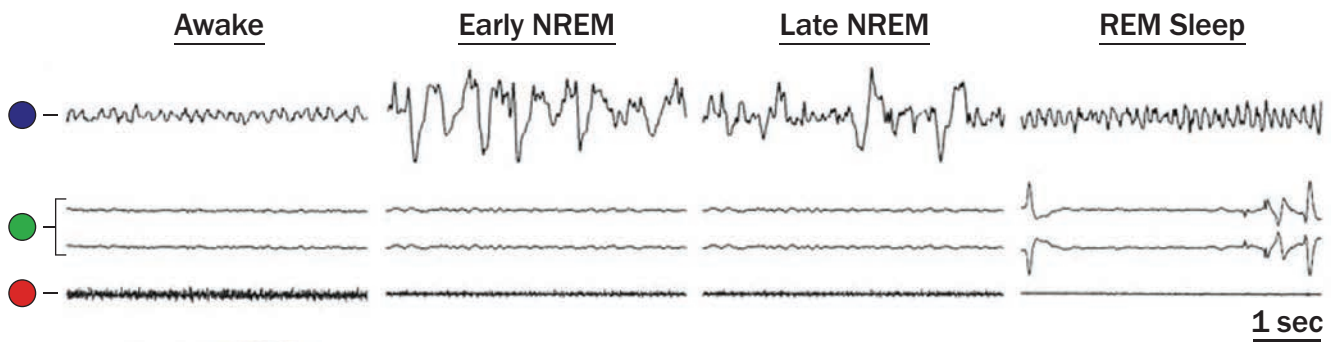
- EEG
- EOG
- EMG

In a modern sleep laboratory, wakefulness and the different stages of sleep are defined by various measures of electrical activity. They include EEG (electroencephalography), which tracks neural activity in the neocortex; EOG (electrooculography), which tracks eye movements; and EMG (electromyography), which measures muscle tone. The frequency and amplitude of EEG signals fluctuate sharply during the various sleep cycles. Muscle tone tends to decrease throughout the course of the night, whereas rapid eye movement (REM), the time when dreams are most common, follows the non-REM (NREM) stages of sleep.

oculography, or EOG), and of facial or other muscles (via electromyography, or EMG). For scientists, it is this triad of simultaneous measurements that operationally defines the state of sleep, leading to both surprising and counterintuitive insights.

Even without these tools, there are some basic things we do know about sleep. It is essential for our brain to function properly. Most of us have pulled all-nighters or have wanted to sleep but could not, unable to switch off our mind. The next day we are irritable, have trouble keeping our eyes open, and are terrible at tasks that demand sustained attention. Indeed, sleep deprivation causes many traffic accidents—the reason countries have laws that mandate a minimum rest period and maximum working hours for truck drivers.

Sleep is for the brain rather than for the body. Otherwise, eight hours of binge watching our favorite TV series in bed could replace sleep. Thus, we need to look at the sleeping brain to better understand the why and how of a state in which we pass one third of our life.

The Study of Shut-Eye

One milestone in the scientific study of sleep came in 1953, when Eugene Aserinsky and Nathaniel Kleitman of the University of Chicago discovered an until then unnoticed distinction in two distinct forms of sleep: rapid eye movement (REM) sleep and non-REM (NREM) sleep. When subjects are awake, before entering either of these states, their brain waves, recorded via EEG electrodes on the skull, display a typical pattern of electrical activity—low-amplitude, high-frequency signals—while their EMG reveals elevated muscle tone [*see illustration above*].

As individuals fall asleep and enter lighter and then deeper stages of NREM, also known as deep sleep, their brain waves progressively slow while increasing in amplitude. Eye movements, a hallmark of wakefulness, cease, and muscle tone diminishes. As sleep deepens, assayed by how difficult it is to wake a sleeper, so does the person's EEG. In the most restful form of sleep early on during the night, the EEG is dominated by high-amplitude waves, or oscillations, that slowly wax and wane. Electrical recordings of individual nerve cells in the neocortex directly underneath the skull show regular occurrences of on periods, when cells fire a series of all-or-none electrical pulses, called spikes, as happens when a person is awake. Pulses alternate with off periods,

SLEEP IS FOR THE BRAIN, NOT THE BODY. OTHERWISE, AN EIGHT-HOUR TV BINGE WATCH **COULD SUBSTITUTE FOR NIGHTLY SLUMBER.**

when neurons turn silent. These on and off periods and the associated slow waves in the EEG, termed slow-wave activity (SWA), occur as often as four times every second or as infrequently as once every four seconds (covering a frequency range from 0.25 to four hertz).

NREM sleep is interrupted by shorter episodes of REM sleep during which the EEG has a drastically different character: the slow and large waves are replaced by fast and choppy ones that superficially resemble the awake brain. The same paradoxical activation is seen at the level of individual neocortical neurons that fire spikes with the same
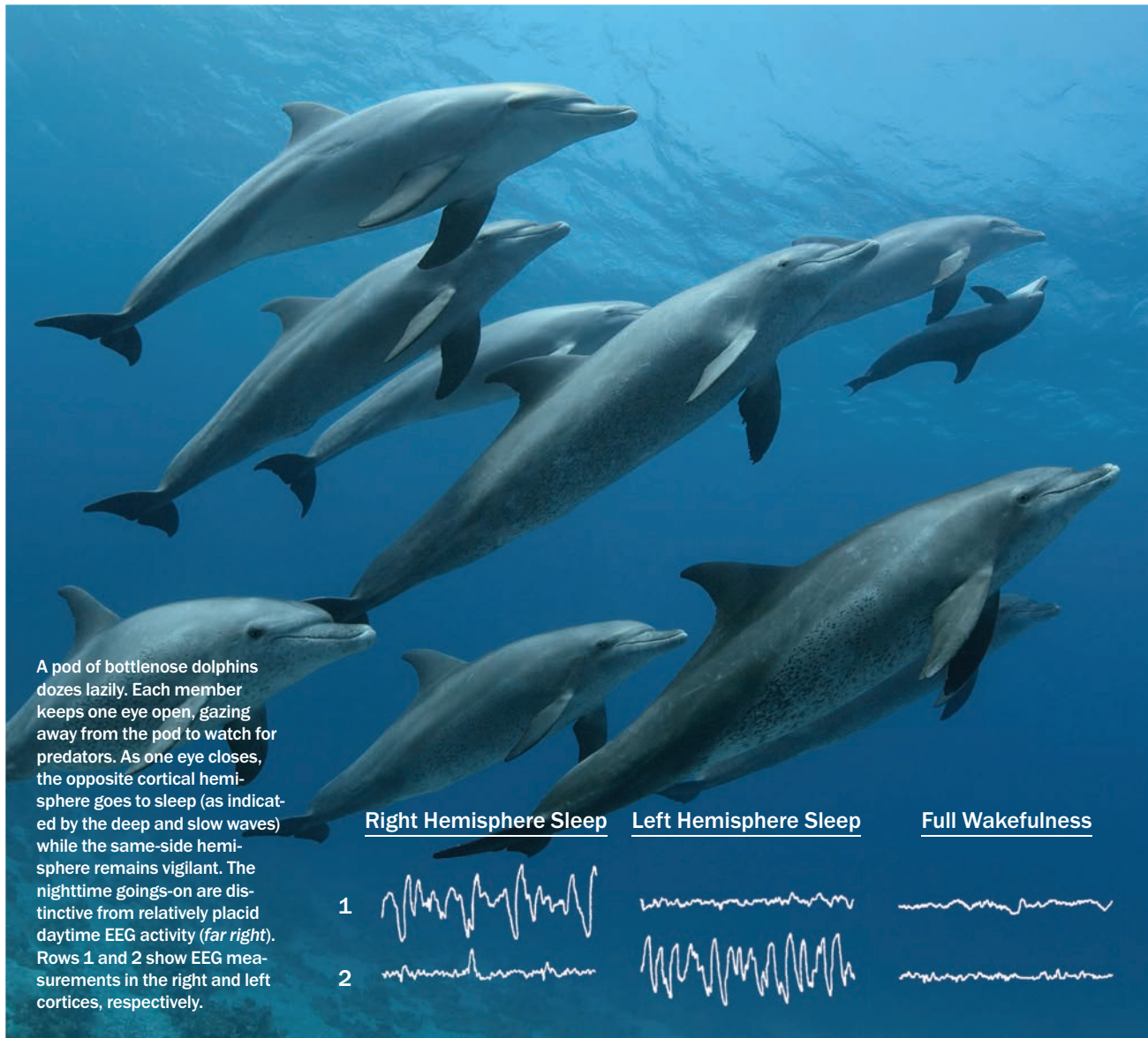
A pod of bottlenose dolphins dozes lazily. Each member keeps one eye open, gazing away from the pod to watch for predators. As one eye closes, the opposite cortical hemisphere goes to sleep (as indicated by the deep and slow waves) while the same-side hemisphere remains vigilant. The nighttime goings-on are distinctive from relatively placid daytime EEG activity (*far right*). Rows 1 and 2 show EEG measurements in the right and left cortices, respectively.

Right Hemisphere Sleep   **Left Hemisphere Sleep**   **Full Wakefulness**
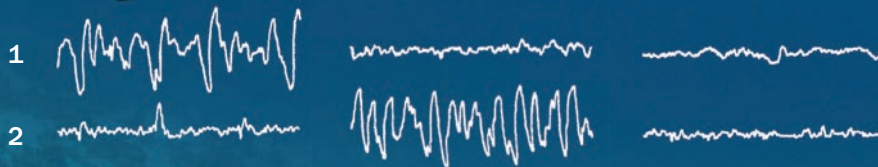
intensity as they do during the day. Muscular tone is gone—to all intents and purposes the body is paralyzed—except for the breathing musculature and the jerky, rapid and symmetric movement in each eye that give this phase of sleep its name.

Most of the night is spent in NREM, with the most restorative deep sleep and its associated SWA, taking up 20 to 25 percent of a full night's slumber. Slow-wave activity is homeostatically regulated—that is, the longer somebody stays awake, the deeper and more frequent slow waves occur the following night. Conversely, early in the morning when sleep pressure has lessened, SWA diminishes, and sleep becomes shallower. Likewise, taking a nap reduces nighttime slow waves.

A number of consumer devices now on the market play regular soft tones through headphones at the same frequency as the SWA to entrain deep-sleep waves and thereby induce a more restful power sleep.

One Hemisphere on Watch

Until recently, deep sleep in humans was thought to be a global condition: a person is either asleep or awake but not both simultaneously. Put differently, their brain is either in deep sleep, as characterized by slow-wave activity, or awake, but not both. Yet birds and aquatic mammals such as dolphins and whales display the remarkable phenomenon of unihemispheric slow-wave sleep: one half of their brain is awake, including an open eye, and the other half shows the electri-
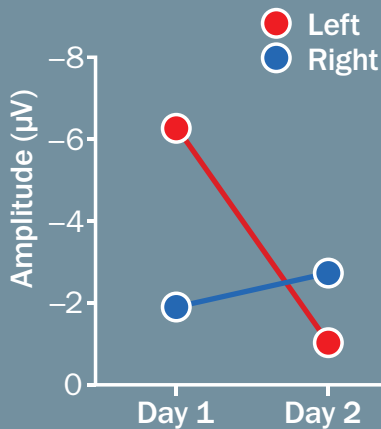
Unusual sounds that occurred while study subjects slept their first night in a new place spurred elevated activity only in the brain's left hemisphere—measured as signal amplitude in microvolts (µV). This semivigilant state vanished on the second night.

cal signatures of sleep. This is most likely a protective mechanism, enabling the animal to fly or swim and monitor its environment for threats with one hemisphere while the other gets some rest.

It now turns out that even for people, there is more to sleep than meets the (shut) eye. Frequent travelers will be familiar with the first-night effect, the observation that the initial night in an unfamiliar place, whether a hotel, a friend's apartment or a tent, is less restful than subsequent nights. We find it more difficult to shut our mind down and wake up groggy. A team of researchers under Yuka Sasaki and Takeo Watanabe of Brown University set out to investigate this phenomenon [see "Why We Toss and Turn in an Unfamiliar Bed," on page 9].

Eleven healthy volunteers slept for two nights inside an advanced neuroimaging scanner that allowed recordings of the brain's weak but ever changing magnetic field. The scientists focused on slow-wave activity, measuring its strength in four networks in the left cortical hemisphere and four in the right. Intriguingly, they found that the left cortical default-mode network, a set of interacting re-

gions associated with mind wandering and daydreaming, had less SWA than the right one during the first night. No such imbalance emerged during a second night sleeping in the scanner. Also, the more asymmetric the pattern of SWA during the first night, the longer it took subjects to fall asleep. Part of the left hemisphere, in essence, is not sleeping as deeply as the right one during the first night.

To test the extent to which the left hemisphere is more vigilant in an unfamiliar environment, the team delivered tones via earphones to 13 subjects (different from the initial 11 volunteers, who were by now used to the sleep setup). Most of the tones were the same, but on rare occasions a different one sounded: beep, beep, beep, *boop,* beep, beep. The oddball tone drew attention and triggered a signature electrical response. When the deviant tone is played to the left ear, its output is predominantly relayed to the right cortical hemisphere, which shows the characteristic vigilance response.

During the first night, the left hemisphere had a more pronounced vigilance response to these deviant tones as compared with the right hemisphere. The enhanced vigilance response also led to the left brain being more frequently aroused (as defined by EEG criteria) than the right hemisphere.

During the second session in the scanner, both left and right hemispheres responded weakly and in the same manner to oddball sounds, as they did to the stereotyped beeps during both nights. If a brain network in the left cortical hemisphere acts as a night watchman for the sleeper, then an irregular event registered only by the left brain (via the right ear) should elicit a faster response than an oddball sound delivered to the right brain (via the left ear). This idea was tested in a third group of 11 volunteers: they had to lightly tap their fingers whenever they heard the sounds while asleep in the

scanner. (I know, it doesn't sound like the most restful way to sleep; they were also not permitted to drink caffeine or alcohol or to take a daytime nap.) Sounds delivered to the ear projecting into the left hemisphere were much more likely to trigger an awakening during the first night than sounds to the opposite ear and hemisphere. This left-right asymmetry disappeared during the second night's sleep. Furthermore, it took the left brain less time to awaken in response to the deviant sound than the right brain.

In short, while sleeping in an unfamiliar place, the left cortical hemisphere is more vigilant and responds stronger and faster than the right one. Evolutionarily, this reaction makes a great deal of sense. It is important that a sentinel—here the left cortical default-mode network—monitors the unknown environment for threatening events while we sleep. The human brain, it turns out, is endowed with a less dramatic form of the unihemispheric sleep found in birds and some mammals. For humans, familiarity with a place breeds a deep night's sleep.

If we consider the individual we routinely share a bed with—whether spouse, partner or child—to be the most important social component of the environment, then I suspect that the left hemisphere might also be more watchful during the first night we sleep alone in our familiar bedroom. It knows something is amiss, and we'll sleep less restfully as a consequence.

In my next column, I will discuss another recent discovery: how deep sleep can intrude into our waking brain. **M**

MORE TO EXPLORE

■ **Night Watch in One Brain Hemisphere during Sleep Associated with the First-Night Effect in Humans.** Masako Tamaki et al. in *Current Biology,* Vol. 26, No. 9, pages 1190–1194; May 9, 2016.

From Our Archives

■ **Quiet! Sleeping Brain at Work**. Robert Stickgold and Jeffrey M. Ellenbogen; August/September 2008.

Huddled over her desk in the newsroom, she feared anything that might interfere with her lunchtime routine. She no longer felt proud of her behavior. Her friends stopped complimenting her "self-control" years ago when her weight plummeted perilously low.

ILLUSTRATIONS BY JOHN HOLCROFT

Disrupting the Habits of Anorexia

A patient learns to escape the rigid routines of an eating disorder

By Deborah R. Glasofer and Joanna Steinglass

Every day on the dot of noon, Jane* would eat her 150-calorie lunch: nonfat yogurt and a handful of berries. To eat earlier, she felt, would be "gluttonous." To eat later would disrupt the dinner ritual. Jane's eating initially became more restrictive in adolescence, when she worried about the changes her body was undergoing in the natural course of puberty. When she first settled on her lunchtime foods and routine—using a child-size spoon to "make the yogurt last" and sipping water between each bite—she felt accomplished. Jane enjoyed her friends' compliments about her "incredible willpower." In behavioral science terms, her

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Jane is a pseudonym. Some details of her story have been altered to further protect her identity.

ANOREXIA NERVOSA: DIAGNOSTIC CRITERIA*

This life-threatening eating disorder is identified by these three behaviors:

Dietary restriction leading to a significantly low body weight for one's sex, age, development and physical health.

Intense fear of becoming fat or persistent behaviors that interfere with weight gain.

Disturbed experience of one's body weight or shape, undue influence of body weight or shape on self-evaluation, or a lack of recognition of the seriousness of low weight.

Adapted from the DSM-5.

actions were goal-directed, motivated by achieving a particular outcome. In relatively short order, she got the result she really wanted: weight loss.

Years later Jane, now in her 30s and a newspaper reporter, continued to eat the same lunch in the same way. Huddled over her desk in the newsroom, she tried to avoid unwanted attention and feared anything that might interfere with the routine. She no longer felt proud of her behavior. Her friends stopped complimenting her "self-control" years ago, when her weight plummeted perilously low. So low that she has had to be hospitalized on more than one occasion.

The longed-for weight loss did not make her feel better about herself or her appearance. Jane's curly hair, once shiny and thick, dulled and thinned; her skin and eyes lost their brightness. There were other

costs as well—to her relationships, to her career. Instead of dreaming about a great romance, Jane would dream of the cupcakes she could not let herself have at her niece's birthday party. Instead of thinking about the best lead for her next story, she obsessed over calories and exercise.

Jane's ritualized and restrictive approach to food, her obsession with calories and her painfully low body weight are common symptoms of anorexia nervosa, a dangerous eating disorder that affects roughly one in 200 American women. Anorexia has a high relapse rate and ranks among the deadliest of all psychiatric conditions. Individuals with the disorder, about 10 percent of whom are men, enter a state of starvation that can cause numerous medical complications, including heart ailments, anemia, bone loss, infertility, and more. A young woman with this illness faces six times the average risk of death for someone her age, according to a 2011 meta-analysis of 36 studies, and mortality rises by

5 percent for every decade of illness.

Anorexia nervosa is often misunderstood by a public that tends to glorify thinness and view rule-ridden eating as an act of enviable self-control. This is nothing new. In the Middle Ages, a handful of religious figures, including Saint Catherine of Siena, were admired for engaging in extreme self-starvation—a condition termed "holy anorexia." Today we see self-starvation in the name of a culturally sanctioned pursuit of thinness. But there is nothing glorious about this disease, nor does it provide any actual measure of true control. Rigid, behavioral routines gradually close in on the afflicted individual until life becomes entirely about numbers on a food label, or a scale, or a clothing tag.

A new line of research suggests that the core of Jane's condition—her low weight—is not simply a matter of self-control. Rather her routines now occur almost automatically without regard for the outcome. Jane weighs herself each
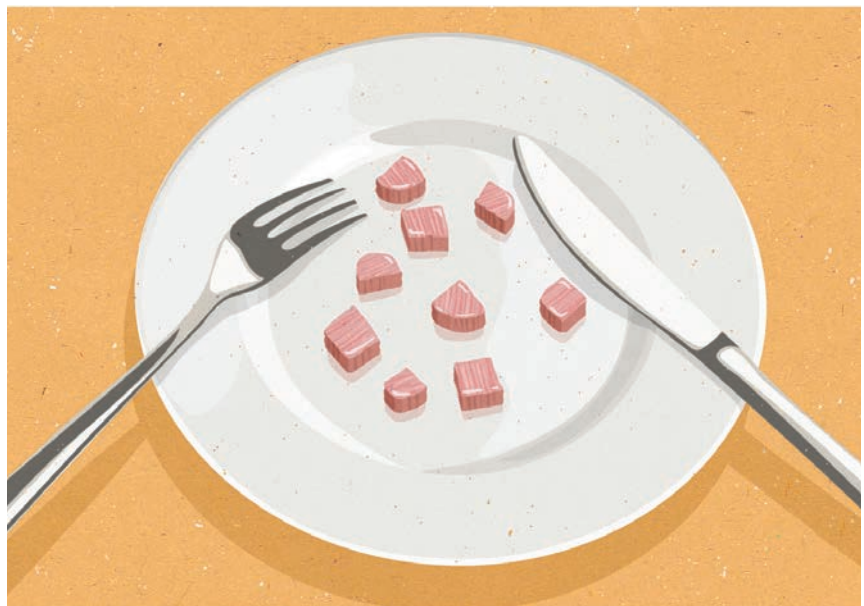
morning before she showers and again before she leaves for work. At each meal, she reads and rereads food labels for their nutritional breakdown. She cuts food into tiny pieces without thinking. In behavioral science terms, her mind has been overtaken by habit.

Habits can be incredibly useful. They allow the mind to multitask and in so doing enable efficiency. Behaviors get linked together into a routine, and once the chain of action is initiated, the rest follows with little mental effort. Yet sometimes habits take hold when they are not useful. We and others in the field are learning that this may occur with anorexia nervosa.

The habit-based model of the disorder offers a compelling explanation for why patients such as Jane struggle for years through chapters of outpatient and inpatient treatment without finding lasting recovery. If her illness is even partially explained by hijacked habit learning, it suggests that habit-busting techniques could be part of the solution. Habit-reversal therapy, for example, is well supported for conditions such as trichotillomania (hair-pulling disorder) and tic disorders. This type of treatment helps people become more aware of the cues that set their habits in motion and develop competing responses. For example, those with an urge to pull hair might be instructed to occupy their hands by imagining they are squeezing a lemon. We have adapted this approach for patients with anorexia in an intervention called REACH (*r*egulating *e*motions *a*nd *c*hanging *h*abits).

Jane worked with us in the REACH framework. The habit hypothesis made sense to her and helped her to feel better about why she had been stuck in routines that she knew were not healthy. We shared with her results from a brain-imaging study, published last year in *Nature Neuroscience,* that one of us (Steinglass) co-authored. It showed that when people

with anorexia nervosa make decisions about what to eat, they use a different part of the brain—the dorsal striatum—than those without eating disorders. Studies in both animals and humans have shown that this deep-brain structure is involved with many aspects of behavior, one of which is habitual behavior.

In individual psychotherapy sessions, we helped Jane identify a number of habits that served the eating disorder better than they served her. At home and work she kept track of these routines and paid attention to their earliest cues. For example, Jane noticed that her mealtime rituals began with washing her hands. In therapy, she identified another action to try when faced with this cue. She began to bypass the sink, altering her route to the dining table. This small change made a difference in the subsequent chain of behaviors. Jane practiced moving her water glass out of arm's reach at the start of a meal; with improved awareness, it became easier to resist taking sips between each bite. Behaviorists refer to this as stimulus control: altering the environment to encourage an alternative behavior. In other instances, Jane developed competing responses—simple, motor-based counteractions—that made it harder to act out of habit. For example, she practiced picking up her utensils with her nondominant hand to help her take bigger and less "perfect" bites.

As new behaviors helped her break old habits, Jane tackled other routines of illness. For years she had kept a written record of what she ate at every meal. Jane decided to switch the location of her food journal, putting it out of her line of sight after meals. Instead of reaching for the journal, she turned to friends and family after eating—by phone or e-mail or in person if possible—which also provided an element of distraction. Nevertheless, this change provoked anxiety. To

manage it, her therapist taught her a muscle-relaxation exercise—tensing one muscle at a time and then letting it go.

Most important, Jane learned that reversing or replacing old habits brought good outcomes. This was an essential element because behaviors that are associated with reinforcement grow stronger over time. During meals, Jane felt more present, and she found, to her pleasure, that she could participate more fully in conversation during and after eating. As she spent less time logging calories in her journal, she could focus instead on reading for work and leisure. Breaking these routines felt frightening at first, but loosening the grip of old preoccupations also brought an unanticipated element of relief. Jane's weight slowly improved, and although this change felt scary, she described feeling more motivated and able to maintain her new behaviors because they led to clearly positive rewards.

Encouraged by success with our initial patients, we have begun a small, randomized controlled trial to compare our habit-breaking approach with routine treatment for anorexia nervosa. By linking treatment directly with mechanisms of illness—in this case, the neural circuitry of habit—we hope to better understand this puzzling disorder, improve treatment and free more patients like Jane from the prison of habit. **M**

MORE TO EXPLORE

■ **The Enigmatic Persistence of Anorexia Nervosa.** B. Timothy Walsh in *American Journal of Psychiatry,* Vol. 170, No. 5, pages 477–484; May 2013.

■ **Neural Mechanisms Supporting Maladaptive Food Choices in Anorexia Nervosa.** Karin Foerde et al. in *Nature Neuroscience,* Vol. 18, pages 1571–1573; November 2015.

■ NeuroPod, *Nature*'s neuroscience podcast, on eating disorders: **www.nature.com/ neurosci/neuropod/index-2015-10-29.html**

Work Smarter, Work Happier

Did you take a holiday this summer, or were you too busy at work? You're hardly alone if you fall into the latter category. In the U.S., 42 percent of us fail to use up our paid vacation days—to the tune of more than $52 billion in unclaimed benefits a year, according to a 2014 analysis by Oxford Economics. We work long days, too: the average full-time employee clocks about 47 hours a week.

It would be one thing if we labored so much out of love. But a survey of 5,000 households published last year by the nonprofit Conference Board revealed that more than half of working Americans found their job unsatisfying.

Fortunately, science may offer an antidote for the weary worker. Behavioral research is coalescing around the idea that being productive and happy actually go hand in hand. As the writers in this three-part special section explain, many of the same tactics that foster an employee's fresh thinking and improve time management and performance also bolster his or her social support, autonomy and job satisfaction. Each story offers practical, research-backed advice on matters such as how to promote greater collaboration through technology, how to work more effectively from home, and how to boost creativity with mental and physical breaks.

The lesson, in essence: a happier, less stressed worker is also a more successful one.   *—The Editors*

ILLUSTRATIONS BY RADIO

Betting on People Power

By using technology to facilitate idea exchange in the workplace, organizations can raise their collective smarts

By Alex "Sandy" Pentland

Let's say your company is in trouble—new competitors are coming on strong, and it's your job to assemble a crack team to act fast, solve problems and secure the firm's future. What qualities would you look for? Would you try to pick the people with the most experience? The strongest résumés? The highest IQs? These traits are important, but your best bet might be to observe your candidates at a cocktail party. In that setting, you could quickly get a sense of how well they find new ideas, make allies and discover potential conflicts.

These abilities are fundamental for building human enterprises that are creative and agile. Our social brain—which gives rise to our capacity to manage people, interactions and relationships—is the most powerful component of human intelligence. Indeed, the so-called social brain hypothesis holds that humans have a relatively large brain, compared with other vertebrates, mainly because of our need to keep track of all this social information. To date, though, our society has not developed many useful applications to support our social brain. Facebook, LinkedIn and other networking sites are mostly gossip machines, opinion echo chambers or CV catalogs. In many ways, they are run more for the benefit of their owners than their users.

But imagine if we could create tools and information feeds to reveal what is really going on inside companies, cities and governments—not just with our "likes" and friends. To accomplish this feat, we would need systems that support our social brain's talents for reading other people's behavior and fine-tuning relationships, just as today's computer tools extend our memories and computational skills. By teaching computers more about how humans interact best, the hope is that they can play the role of social secretaries and facilitate genuine social connections.

To understand how this might work, think of an organization as a kind of brain, with the employees or members as the individual neurons. Static firms—symbolized by the ubiquitous "org chart"—have fixed connections and, as a result, a limited ability to learn. Typically their departments become "siloed," with little communication between them; the flow of fresh, cross-cutting ideas is blocked. In that state, firms risk falling to newer, less ossified competitors. But if we could supercharge an organization's social skills, the connections—among employees, departments and teams—

might continuously reorganize themselves in response to shifting circumstances and challenges.

Of interest, this idea of adaptable connections is exactly the insight powering today's cutting-edge artificial intelligence, including both statistical-machine-learning and deep-learning-neural-network approaches. In these models, the connections between simple logic machines are reconfigured as the system learns. In contrast to logic machines, people can remake not just their connectivity but also their function, offering a fluid architecture that is qualitatively more powerful. Armed with the right feedback, human "smart neurons" in an organizational brain can fill communication gaps to accelerate learning, anticipate "unknown unknowns" and invent new structures to address emerging market forces.

My research group at the Massachusetts Institute of Technology is using technology to help organizations tap into and capitalize on this kind of people power. Instead of focusing on machines that might replace employees, as most AI applications strive to do, we are interested in developing machines and tools to make people more socially aware and effective. In the laboratory and in real life, we have found that these aids can help co-workers communicate better, find greater success and enjoy work more.

Go with the Flow

To optimize a company's social brain, you need to first understand how ideas flow through it and ultimately take flight. But how do you track this invisible current as it passes from one person to the next? In the early 1990s my students and I at the M.I.T. Media Lab helped to pioneer the idea of wearable computing. Our work paved the way for Google Glass and similar products. From the start, though, we were also keenly interested in developing what we call collaboration wearables, sensors capable of measuring and providing feedback on social interactions, not just on individual behavior.

During the past two decades we have designed several generations of instruments in various forms—from credit-card-size name badges and wristwatch-style devices to cradles that also keep smartphones charged. The devices keep track of how often colleagues listen to, interrupt or speak with one another. They do not record what people actually say—privacy concerns trump all else. But the data they do collect, combined with e-mail and phone records, reveal a pattern of idea exchange through time and space—creating what is, in essence, a snapshot of an organization's "social physics," to borrow a term from Auguste Comte, a founder of sociology.

Using these wearable devices, my colleagues and I looked for patterns of behavior that were associated with high performance. We ran a series of experiments in 2010 in which we administered standard IQ tests and other measures to nearly 700 people, divided them into teams of two to five members and then gave them a variety of problems to solve. Somewhat surprisingly, we found that a group's success at meeting these challenges was only weakly related to the IQs of its individual members. So, too, we found little correlation with the group's cohesion or levels of motivation and satisfaction—as measured with standardized questionnaires. Instead the most successful teams were those that were able to optimize communication within the group. If every team member was engaged and making many contributions, then the group was very likely to be successful. This also meant that members of racial and cultural minority groups, whose ideas and experience may be different from the majority, had the opportunity to contribute and be heard.

In a follow-up study in 2014, we were able to show that the same strong pattern of exchanges that give rise to successful teams also produce what retired U.S. Army General Stanley A. McChrystal described as a "team of teams." McChrystal used this concept of meta teams—groups that assemble collaborators from different parts of a company—to help decentralize

In the most productive groups, everyone speaks concisely and makes roughly the same number of contributions.

decision making when he took command of the Joint Special Operations Task Force during the Iraq War. Our findings indicated that people who are especially adept at forging and maintaining connections across an organization are critical for opening up channels for ideas to spread. These cross-team ties help to break down silos and increase the organizations' productivity and ability to innovate.

Seeing Is Believing

As part of our research at M.I.T., we have deployed collaboration wearables in more than two dozen different work environments: among creative and research staffs, at consulting firms, and in banks, pharmaceutical companies, military installations, call centers and postoperative hospital wards, to name just a few. These real-world analyses have demonstrated just how powerful the relation is between a company's performance and its pattern of communication—not the actual content of that communication but how it spreads.

Critically, we find that rich channels of communication—ideally face-to-face interactions but also videoconferences among small numbers of people—tend to be vital for ideas to gain momentum. This finding is perhaps not so hard to explain. Unlike e-mail and other forms of electronic communication, face-to-face dialogue is imbued with all kinds of nonverbal cues. I refer to them as honest signals because they convey the truth about people's thoughts and intentions, regardless of what they actually express in words. These cues tell us when someone is bluffing, interested in our ideas or not really paying attention at all. And it is on this nonverbal level of interaction that people can intuit where they stand in a group's hierarchy and get a sense for how decisions are unfolding.

One of our case studies highlighted just how well face-to-face interactions can grease the wheels of progress. In 2009 we used collaboration wearables to assess why operators at an American bank's call center handled calls at wildly different speeds—despite the fact that their workdays were largely scripted and fairly uniform. We found that among several different teams, those who, on average, handled calls the fastest were also those who talked to the most other operators. Managers at the call center had scheduled individual coffee breaks to try to cut down on such socializing. But when we prescribed team-wide coffee breaks to encourage the operators to share more ideas—not just about work but life in general—the lagging teams rapidly caught up. Profits rose by $15 million when the bank's bosses implemented our advice at all call centers.

An earlier case study showed how teams also win when they meet face-to-face with colleagues outside their own groups. In 2007 we assessed the communication patterns among five departments within a German bank, collecting data from e-mail records and name-badge-style wearables. We noted that nearly all communication with members of the customer service department was via e-mail. Almost no one spoke to them in person, whereas the other four departments interacted frequently in hallways and around coffee machines. The problem was sim-

The most effective information exchanges happen in small groups meeting face-to-face or via videoconferencing, so that people can more readily interpret nonverbal cues.

ply that customer service was in another part of the building. When bank management saw our analysis, they moved the department nearer to everyone else. Greater proximity meant more input from these employees. As a result, several new ad campaigns took off where previous initiatives had failed.

Follow the Bouncing Ball

More recently, we have been finding that we can optimize the flow of ideas during face-to-face conversations using real-time visual feedback. For instance, we have developed an application for small groups, now being commercialized by Google, in which a floating ball displayed on a screen represents the conversational tide. The position of the ball shows who is dominating the conversation around a conference table at any one time. In tests, we find that this tool encourages more people to join in at meetings—shaping the pattern of communication so as to maximize collective intelligence. This kind of feedback is especially valuable for people participating in a

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When teams have an opportunity to socialize and develop a group identity, it boosts productivity and resilience to help get them through tough times.

meeting remotely, for whom it can be harder to track the social dynamics in the room.

Such real-time feedback can dramatically improve digital learning. By some estimates, 30 to 45 percent of all workers in the U.S. do their jobs remotely at least part of the time, and distance learning is one of the fastest-growing segments of corporate training [see "No Workplace Like Home," on page 38]. We have designed a system that, in addition to standard video lectures, offers e-learners access to smaller breakout groups of three to five people who can engage in a video-conference and see a floating-ball visualization of the communication pattern among them. When these breakout groups optimize their discussions so that everyone contributes more or less equally, all the participants benefit from the kind of peer-to-peer learning that happens naturally in person.

Even on-site workers have a limited capacity to know what else is happening in the company. To remedy this problem, we are testing so-called deep-learning algorithms to prioritize what might be productive new connections within a larger organization. For instance, these algorithms might sort through gigabytes of business-process data to connect people with similar responsibilities in different divisions. Such algorithms might also ping us when existing connections would benefit from more urgent coordination. And computers could also compare actual patterns of human-to-human communication with best practices, checking for communication gaps between departments that should be working together more closely.

These kinds of workplace tools might also help fill in for some missed watercooler chats by keeping track of useful skill sets. For instance, an app might give suggestions such as: "Most people working in this design group are also familiar with the production process. Perhaps you would like to look over the production process plan before you begin?" It might also offer process suggestions such as: "People from your group almost never set the permissions for this file to be publicly shared. Are you sure you want to do this?" These process suggestions are becoming increasingly important as companies realize that more and more cyberattacks are successful because people inadvertently fail to follow standard procedures.

Actively encouraging greater engagement among team members offers yet another mission-critical benefit: when everyone participates and shares ideas, individuals feel more positive about belonging to a team, and they develop greater trust in their colleagues. These feelings are essential for building organizational resilience. Social psychology has documented the incredible power of group identities to bond people and shape their behavior, and the same holds true in the office: group membership provides the social capital needed to see employees through inevitable conflicts and difficult periods.

Wisdom of Crowds

Some of these tools might sound a little too close to Big Brother micromanagement for comfort. But if everyone gets a voice in creating and modifying the suggestions they offer, then they become a cooperative effort—which is exactly how our social brain generates collective intelligence, something that is

The best strategies tend to emerge from striking a balance between engagement within your own team and exploration across the organization.

CASE STUDY

TECHNOLOGY CAN STRENGTHEN TEAMWORK

The author and his colleagues assessed communication patterns at a bank in Germany by examining e-mail records and using small collaboration sensors. The badgelike sensors tracked patterns of verbal communication between employees—namely, how and where they spoke but not what they said. The data the researchers collected revealed a problem that was stymieing efforts to attract new business. Although most departments had a healthy mix of digital communication (*blue lines*) and in-person dialogue (*red lines*), often conducted around coffee stations and in hallways, almost all conversation with the customer service department was confined to e-mail. That department happened to be housed in a distant part of the building. When the bank moved customer service closer to the other teams, its overall input increased, which led to more successful advertising campaigns.

MANAGER | DEVELOPMENT | SALES | SUPPORT | CUSTOMER SERVICE
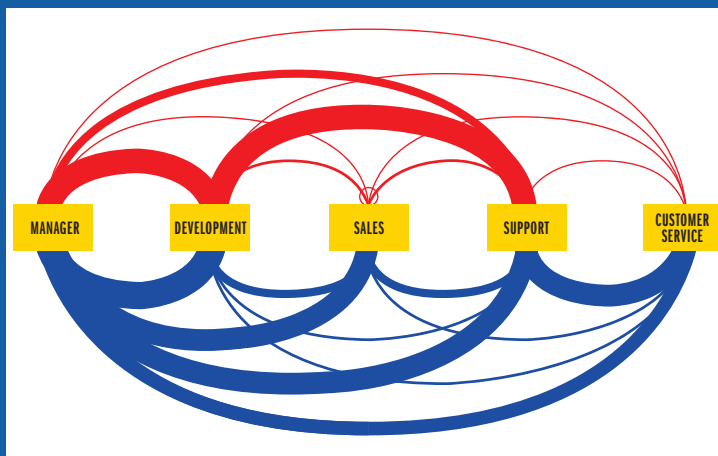
often greater than the sum of its parts. A big discovery my colleagues and I have made, now in hundreds of case studies, is that we can consistently improve on the decisions of top bosses or leadership committees by incorporating the opinions of employees who actually have skin in the game.

For instance, call-center workers often have better ideas about how to meet customer demand than the people who do financial planning, and production engineers know more about how a new product is shaping up than its designers do. The secret to creating an agile, robust organization is closing the loop between workers and bosses so that employees are both helping to create corporate plans and executing them. This circulation fits with another key finding: developing the best strategy in any scenario involves striking a balance between engaging with familiar practices and exploring fresh ideas.

To investigate how people maximize the wisdom of a crowd, we worked with eToro, a social-network stock-trading site where people can see what trades other people choose, discuss them and copy them. In 2012 we analyzed some 5.8 million transactions and found that the traders who fared best maintained the most diverse networks. Up to a certain point, they made better forecasts as they combined insights from more people using different strategies. But when they started adding people with approaches that were only slightly different from their own, their forecasts declined. We calculated that the forecasts from "Goldilocks" groups—those with eight to 10 very diverse people and their strategies—reliably beat the best individual forecasts by a margin of almost 30 percent. Furthermore, when we showed traders with the least diverse social networks how to optimize their reach, they doubled their return on investment.

Given the increasing pace of technological disruption and international competition, organizations ranging from small family businesses to giant government bureaucracies face increased pressure to raise productivity and accelerate innovation. This pressure has serious ramifications for many workers, whose skills are becoming obsolete and whose jobs are disappearing. But I believe that we can reduce this disruption and pain by focusing on technology that complements the unique social abilities of humans rather than focusing on technology that replaces people.

By tracking the flow of ideas among colleagues, we are finding ample new support for an old notion: innovation happens when you bring diverse people together to bounce ideas off one another. Companies that bet on enhancing their social brain will be better at interacting with customers and planning for the future. By using wearables and computers to keep track of how well communication patterns match business processes, companies can achieve both greater agility and higher performance while still being people-centered and humane. **M**

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No Workplace Like Home

Ditching the office can boost both profitability and personal happiness— provided it's done right

By Rachel Nuwer

I am a diligent worker who follows through on my commitments. I'm quick to get started on tasks, usually avoid getting sidetracked and have a fairly optimistic outlook, although I can be plagued by self-doubt. An introvert, I prefer working alone and value autonomy. At times I can be untrusting and skeptical of other people's motives, and I have a tendency to become frustrated by and anxious about work-related difficulties. Sometimes I struggle to balance work and life.

This is not a self-critique. It's a summary of my Distributed Worker Personality Profiler, a psychometric assessment created by Work EvOHlution, a company founded by an organizational psychologist whose goal is to use scientific evidence to help people excel at flexible work arrangements. Employees and managers use it to determine how naturally suited an individual is to working outside a traditional office. The Profiler flags potential pitfalls and provides advice on how to circumvent them. For example, although I am very satisfied working from home

as a freelance journalist, the assessment points out that some of my personality quirks may present a challenge. If an editor is stressing me out with what I perceive as unrealistic demands, my knee-jerk reaction to fire off a frustrated e-mail could make the situation worse. Fortunately, as the assessment's customized feedback advises, there are work-arounds. I can pause before responding, go burn off some steam at the gym, or write an angry draft e-mail and then delete it.

The test's creators believe that telecommuting is

here to stay and that almost anyone, with the proper guidance and support, can excel at it. Indeed, "telework"—also known as flexplace, smart work, distributed work and blended working—has never been more popular, thanks to fast Internet connections, video-chat capabilities, smartphones and other technologies.

The U.S. Census Bureau reports that the number of Americans who worked at home at least one day a week shot up by 35 percent from 1997 to 2010—from 9.2 million to 13.4 million people. Other estimates are even higher. According to Global Workplace Analytics, a research and consulting company specializing in emerging workplace strategies, in 2015 about a quarter of the U.S. workforce clocked some hours away from the office. Another 80 to 90 percent of those people whose jobs would allow it said they would like to work from home two or three days a week.

Global trends are similar. In a 2011 survey of more than 18,500 workers in 24 countries, 35 percent telecommuted at least once a week and more than 60 percent reported that they would consider working remotely full-time, if given the chance.

Companies have taken note of these trends and are eager to know how telework affects the bottom line and what factors predict whether someone working from home will thrive or sink. But even as teleworking becomes more mainstream, many managers remain loath to let professional charges out of their sight, thinking that remote work fosters slacking.

The science, however, suggests that such fears are largely unfounded. Off-site workers may be more productive and satisfied with their jobs than colleagues tethered to cubicles, evidence reveals. And although some personality types lend themselves better than others to telework, a little guidance, research shows, can help just about anyone succeed.

For society as a whole, the potential

benefits are numerous. Employers can save on office costs and increase profits brought by more efficient employees; fewer commuters can ease congestion and pollution; and workers can enjoy more freedom to live where they want, rather than where their job dictates.

Home Sweet Office

Working from home is sometimes mocked as "shirking from home." Until recently, advocates of telework had no evidence to refute this perception, because no experimental studies had been carried out on remote working.

Nicholas Bloom, an economist at Stanford University, and his former Ph.D. student, James Liang, conducted a study of employees at Ctrip, a NASDAQ-listed travel agency in Shanghai that was co-founded by Liang. Bloom, Liang and their colleagues selected 249 of the company's 16,000 employees to take part in a nine-month experiment in which half

the group worked from home and the rest remained in the office.

The findings, published in 2015 in the *Quarterly Journal of Economics*, likely came as a shock to many managers. For each employee who worked from home, the firm earned an addition-

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A study of 249 employees found that those who worked from home were 13 percent more productive and saved the company $1,900 annually per person.

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al $1,900 annually. This boost was largely the result of savings on office rent, but in addition, those working at home were 13 percent more productive than their office-bound colleagues. Homebodies took fewer breaks, were more punctual to start work in the morning and typically finished their lunches within 30 minutes. They also reported a greater ability to concentrate and an overall higher sense of satisfaction. And they were half as likely to quit their job compared with someone who worked five days a week in the office.

Some of that extra happiness may help keep homebound workers motivated and on point, especially when the chips are down. In a 2016 *Computers in Human Behavior* study of 657 workers from a variety of industries, Nico W. Van Yperen, a psychologist at the University of Groningen in the Netherlands, found that people who are high in their need for autonomy and who can blend on-site and off-site work do not lose their intrinsic motivation—that is, wanting to tackle a task because they find the job itself rewarding—as work demands increase.

In contrast, colleagues who worked in the office reported a drop in motivation when work gets tough. "If you're tired but you have to continue working because you're in the office, you feel even more strained," Van Yperen says. "But having the flexibility to take a nap, go to the gym

FAST FACTS
HOMEWARD BOUND

❶ The trend toward telecommuting—working away from the office either part- or full-time—is growing as new technologies facilitate quick communication and collaboration over long distances.

❷ Flexible arrangements can be especially attractive and well suited to diligent individuals who thrive with heightened autonomy. But there are drawbacks—particularly for those who miss workplace interactions or struggle to stay on task.

❸ Researchers are developing assessments and guidelines to help both employees and managers maximize the benefits of working remotely.

or play with your child—and then to continue working later—makes it easier for you to handle high demands because you can work when it's most convenient for you."

The autonomy gained from being out of the office is one of telecommuting's greatest benefits, says Ravi Gajendran, an assistant professor of business administration at the University of Illinois at Urbana-Champaign. In a 2007 meta-analysis of 46 studies involving 12,833 employees, he and co-author psychologist David Harrison of the University of Texas at Austin found that telecommuters reported more job satisfaction, less stress and a better work-family balance. They were also less likely to express a desire to quit. A heightened sense of autonomy, Gajendran says, can explain most of these perks.

In a 2015 study, he and his colleagues found that teleworking can improve the effectiveness of workers who have strained relationships with their bosses and has no effect on the performance of employees who already get on well with their supervisor. One possible explanation, Gajendran says, is that employees who perceive themselves as being in the doghouse at work are especially eager to reciprocate any favors that provide relief from that situation—such as working from home—by stepping up their performance.

Remote work does have drawbacks, however. In the Chinese study, Bloom and his colleagues found that although at-home employees performed better, they did not receive promotions any faster than co-workers in the office. The reason for this disparity is unknown. They may be discriminated against, Bloom says, or they may be uninterested in managerial roles that require showing up at the office.

Too much time away from the workplace can hurt relationships with colleagues, Gajendran's meta-analysis sug-

Tallying the Perks of Telework

Roughly a quarter of full-time employees in the U.S. work from home for at least part of an average day, according to federal records. If the trend extends so that 25 percent spend half the workweek telecommuting, then some big savings—$900 billion a year—are in store, estimates Global Workplace Analytics, a research and consulting group:

$170 BILLION saved by businesses in real estate costs

$466 BILLION worth of work gained through increased productivity

UP TO **$7,000** saved by individuals on work-related costs (such as transportation and dry cleaning)

2–3 WEEKS of free time gained by workers spared their commute

51 MILLION TONS of greenhouse gases reduced by taking cars off the road

gests. Those who spend more than a few days a week outside the office tend to be unsure of where they stand with colleagues (but not with managers); on the flip side, those stuck in the office may feel "teleresentment" of employees working from home.

The best arrangements may involve a blend of remote and on-site work. Timothy Golden, an associate professor of management at Rensselaer Polytechnic Institute, along with business professor John Veiga of the University of Connecticut, asked 321 telecommuters in professional-level jobs how often they worked remotely and how they felt about it. Their results, published in 2005, revealed that job satisfaction and remote work have a nuanced relationship. Job satisfaction increases alongside more remote work—but only to a point. After about 15 hours out of the office a week, employee satisfaction tends to plateau and then to dip (although it still remains higher than those who telecommute infrequently).

Satisfaction also depended on several other aspects of work, including how interdependent the employee was on others. "There's an optimal point where job satisfaction peaks," Golden says. "When we think about telecommuting, we need to consider the extent to which

an individual does it because that determines outcome to a large degree."

The Perfect Profile

Remote work does not suit everyone. Construction workers, surgeons, actors, day care attendants and others have to physically be on-site. Personality also plays a role in determining whether a worker is a good fit for telecommuting.

Those who succeed at teleworking often have a strong need for autonomy, believe they are in control of their own destiny and feel confident in their work. Diligence is another important factor: people who feel a sense of duty and loyalty to their employer and who take pride in being trusted excel off-site. Introverts, who find social situations to be draining and do not mind long periods of solitude, also perform well remotely.

Meanwhile, says director of research at Work EvOHlution Thomas O'Neill, an industrial and organizational psychologist at the University of Calgary in Alberta, "those who get their energy from being around others—the social butterflies of the office—they tend to struggle in terms of satisfaction and engagement when working from a distance." And procrastinators may lose focus when outside the conventional office.

Van Yperen and his colleagues uncovered complementary results. In a 2014 study of 348 employees working across industries, they found that people with a high need for autonomy and a low need for structure and connection to others came out on top in a self-reported survey of how effective they thought

THE AUTHOR

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the old way of doing things. Upper management tends to be averse to risk and change, in part because if something goes wrong they may be blamed or even fired. Some bosses fear unsupervised reports will neglect their duties—even though a large share of managers telecommute at least part-time themselves. Ego may also play a role. "Managers like to have people around because it gives them a sense of empire and status," Gajendran says. "They also want employees in the office just because it makes things easier for them."

Regardless of the motivation, a policy forbidding telecommuting can be harmful to a business by excluding talented staff who desire more flexible or autonomous arrangements. Businesses can get around this potential pitfall by putting top-down rules in place that outline a specific policy for teleworking, which would mean the decision to allow a particular employee to work remotely does not depend solely on a single manager's discretion.

Ideally, companies would also provide training to bosses on how to respond when an employee asks about telecommuting; how to adapt their management style for remote work; and how to set appropriate expectations. (Indeed, Work EvOHlution issues a Supervisor Companion Report to advise managers on specific support tactics. Another company, FlexMatch Suitability Assessments, offers a Manager Scorecard to test supervisor readiness for working with remote reports.)

Meanwhile some businesses are going in the opposite direction. In 2013 a leaked memo revealed that Marissa Mayer, the newly appointed CEO of Yahoo, had decided to terminate telecommuting. "Speed and quality are often sacrificed when we work from home," the memo, issued by the HR department, stated. "We need to be one Yahoo!, and that starts with physically being together."

Days later Virgin Group founder Richard Branson wrote that he found Yahoo's decision "perplexing" and that companies that do not embrace new

they would be if given the opportunity for blended working.

Several companies are attempting to translate these and similar findings into practical tools. The Distributed Worker Personality Profiler, which I took, asked participants to rank how strongly they agree with statements such as "I value cooperation over competition" and "I believe that my success depends on ability rather than luck." Algorithms analyze answers to produce a ranking of an individual's predicted success—either "caution," "moderate" or "high"—for remote work.

Even people who do not have the perfect personality profile for teleworking can still succeed at it, because "you can develop strategies to mitigate certain aspects of your profile," says Laura Hambley, Work EvOHlution's president and a psychologist at the University of Calgary. Procrastinators can kick-start their day by beginning with tasks they are most excited about, for example, and more social

people can schedule regular teleconferences and in-person coffee dates.

External factors can also interfere with a teleworker's success. A home office located above a construction site or constant interruptions from a roommate or family member would trip anyone up. In a 2006 survey of 454 part-time telecommuters, Golden found that those who worked more at home reported lower work-to-family conflicts but experienced higher family-to-work problems. In other words, for extensive telecommuters, work interfered less with their family, but the family interfered more with their work. Fortunately, there are solutions for some of these problems, too. In some cases, simply installing a door, finding child care or investing in a pair of noise-canceling headphones can help.

Off of Site, Out of Mind?

Despite growing evidence in support of telework, some managers still prefer

ways of working are missing out. Still others sided with Mayer, including then New York City mayor Michael Bloomberg, who commented that "telecommuting is one of the dumber ideas I've ever heard."

Her supporters soon felt vindicated. After workers were grounded, Yahoo saw its best first quarter in four years and reported greater stability—out-

Hambley points out, however, that de Leede's results are dated. Current technologies such as GoToMeeting, WebEx and Skype for Business may circumvent obstacles that existed even five years ago and foster problem solving at a distance.

Possibly the only other examination of telecommuting's influence on innovation comes from a 2015 study of more

certain employees, such as those who live in a given zip code, to work from home. Weeks or months later they can compare effectiveness of the two groups to determine if telework might be a good fit for the company. "Test it out but make sure you don't set expectations," Bloom says. "If you tell people you're doing this, they'll work like crazy to make it worthwhile."

Remote Future

Despite the holdouts, telecommuting is fast becoming just another way of being on the job. As technology allows for more meaningful digital connections, experts such as Gajendran predict that we might eventually do away with the need for certain workers to physically come together at all. In the process, employees who can excel at telework may become more attractive to managers, too.

These changes promise to shape not only the working landscape but the physical one as well. Offices could scale back; urban infrastructure could become less congested; and workers could choose to live hours from company headquarters.

Those implications may also extend to changes in how we relate to one another and interact. "We're social animals, and we've been working face-to-face for the entire evolution of humankind," Calgary's O'Neill says. "It won't be overnight that people can adapt to this extreme mobility, but I think we are moving into an age where remote work is inevitable." **M**

Job satisfaction increases with more time spent working at home—up to a point. It plateaus at 15 hours a week of remote work, and then it dips.

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comes often attributed to ending teleworking. Yet that conclusion, Stanford's Bloom says, is flawed: "Yahoo is a great example of why case studies are misleading because if you looked at it, you'd say banning working from home leads to surging stocks. But those outcomes could have been driven by something else." In fact, Yahoo's spike in profitability was short-lived.

Whether or not Mayer's decision was the right one, there is some evidence that innovation could be stymied by telework. A small survey-based study, published in 2008, found that creative thinking took a hit when people worked remotely and that complex projects, especially ones with a tight deadline, were better suited to in-person collaborations. (To measure innovation, the researchers asked 83 employees from several industries to rate how well they agreed with statements such as "In my work, I discover new solutions for bottlenecks that remain unsolved.") The lesson, according to Jan de Leede, an assistant professor of human resource management at the University of Twente in the Netherlands and the study's lead author, is that companies should carefully consider the type of work at hand before embracing telework.

than 900 Belgian workers. This research found that working from home is related to greater innovation but that working outside the typical nine-to-five schedule may have small negative effects on creativity.

Bloom and his colleagues hope to better identify the relation between innovation and telework with a follow-up to their China study involving workers whose jobs entail more collaboration and creativity. In the meantime, he suggests that managers interested in making the telework switch covertly pilot their own experiments. Bosses can use an event—a storm, a road closure, the Olympics—as an excuse for allowing

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Give Me a Break

A wealth of psychological research shows that mental downtime is vital for productivity and health. Some progressive companies are finally starting to listen

By Ferris Jabr

The moment that incited Mark Bertolini's workplace revolution did not happen in the office, at a conference or even when he was thinking about his job—it occurred during a family vacation. But it was not a happy moment; in fact, it nearly killed him.

In February 2004 Bertolini, then 47 years old, was on a skiing trip with his family in Killington, Vt. While speeding downhill, he collided with a tree and fell 30 feet down a ravine. The plummet fractured bones in his neck and back and severely damaged nerves in his arm. Yet he lived, gradually regaining mobility despite chronic pain. Not wanting to remain on pain medications for the rest of his life, he turned to yoga and mindfulness meditation, which teaches people to observe their thoughts, feelings and perceptions as they arise without judgment or resistance.

He was so impressed by these pain- and stress-reducing therapies that he started to wonder whether his 50,000 employees might benefit from them, too. Bertolini is chief executive officer of the health insurance giant Aetna.

By 2010 Bertolini had enlisted the help of the American Viniyoga Institute and the meditation instruction company eMindful to customize free yoga and meditation classes for Aetna employees, even providing spaces at the office to practice. And he did not stop there. He also teamed up with health psychologist Ruth Wolever, then at Duke University and now at Vanderbilt University, to formally investigate the outcomes of these innovations.

In a three-month study of more than 200 Aetna employees, individuals who engaged in meditation and yoga slept better, felt less stressed overall and had more efficient heartbeat recovery rates after stress than those who abstained. In a follow-up study involving more than 1,000 employees, presented this past May at the International Congress of Integrative Medicine and Health, meditation and yoga were correlated not only with less stress but also with 47 to 62 minutes of increased productivity per week. The practices even seemed to reduce employees' spending

on health care. (The studies were funded in part by Aetna and eMindful, but all were reviewed by independent committees at Duke.) "The first year after we did the program, our health care costs actually dropped as a company," wrote Bertolini in an e-mail. He attributes some of Aetna's recent success and growth to the new practices.

The programs have been so successful and popular that in February, Aetna brought on mindfulness instructor and consultant Andy Lee as its full-time chief mindfulness officer—presumably the first position of its kind in the country. "In today's workplace, we all have more information than we know what to do with, and people are always asked to do more with less," Lee says. "That taxes our minds and our bodies. Dedicated time for rest and relaxation is an ideal countermeasure."

Around the world, especially in industrial nations, overworked employees and the scientists who study them are reaching similar conclusions. A preponderance of evidence now confirms that downtime of all kinds—whether it be a meditation session, lunchtime stroll through the park or weeklong vacation—is crucial for productivity and overall health. When we are relaxing or daydreaming, the brain does not slow or stop. Rather—much as an array of crucial molecular, genetic and physiological processes transpire during sleep—many mental processes require periods of waking rest during the day. Downtime restores attention and motivation, fosters creativity, improves work efficiency, and is essential to both achieve our highest levels of performance and simply make it through the day.

Under Pressure

Psychologists began formally studying the health and habits of workers in the first decades of the 20th century. Pioneering workplace psychologist Walter Dill Scott, elected president of the American Psychological Association in 1919, focused on how best to choose employees with the most appropriate skills. In the early 1900s Hugo Münsterberg published the first textbooks explicitly focused on human behavior in the workplace, a field that is now variously known as industrial/organizational, occupational or, simply, work psychology.

FAST FACTS
PAUSE FOR PRODUCTIVITY

1. Technology and globalization have increased pressure to stay connected to work 24/7, which may explain why American workers, on average, take only half their available vacation days and work throughout sick leave and holidays.

2. Time off boosts productivity and job satisfaction—but the effects can be short-lived. An optimal strategy involves taking frequent, short breaks throughout the year.

3. Simple daily practices such as naps, meditation or a walk outside can help people refresh their attention before returning to desk work.

Although the field has long been interested in the relations among stress, rest and productivity, it was not until the 1980s and 1990s that topics such as work-related fatigue, mental breaks and work-life balance received widespread attention. In the past decade the number of studies on such issues has increased dramatically.

Researchers identify several reasons for this new emphasis, such as the growing number of couples and families in which both partners are managing full-time careers, as well as the rising prevalence of white-collar desk jobs in which the psychological toil of work takes precedence over the kind of physical repercussions associated with hard labor. But the biggest impetus is probably the advent of technology that makes it possible to keep working 24/7 and remain in touch with colleagues even when far away from the office. "We've created a culture of immediate responsiveness," says Leslie A. Perlow, a professor at Harvard Business School. "It's getting to the point where

Many workers feel "telepressure" to stay connected even on days off, but the benefits of breaks come from detaching.

thanks to mobile devices we can work from anywhere, and we can interrupt one another anytime."

Studies confirm that many modern employees, especially in the U.S., are perpetually preoccupied with work: even when they get a break, they feel obligated to keep working. The European Union mandates 20 days of paid vacation, but the U.S. has no federal laws guaranteeing paid time off, sick leave or breaks for national holidays. Canada, Japan and Hong Kong mandate just 10 or fewer days of annual vacation; in the U.S., workers receive an average of just eight days after one year on the job. But a 2014 survey by Harris Interactive found that we use only half of our eligible vacation days and paid time off. A 2015 report by Expedia showed that Americans collectively neglect 1.3 million years of vacation annually. And in several surveys, U.S. workers have confessed that they do not fully unplug from phone or e-mail even when they are on vacation or sick leave.

Larissa Barber, a workplace psychologist at Northern Illinois University, and her colleagues recently coined a new term for such feelings: workplace telepressure, a nagging preoccupation with work-related e-mails and related communications, combined with a compulsion to respond immediately. "All of this is tied to the American culture of busyness," Barber says. "Being busy means status and prestige, and if you are not busy and overwhelmed, it means you're not important or not working hard enough."

In a survey of more than 300 part- or full-time workers

published last year in the *Journal of Occupational Health Psychology,* Barber and her colleagues found that employees who reported greater workplace telepressure missed more days of work, experienced more physical and mental burnout, and did not sleep as well as their less e-mail-obsessed peers. Barber also suspects that telepressure can lower the quality of an employee's work. "Responsivity doesn't always mean productivity," she says. "All it shows is that someone is responding and available, but that is different from doing good work."

The increasingly intrusive nature of work-related communication is especially troubling in light of one of the strongest conclusions from the past decade of occupational psychology research: to maximize the benefits of breaks, we need to fully disengage from our jobs—physically and mentally. "No matter how we look at it, detachment is good for well-being," says Charlotte Fritz, an organizational psychologist at Portland State University who published a review paper on the topic last year. "The benefits include lower exhaustion, higher positive mood, better sleep and better quality of life."

The (Qualified) Case for More Vacation

Perlow and her colleagues have conducted some of the most rigorous research on how uninterrupted downtime improves health and productivity. In one four-year study, she and her team monitored the work habits of employees at the Boston Consulting Group, who were used to working nearly nonstop. Every year the researchers insisted that employees take regular time off, even when they felt they should be in the office. In one experiment, published in 2009 in the *Harvard Business Review,* each of four consultants on a team took a break from work one day a week. In a second experiment, every member of a team scheduled one weekly night of inviolable personal time.

Everyone resisted at first, fearing that work would pile up. But the consultants gradually came to love their mandated time off because it restored their willingness and ability to work, making them more productive overall. After five months the study subjects were more satisfied with their jobs, more likely to see a long-term future at the company, more satisfied with their work-life balance and prouder of their accomplishments. These initial experiments were so successful that within four years, the Boston Consulting Group had implemented the same practices in more than 2,000 teams in 66 offices in 35 countries.

Collectively, studies by Perlow and other researchers suggest that the current model of consecutive 40-hour workweeks, punctuated by two-day weekends and one or two vacations a year, is not ideal for mental health or productivity. Psychologists have established that, like weekends and evenings, vacations have genuine physical and psychological benefits: they reduce stress, promote creativity and revitalize attention.

Yet a comprehensive meta-analysis, published in 2011 by Jessica de Bloom, a psychologist now at the University of Tampere in Finland, demonstrates that these benefits generally fade within two to four weeks. In one of her own studies, for example, 96 Dutch workers reported that compared with their typical daily experience they felt greater energy and happiness, less tension and more satisfaction with life during a winter sports vacation between seven and nine days long. Within just one week of returning to work, however, all sense of renewal had vanished. A second experiment on four and five days of respite came to essentially the same conclusion.

A vacation is like applying a single ice cube to a burn: it will help for a little while, but soon enough the ache returns. The U.S. standard of two weeks' annual vacation time is nowhere near enough to sustain such ephemeral benefits throughout a given year because it allows for too few discrete breaks. And many people save up their scant vacation time to use all at once. "It's not necessarily true that longer breaks or holidays have better results," de Bloom says. "It seems that regularity is much more important."

Given the current work climate, the prospect of frequent

THE AUTHOR

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breaks during which employees disconnect *completely* from their jobs may seem unlikely, but it is a much more pragmatic and affordable strategy than lengthy vacations. Baby steps involve curtailing job-related communications in the evenings and on weekends.

Some companies do set boundaries on work e-mail: in 2011, for example, Volkswagen prevented employees from accessing work-related e-mails on company-issued phones during nonwork hours. France and Germany have restricted after-hours work communication in certain sectors or situations. But such practices are the exception. In one 2012 survey, only 21 percent of organizations had a formal policy limiting use of work-issued mobile devices during off-hours.

On an individual level, Barber recommends strictly managing expectations. Replying too quickly too often sets up unrealistic standards. On her class syllabus, she explicitly states when she is available to reply by e-mail and when she is not. Meanwhile de Bloom spreads her vacations as much as possible throughout the year. And her polite but firm out-of-office e-mail response cites studies on the benefits of mentally detaching from work during vacation.

Hitting Refresh

Weekends and holidays aside, simple daily practices can allow workers to mentally detach from their desk work. Tony Schwartz, a journalist and CEO of the Energy Project, has made it his mission to advise people on implementing these practices. Building on the available science, his company

provides coaching and consultations for organizations that want to help employees avoid burnout and dissatisfaction.

The Energy Project instructs workers to get seven to eight hours of sleep each night, use every vacation day, take naps and other small breaks throughout the day, learn to meditate and take on the most challenging projects first to give them maximum attention. Although their approach counters the reigning cultural conviction that busier is better, the organization has partnered with Google, Apple, Facebook, Coca-Cola and a wide range of Fortune 500 companies. According to Schwartz, their strategies have pushed workers' overall engagement well above average levels (as measured by self-reports of how much people enjoy their job and are willing to take on extra duties). Google has maintained the partnership for more than five years.

More than a decade of research has uncovered the fact that although our mental resources gradually ebb from dawn to dusk, breaks can restore at least some of these cognitive faculties. Naps, for instance, can sharpen concentration and improve the performance of both the sleep-deprived and fully rested on all kinds of tasks. In a 2002 study, 26 physicians and nurses working three consecutive 12-hour night shifts dozed for 40 minutes at 3 A.M. while 23 of their colleagues worked continuously without sleeping. Although doctors and nurses who had taken a siesta scored lower than their peers on a memory test at 4 A.M., at 7:30 A.M. they actually outperformed their counterparts on a test of attention, more efficiently inserted a catheter in a virtual simulation and appeared more alert during an interactive simulation of driving a car home.

Some start-ups and progressive companies provide employees with spaces to nap at the office, but most workers in the U.S. do not have that option. Another restorative solution is spending more time outdoors, away from man-made spaces. Marc Berman, a psychologist at the University of South Carolina, studies the hypothesis that natural environments restore our attention. Built-up environments, such as busy city streets, he argues, may overwhelm the brain with noisy, glaring stimuli, whereas the calm and quiet of green spaces, such as parks and forests, allow the mind to relax and recuperate.

In one of the few controlled experiments in this area, published in 2008, Berman asked 38 University of Michigan students to complete two attention-draining tasks: first studying lists of numbers and reciting them from memory in reverse order, then memorizing the locations of words in a grid. Half the students subsequently ambled along an arboretum path for about an hour, and the other half walked the same distance through busy downtown Ann Arbor. Back at the laboratory the students once again memorized and recited strings of numerals. On average, the volunteers who had spent their time

amid trees rather than city traffic recalled 1.5 more digits than the first time they took the test; those who had walked through the city improved by only 0.5 digit—a small but statistically significant difference between the two groups.

Clearing the Mind

In addition to enhancing one's powers of concentration, downtime can strengthen attention—something that scientists have gleaned through studies of meditation. In the past decade

In one study, meditation and yoga were correlated not only with less stress but also with 47 to 62 minutes of increased productivity per week.

mindfulness training has become incredibly popular as a strategy to relieve stress, exhaustion and anxiety—especially for overworked nine-to-fivers (or nine-to-niners, as is often the case).

Critics of mindfulness research observe, correctly, that studies on the benefits of this practice are typically small and that they lean on subjective reports; the science of mindfulness is still not a rigorous one. Nevertheless, at this point researchers examining the benefits of mindfulness have gathered enough evidence to conclude that meditation can improve mental health, hone concentration and strengthen memory. Experiments that contrast longtime expert meditators with novices or people who do not meditate often find that the former outperform the latter on tests of mental acuity.

In a 2009 study, for instance, neuroscientist Sara van Leeuwen, then at Goethe University Frankfurt in Germany, and her colleagues tested the visual attention of three groups of volunteers: 17 adults around 50 years old with up to 29 years of meditation practice; 17 people of the same age and gender who were not longtime meditators; and another 17 young adults who had never meditated before. These participants viewed a series of letters flashed on a computer screen, concealing two digits in their midst. Volunteers had to identify or guess both numerals; recognizing the second number was often difficult because earlier images masked it. Performance on such tests usually declines with age, but the expert meditators outscored both their peers and the younger participants.

Changes to the brain's structure and to behavior most likely explain these improvements. Over time expert meditators may develop a more intricately wrinkled cortex—the brain's outer layer, which is critical for many sophisticated mental abilities, such as abstract thought. These practitioners may also have increased volume and density in the hippocampus, an area that is absolutely crucial for memory. Finally, meditation appears to thicken regions of the frontal cortex that we rely on

to regulate our emotions and prevent the typical wilting of brain areas responsible for sustaining attention as we age.

At this point, scientists are still unsure of how quickly these changes occur, although some studies suggest that a few weeks of meditation or a mere 10 to 20 minutes daily can sharpen the mind. But there is likely a catch: as with vacations, a few studies indicate that regularity is ultimately more important than the length of any one session. Just 12 minutes of daily mindfulness meditation helped to prevent the stress of military service from corroding the working memory of 34 U.S. marines in a 2011 study conducted by Amishi Jha, now at the University of Miami, and her colleagues. Jha likens mindfulness training to push-ups: as a mental workout, she says, "it's low-tech and easy to implement." In her own life, she looks for any opportunity to practice, such as her 15-minute daily commute.

Since Bertolini introduced mindfulness and yoga courses to Aetna, more than 13,000 employees have participated. Now the company is deciding how best to extend these benefits beyond their offices to their 22.9 million health insurance members. "There's been this incredible trajectory in peer-reviewed work on mindfulness and related relaxation techniques in the workplace," says Wolever, the former Duke researcher who studied Aetna employees. "We need to work against that culture of always being busy and develop more realistic expectations of what our brains and bodies can handle." **M**

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WOULD YOU VOTE FOR A PSYCHO

RESEARCH SHOWS THAT SOME OF THE COMPONENT TRAITS OF PSYCHOPATHY CAN HELP LEADERS SUCCEED
BY KEVIN DUTTON

ILLUSTRATIONS BY EDDIE GUY

W as Adolf Hitler a psychopath? Would he meet the criteria established by modern psychiatry? These were the questions invariably raised by audiences in Germany when I would give talks there about my 2012 book *The Wisdom of Psychopaths*. Fortunately, I was in a position to answer them with data. In an ongoing study, I had been asking the official biographers of prominent historical figures to fill out, on their subject's behalf, an abbreviated version of the Psychopathic Personality Inventory–Revised (PPI-R). This short psychometric test uses 56 questions to quantify a person's psychopathic personality traits.

The Führer, predictably, scored very high. What *was* surprising—and of some consolation to my German audiences—was that so did British prime minister Winston Churchill. Although Hitler's scores suggested that he was a hole-in-one psychopath, the numbers I collected for Churchill—one of the most celebrated figures ever to grace the world political stage—put him, too, solidly on the green. What did that say about politicians in general? If one of the all-time greats scores high on the psychopathic spectrum, might not many lesser luminaries lie there as well?

Now seems like a particularly good time to consider this issue. The U.S. presidential race has brought a host of personalities to the fairway, so to speak. The so-called Goldwater rule, part of the American Psychiatric Association's ethical guidelines, deems it unethical for psychiatrists to comment on an individual's mental state without examining him or her in person. (Indeed, the rule came about because in the 1960s, a now defunct magazine called *Fact* polled clinicians about whether Senator Barry Goldwater was fit for the presidency.) But from the media this election cycle, there has been no shortage of armchair diagnoses declaring several of the front-runners to be narcissists, megalomaniacs or psychopaths.

Are any of the candidates who have thrown their hat into the race *really* psychopaths? The label is far from one-size-fits-all. Although for most people it brings to mind serial killers such as Ted Bundy and Jeffrey Dahmer, experts use the term specifically to refer to individuals with a distinct subset of personality characteristics, among them ruthlessness, fearlessness, self-confidence, superficial charm, charisma, dishonesty, and core deficits in empathy and conscience. And while no one likes a heartless liar, the fact is that none of these traits in and of themselves presents a serious challenge to mental health. Instead what distinguishes the cold-blooded murderer from a psychopathic president is a question of context and degree. As with any personality dimension, resting levels of psychopathic characteristics vary. Using measures such as the PPI-R, researchers can conduct fine-grained analyses of these different components to uncover potentially toxic or helpful combinations—mixes that assist or derail the people who possess them.

Several studies have now placed past U.S. presidents and historical leaders under this microscope, revealing intriguing patterns. My own research has found that there are particular psychopathic traits that can benefit leaders enormously and others that lead to disaster in office. Recently I turned my attention to men and women vying for the U.S. presidency, who were, at the time I was writing this article: Hillary Clinton, Ted Cruz, Bernie Sanders and Donald Trump. In a new study, I assessed their psychopathic traits in much the same way I analyzed Hitler and Churchill. My results, described below, may give U.S. voters something to think about come November.

Will the Real Psychopath Please Step Forward?

To understand psychopathy better, imagine a personality "mixing desk" on which its hallmark traits, as measured by the PPI-R, consist of a hodgepodge of knobs and sliders. It would feature eight dials grouped across three different regions of the console. Though disputed by some scholars, one area would be labeled Fearless Dominance and include three components: Social Influence, Fearlessness and Stress Immunity, which are all self-explanatory. Another section, called Self-Centered Impulsivity, would feature four traits: Machiavellian Self-Interest, Rebellious Nonconformity, Blame Externalization and Carefree Nonplanfulness (a devil-may-care attitude toward the future). The third region would have a single dial: Coldheartedness.

If you could twiddle these controls in various combinations and see the results, you would soon arrive at two conclusions. First, there is no correct setting that defines all psychopaths. Depending on the timing and circumstances, individuals will constantly dial these traits up or down in search of the most effective alignment. And second, some jobs and professions—including management roles, business, law, the military, emergency services and surgery—demand that some of these dials are always cranked up a little higher than average. In general, high-risk, high-status positions place a premium on qualities such as decisiveness, mental toughness and emotional detachment—all of which are made easier by high settings on certain psychopathic qualities.

What specific mix serves as a psychological booster rocket in politics? To begin to find out, I conducted interviews with a number of British politicians and political commentators—from

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FAST FACTS
POWERFUL PERSONALITIES

1 Many well-regarded leaders appear to find success through psychopathic traits—namely, fearlessness, social influence and immunity to stress.

2 Research suggests that leaders who also possess psychopathy's negative characteristics—including self-centeredness, impulsivity and a lack of empathy—are far less effective in office.

3 An analysis of some of the top contenders in the current U.S. presidential race reveals who might have the best temperament to become leader of the free world.

How Presidents Rank in Psychopathy

Psychologists asked presidential biographers and scholars to fill out a standard personality assessment on behalf of their subjects. Based on the answers, the researchers calculated how high each president might score on measures of psychopathy. The results shown here rank all presidents up to George W. Bush by total score. Those listed in blue were among the top-10 scorers in Fearless Dominance traits of psychopathy, which are associated with successful leaders. Those listed in red ranked in the top 10 for psychopathic traits known collectively as Self-Centered Impulsivity, which are linked to less success. Four presidents, in boldfaced black, made both top-10 lists. The numbers in parentheses indicate position on the two lists.

1. John F. Kennedy (2) (6)	22. George Washington
2. Bill Clinton (7) (1)	23. Thomas Jefferson
3. Andrew Jackson (9) (4)	24. Ulysses S. Grant
4. Teddy Roosevelt (1)	25. John Q. Adams (10)
5. Lyndon B. Johnson (2)	26. Dwight D. Eisenhower
6. Franklin D. Roosevelt (3)	27. Gerald Ford
7. Chester A. Arthur (5)	28. Abraham Lincoln
8. George W. Bush (10) (9)	29. James Garfield
9. Ronald Reagan (4)	30. Harry S. Truman
10. Richard Nixon (7)	31. Herbert Hoover
11. Andrew Johnson (3)	32. Franklin Pierce
12. James K. Polk	33. James Madison
13. John Adams (8)	34. Calvin Coolidge
14. John Tyler	35. George H. W. Bush
15. Martin Van Buren (8)	36. Grover Cleveland
16. Woodrow Wilson	37. James Buchanan
17. Warren G. Harding	38. William Howard Taft
18. William Henry Harrison	39. Rutherford B. Hayes (5)
19. Benjamin Harrison	40. James Monroe
20. Jimmy Carter	41. Millard Fillmore
21. Zachary Taylor (6)	42. William McKinley

members of the House of Lords, to local elected officials, to well-known radio and TV anchors. They all deemed a few key traits to be indispensable for any politician. Foremost, they agreed that politicians must be able to make difficult decisions under considerable pressure. They need to be able to juggle many multifaceted crises, ranging from the threats posed by rogue nations to those caused by natural disasters. They have to be willing to send their country's young people to war in the certain knowledge that some will lose their lives. And they need excellent self-presentation skills and superficial charm—specifically, the ability to feign empathy even if they do not feel it. As Teddy Roosevelt once said: "The most successful politician is he who says what the people are thinking most often and in the loudest voice." (Indeed, some observers credit the rise of Donald Trump to precisely this, at least among a portion of the electorate.)

Finally, the politicians I interviewed noted that even to run for office, politicians need supreme self-confidence. It then takes that same kind of Teflon-coated self-belief and unrelenting focus to implement policy. Dealing with opponents often calls for considerable ruthlessness and mental toughness. As one senior British politician told me: "The only way to tell who's stabbing you in the back in politics is to see their reflection in the eyes of the person who's stabbing you from the front!"

The picture of an ideal candidate that emerged from this survey was one of a charming, persuasive, self-confident individual who can be ruthless when necessary and who is also heat-resistant: he or she can maintain focus, keep a cool head and perform under fire. In terms of our personality mixing desk, the best setting would be "high" on all the Fearless Dominance dials, variable for the Coldheartedness dial and low for the Self-Centered Impulsivity dials. Put another way, politics came out as a profession in which an official consignment of legalized, precision-engineered psychopathy would come in rather handy.

Our Fearless Leaders

Several years ago psychologist Scott O. Lilienfeld of Emory University, who co-developed the Psychopathic Personality Inventory and is a *Scientific American Mind* advisory board member, joined psychologists Steven Rubenzer, Thomas Faschingbauer and others in an intriguing collaboration. First, researchers handed out the latest iteration of the NEO Personality Inventory, which assesses the so-called big five personality traits, to biographers of, or experts on, every U.S. president up to and including George W. Bush. Just as in my study, these experts used their in-depth knowledge of their subjects to answer on the presidents' behalf. Based on these responses, Lilienfeld then extrapolated to what extent each president exhibited various psychopathic character traits. From these data, I subsequently created two top-10 lists, ranking the presidents' scores in Fearless Dominance and Self-Centered Impulsivity [*see box above*].

The results could not have been clearer. Similar to what I surmised from my survey of British politicians, higher settings on the Fearless Dominance dials were associated with higher ratings

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THE AUTHOR

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Psychopathic Leader Board

The author asked biographers of historical figures to fill out the short form of the Psychopathic Personality Inventory–Revised (PPI-R) for their subjects. The table below reveals each subject's scores for psychopathy's eight component traits: social influence (SI), fearlessness (F) and stress immunity (STI), referred to as Fearless Dominance traits; Machiavellian Egocentricity (ME), Rebellious Nonconformity (RN), Blame Externalization (BE) and Carefree Nonplanfulness (CN), called Self-Centered Impulsivity traits; and Coldheartedness (C). Scores adding to the top 20 percent in the three major dimensions are highlighted. In another analysis, the author asked a seasoned political reporter to complete the PPI-R on behalf of contenders in the U.S. presidential race (*bottom*).
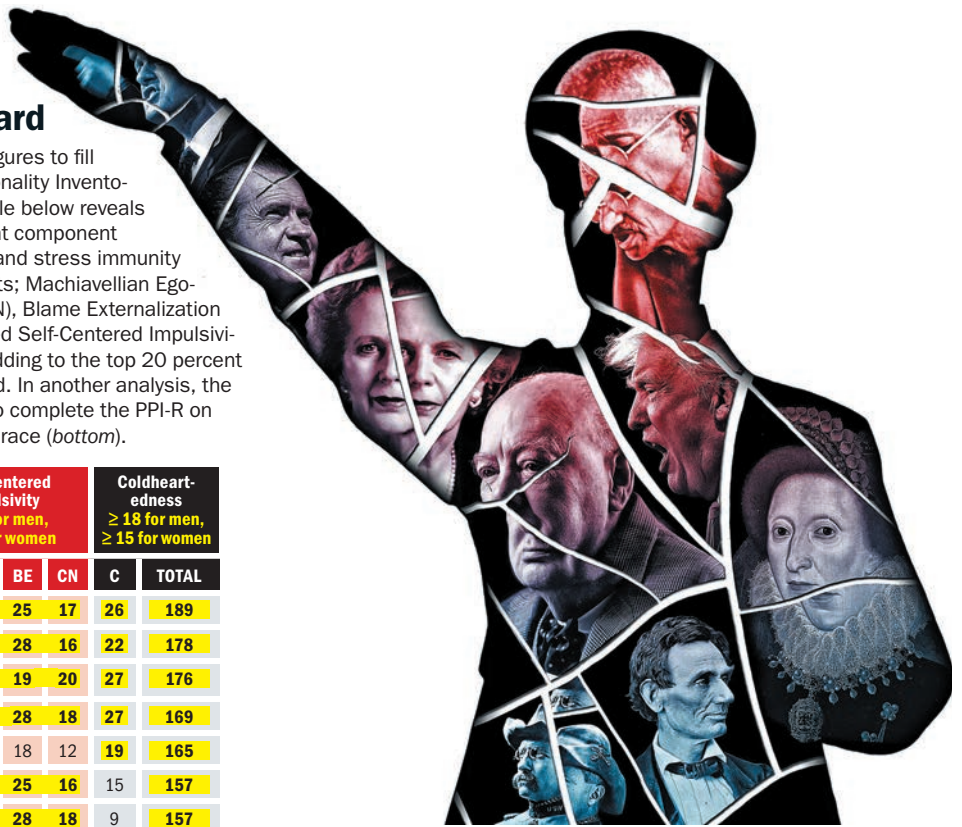
Top 20 Percent	Fearless Dominance ≥ 68 for men, ≥ 62.4 for women			Self-Centered Impulsivity ≥ 69 for men, ≥ 62 for women				Coldheart-edness ≥ 18 for men, ≥ 15 for women	
	SI	F	STI	ME	RN	BE	CN	C	TOTAL
Saddam Hussein	26	27	26	25	17	25	17	26	189
Henry VIII	28	25	14	25	20	28	16	22	178
Idi Amin	24	25	27	22	12	19	20	27	176
Adolf Hitler	26	10	15	27	18	28	18	27	169
William the Conqueror	27	25	27	22	15	18	12	19	165
Saint Paul	23	22	27	13	16	25	16	15	157
Jesus	22	18	27	12	23	28	18	9	157
Winston Churchill	28	25	20	18	17	22	13	12	155
Napoleon Bonaparte	20	13	25	22	18	26	9	20	153
Emperor Nero	21	22	19	15	21	28	8	17	151
Oliver Cromwell	14	17	14	18	11	21	19	22	136
Margaret Thatcher	26	10	25	13	11	24	13	14	136
George Washington	26	22	25	13	8	17	7	14	132
Elizabeth I	26	14	15	16	12	25	9	13	130
Abraham Lincoln	26	15	26	9	10	10	10	17	123
Mahatma Gandhi	22	13	21	9	13	17	11	13	119
2016 CANDIDATES Donald Trump	27	20	21	26	18	17	20	22	171
Ted Cruz	24	18	19	26	18	15	15	21	156
Hillary Clinton	25	15	17	25	18	17	16	19	152
Bernie Sanders	22	14	18	17	15	14	14	15	139

of presidential performance, leadership, persuasiveness, crisis management, perceived standing on the world stage and congressional relations. They were also linked to a number of more objective indicators of a president's performance, such as how many new projects he initiated. In contrast, higher settings on the Self-Centered Impulsivity dials were associated with indicators of an insalubrious interpersonal style—such as invoking congressional impeachment resolutions, tolerating unethical behavior in subordinates and having an unsavory reputation in general.

The findings also confirmed that biographers respond accurately enough to measures such as the PPI-R to reliably evaluate historical figures. For example, it is interesting to note that historians and political scientists consistently rate the two Roosevelts among the top-five greatest American presidents of all time, and in keeping with that assessment, they appear first and

third on the Fearless Dominance top-10 list and are absent from the Self-Centered Impulsivity list. (Talk of Fearless Dominance: Teddy Roosevelt, after his 1912 electoral loss to Woodrow Wilson, set about exploring a previously uncharted tributary of the Amazon River, complete with piranhas, rapids and indigenous people bearing poison-tipped arrows!) In contrast, Andrew Johnson and Richard Nixon, who both feature on the Self-Centered Impulsivity top 10 but not on the Fearless Dominance list, are frequently cited among the worst.

My own ongoing study of historical figures is yielding similar profiles among the great, the good and the not so good [*see box at left*]. As with the full version of the PPI-R, the short version does not have a cutoff score at which nonpsychopaths end and psychopaths begin. Instead it represents scores as percentiles of normative response patterns found across the general population. So to put my results in context, it is useful to know the scores associated with the top 20 percent (or upper quintile) of the evaluated subjects for its various traits.

Among men, that means that if an individual scores in the upper quintile across the three broader dimensions (that is, 68 or above for Fearless Dominance, 69 or above for Self-Centered Impulsivity, and 18 or above for Coldheartedness), he would weigh in with a minimum total score of 155. For women, the same 80th percentile watermark falls a little lower at 62.4 for Fearless Dominance, 62 for Self-Centered Impulsivity and 15 for Coldheartedness, for a total of 139.4.

In my list of leaders, everyone from Emperor Nero and above—including Jesus and Saint Paul—has a notably high total score and a top quintile finish on at least one of the three dimensions. British prime minister Margaret Thatcher falls just short

GETTY IMAGES

of this distinction. If, however, you consider the scores broken down by dimension, you do find that some esteemed leaders land below the top quintile. Both George Washington and Abraham Lincoln are high on Fearless Dominance but low in Self-Centered Impulsivity and so come out with relatively modest total scores. In short, they have all the "positive" aspects of a psychopathic personality—affording them mental toughness, social influence and boldness—with none of the negative characteristics, which manifest as impulsivity, egocentrism and insubordination. In contrast, Hitler had all the "bad" aspects of psychopathy and fewer of the "good" ones.

The 2016 Race

To evaluate the top candidates in the U.S. presidential race, I contacted one of the BBC's most respected and seasoned American political news anchors, whom I assured complete anonymity, and asked this individual to fill out the PPI-R short form on behalf of the four leading contenders at the time—Clinton, Cruz, Sanders and Trump. In each case, this anchor answered the questions by drawing on personal firsthand experiences with the candidates, as well as expert media analysis and dispassionate general impressions.

When the results were tallied, Trump trumped the rest of the field, achieving a total psychopathy score in league with Hitler and Idi Amin. Of particular note, he outscored the other three contenders in the Fearless Dominance dimension, associated with successful presidencies. At the same time, however, his "negative" psychopathic ratings were also higher than the other three candidates. Across all eight psychopathic traits, Cruz ran pretty much neck and neck with his Republican rival—but lost ground when it came to Carefree Nonplanfulness and Social Influence: in other words, his scores suggested he is less impulsive and less persuasive than Trump. In summary, the comparison between the two did not prove a knockout for Trump, but if it were a boxing match, he would have won a unanimous points decision with Cruz still on his feet at the final bell.

Among the Democratic contenders, Clinton and Sanders were fairly evenly matched on "positive" psychopathic traits—both scoring high on Social Influence and in the middle of the road on the rest. That said, the two diverged markedly on "negative" psychopathic characteristics, with Clinton's higher tally forming the basis of her significantly higher total score. At 152, Hillary surged a full 16 points higher than Thatcher, the U.K.'s only female prime minister. Allowing for the gender differences in percentile cutoffs, her score was more on par with Trump's.

"A leader takes people where they want to go. A great leader takes people where they don't necessarily want to go but ought to be," said Rosalynn Carter, wife of Jimmy Carter. The quote suggests that this first lady had some intuitive grasp of the idea that great political leadership entails cranking up *some* psychopathic dials on our personality mixing desk—those associated with fearlessness and dominance—while turning down the ones associated with self-centeredness and impulsivity. So far the research backs her up.

The Price of Greatness

What about leadership in nonpolitical spheres? In 2014 Lilienfeld and I, along with our colleagues, conducted a study that provided the first published data indicating a direct link between job status and psychopathic personality characteristics, drawing on an Internet-based survey of nearly 3,400 people. Specifically, we found that higher total scores on the short form of the PPI-R correlated positively, though modestly, with holding leadership and management positions. The association was significantly stronger for those attributes related to Fearless Dominance. We also found that people in high-risk occupations, such as police officers and firefighters, had much higher scores on all three PPI-R variables. Taken together, these studies support a particular view of what makes for an effective leader. Politicians and executives alike may not all be psychopaths (although some of them, of course, may well be). On the other hand, certain psychopathic traits—including mental toughness, social influence and fearlessness—do appear to be very useful in leadership roles and can help leaders to find considerable success.

These very same traits certainly helped Churchill. On July 3, 1940, early in World War II, he faced a standoff with the French at the port of Mers-el-Kébir in North Africa. In response to the Franco-German armistice of June 22, he dispatched a British task force to demand the surrender of the French battleships stationed there. The task force offered the French admiral three options to prevent the Germans from seizing his vessels: continue fighting the Germans; proceed under escort to a British port for repatriation after the war; or sail to a French safe haven in the West Indies. If he failed to comply, the British navy would scuttle the fleet.

The story does not end well. Churchill's brutal assault cost some 1,300 French sailors their lives. It was ruthless. It was fearless. And boy, was it decisive. It was also a political game changer. The indomitable resolve and unflinching fighting spirit demonstrated that day impressed Franklin D. Roosevelt and proved to be a major influence on the American decision to join forces with the Allies. The next U.S. president will also be poised to redirect world history. To make the right moves in a dangerous world, one can only hope that he or she possesses a similarly effective mix of psychopathic traits. **M**

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Learning

When No One Is Watching

We gain most of our knowledge without any instruction. Cognitive scientists are using virtual reality and other high-tech tools to unravel how we do it

By R. Douglas Fields

I magine you are on your first visit to a foreign city—let's say Istanbul. You find your way to the metro station and stand bewildered before the ticket machine. After puzzling out how to pay your fare, you thread your way through the noisy throng and search for the train that will take you to your hotel. You move tentatively, in fits and starts, with many changes of direction. Yet after a few days of commuting by subway, you breeze through the system effortlessly. Simply by experiencing the new environment, you quickly master its complexities. How was that learning possible? The truth is, neuroscientists do not know.

Learning theory as we know it today still rests largely on the century-old experiments of Ivan Pavlov and his dogs salivating at the sound of a bell. His theory has yielded plenty of knowledge about how we acquire behaviors through the pairing of stimulus and reward (or punishment) and the strengthening of connections between neurons that fire together. It is the kind of training we do with our pets and, to some degree, our children, but it explains little about most human learning. In fact, whether getting to know a stranger, negotiating a new setting or picking up slang, our brain absorbs enormous volumes of information constantly and effortlessly as we go about everyday life, without treats or praise or electric shocks to motivate us.

Until recently, if you asked neuroscientists like me how this process worked, we would shrug our shoulders. But a number of researchers have begun to use technology, including virtual reality, in innovative ways to explore how the human brain operates in complex, real-world environments—a process known as unsupervised learning. What they are finding, as I learned by visiting several pioneering laboratories, is that this type of cognition entails more than building up pathways that link localized neurons. Instead unsupervised learning engages broad swaths of the brain and involves wholesale changes in how neural circuits process information. Moreover, by studying the shifting electrical patterns of brain waves as we learn, researchers can reliably guess what we are thinking about (yes, rudimentary mind reading is possible!), and they can predict our aptitude for learning certain subjects. As these scientists confront the complexity of unsupervised learning, they find themselves grappling with one of the deepest mysteries of being human: how the brain creates the mind.

Onboard a Virtual Ship

The walls and ceiling of the cavernous room are painted black. Twenty-four digital cameras arrayed around the space detect infrared diodes on my body to track my movements, feeding them into a computer as I walk about. I am in a virtual-reality room in the supercomputer center at the University of California, San Diego—probably the closest thing on Earth to the holodeck on *Star Trek*'s USS *Enterprise*. Neuroscientist Howard Poizner uses this facility to study unsupervised learning—in this case, how we learn to master an unfamiliar environment.

The diodes are not the only gizmos I am wearing. On my head is a rubber

cap studded with 70 electrodes that send electrical signals generated by my brain to instruments inside a specialized backpack I am toting. I also wear large goggles equipped with 12 miniature video projectors and high-resolution screens.

The day before my visit here, I toured the U.S. Navy aircraft carrier *Midway* at its anchorage in San Diego Harbor. Little did I know what a happy coincidence that would turn out to be: Poizner and his colleagues had modeled their virtu-

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FAST FACTS
TEACH THYSELF

❶ Unsupervised learning involves no instruction, punishment or reward.

❷ Brain waves coordinate large groups of neurons across the brain and change in characteristic ways during unsupervised learning.

❸ Scientists can predict how rapidly a person will be able to learn by monitoring his or her brain functions at rest.

❹ Researchers are using the secrets of how the brain represents and retains information to read thoughts and transmit them to other people.

al-reality sequences on the carrier's layout. When they turn on the projectors inside my goggles, I am instantly transported back to the ship. What I see is an utterly convincing 120-degree vista of a storeroom inside the aircraft carrier. Looking up, I see triangular steel trusses reinforcing the ceiling that supports the flight deck. Looking down, I see hideous blue government-issued linoleum. High-fidelity speakers all around the lab create a three-dimensional sonic space to complete the illusion.

Verisimilitude is critical, Poizner explains, both for immersion and for helping the brain organize the rich sensory information available to it. "If you are just moving a joystick or hitting a button, you are not activating the brain circuits that construct spatial maps," he says. "Here you are walking out in the environment. You are learning how to move in it, how to interact with it. Your brain is always predicting."

The fact that I can walk through the

peer out onto the hangar deck where fighter jets are stationed in rows. I raise my leg to step over the high threshold leading to the deck. "Don't go out there," Poizner says. "You must stay inside the storage room." I quickly retract my leg. From his perspective, it must look as if I am pantomiming in an empty room.

I see gray bubbles the size of beach balls resting on storage racks inside the room. "You are looking for a green bubble," Poizner says. I search the room. Turning to my left, I see it sitting on the shelf next to the other gray spheres. I reach out and touch the green bubble. It pops! An object hidden inside appears—a red fire extinguisher. I turn, find and probe another green bubble in the opposite corner of the room. I pop it and see that it contains a wrench.

As I explore the novel environment, Poizner can tell from changes in my brain-wave activity that I am forming a mental map of the storeroom space. Neurons communicate by generating

crowd, which is audible in the stadium parking lot while conversations of individual spectators are not.

Building Maps with Brain Waves

The brain's electrical activity takes the form of waves of different frequencies that sweep across the brain. Some brain waves crash in a high-frequency tempest, while others roll by in slow oscillations like ocean swells. Brain waves change dramatically with different cognitive functions [*see box on next page*]. Poizner's experiments have found that low-frequency theta waves—which oscillate at about three to eight hertz—increase in the parietal lobe as the subjects move through the room and build spatial maps. (The parietal lobe is at the top back of the brain, roughly below the part of the head covered by a skullcap.)

Scientists are not sure why brain-wave power at the theta frequency changes during spatial learning. But they do know that theta waves are im-

Studies using electroencephalographic (EEG) recordings of people as they explore a virtual-reality world are showing how the brain learns about an unfamiliar place. In the VR laboratory at the University of California, San Diego, the author (*left*) pops a green sphere containing a hidden object inside a computer-generated storeroom, much like the scene the avatar is exploring (*center*). At the controls, neuroscientist Joseph Snider (*right*) monitors what the author sees as he moves about the room.

virtual environment while my brain waves are being recorded is a breakthrough in itself. Usually people must keep still during electroencephalographic (EEG) recordings to eliminate electrical signals generated by their muscles as they contract, which would obscure the feeble brain waves. Poizner's group devised hardware and software to eliminate this noise as subjects move about freely. "We're putting you *in* the video game," Poizner says.

I wander over to an oval hatch and

brief electrical impulses of about a tenth of a volt in flashes that last a thousandth of a second—a signal so faint that to detect the firing of a single neuron, you would have to open the skull and place a microelectrode into direct contact with the nerve cell. Still, when large groups of neurons fire together, the ensuing fluctuations in the electrical field of the tissue surrounding them are sufficiently strong that electrodes on the scalp can detect them. These EEG recordings are much like the roar of a

THE AUTHOR

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portant in strengthening synapses as we form memories. In fact, in my own research on the cellular mechanisms of memory, I stimulate neurons at the theta frequency to strengthen synapses in slices of rat brain that I keep alive in a dish. Joseph Snider, the research scientist who was operating the computer as I explored the virtual *Midway,* suggests that because of their low frequency, theta waves could be responsible for long-range communication within brain networks, much as lower-frequency AM radio signals propagate farther than high-frequency FM broadcasts.

In that model, the role of brain waves in learning would be to combine large groups of neurons into functional assemblies so that they can fire together and ride the peaks and troughs of electrical waves as they traverse the brain—which is exactly what must happen to form a spatial map of our environment or to encode any complex recollection. Consider all the sensory elements, cognitive processes and emotional sensations that

must converge to give us a vivid memory: the green color of the sphere, the unexpected surprise and sound of the pop, the location in the storeroom, the recognition of the fire extinguisher hidden inside. Each aspect of that experience is coded in circuits in different parts of the brain specialized for sound, color and other sensations. Yet to learn and remember this array as a coherent experience, all these elements must coalesce. From Poizner's eavesdropping on people's brain waves as they encounter the virtual reality environment, we now know that theta waves are crucial to this synthesis and learning.

In addition to their role in the formation of spatial maps, brain waves are key to cognitive function in the wake of a specific stimulus. Such evoked responses are like ripples from a stone cast into a pond, in contrast to the random, ever present movements of the water. Poizner analyzed the brain-wave response at the instant I popped the green bubble and discovered the object hidden inside. He

found that a characteristic ripple in my evoked brain wave erupted 160 milliseconds after I popped the green bubble. "This is amazingly fast," Poizner observes. "It takes 200 milliseconds just to make an eye movement. It is preconscious perception that the brain is detecting something amiss."
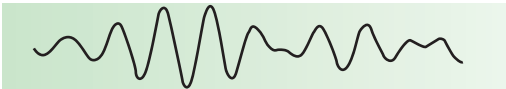
When Poizner brought subjects in his VR study back for a second day, he found that they had clearly memorized the storeroom in detail without any instruction, forewarning or effort. The evoked brain wave revealed this fact in a surprising way. Poizner and his colleagues deliberately misplaced some of the objects that were concealed in the green bubbles. So when a person popped a green bubble that had held a fire extinguisher the previous day but now contained a wrench, the evoked brain-wave response was much larger than when subjects found objects in the same location as before.

Faster than the blink of an eye, our brain knows something has changed

Doing the Wave

Researchers are learning much about how unsupervised learning works by studying brain waves, which are patterns of electrical activity that originate from the simultaneous firing of large populations of neurons in the cerebral cortex. EEGs can record this activity through electrodes on the scalp. These bursts of activity wax and wane at characteristic frequencies, and they change with our cognitive state. The fluctuations in these electrical fields—which create the brain waves—influence the firing of individual neurons and connect large groups of neurons to form cooperative groups.

Wave	Frequency (hertz)	Properties	
Delta	0.2–3	Lowest in frequency and arising in deep, dreamless sleep	
Theta	3–8	Important in strengthening synapses during learning	
Alpha	8–12	Predominant in a relaxed state when the brain is at rest and the eyes are closed	
Beta	12–30	Common when the brain is in an alert state, attentive and concentrating	
Gamma	30–120	Associated with information processing in the cerebral cortex, thinking and learning	

Walking onset
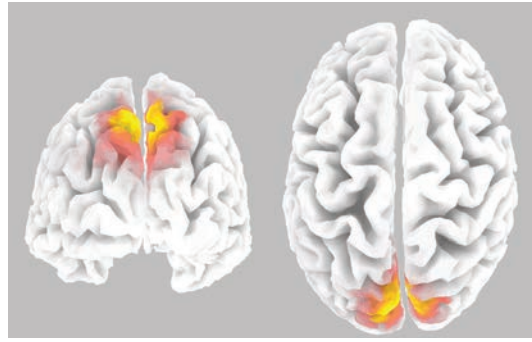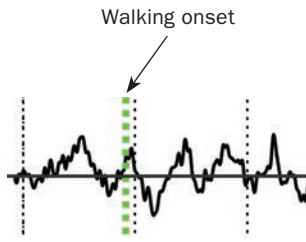
As a subject explores a virtual environment, an EEG shows that changes in his or her theta waves correspond to a specific location (*left*)—the first time scientists have observed the formation of memory-related spatial maps in the human brain in real time. The activity occurs in the parietal lobe (*right*), a region that handles 3-D perception, spatial memory and navigation.

in our environment, and our brain knows it before our mind can comprehend it. The U.S. Navy, which funds Poizner's research, is interested in tapping into these rapid preconscious brain signals. Reading a pilot's brain waves could let a computer take action even before the pilot is consciously aware of the threat. The quickest draw in such a gunfight would not even know he had pulled the trigger.

Poizner's research reveals another ripple in the evoked brain wave about half a second later, the result of the brain cogitating on the anomaly and putting it into context. "We think this represents a second pass [of neural processing]," he says. "The first pass is, *Something is wrong.* The second is, *Oh! Okay, I've now incorporated the new information into my reconstruction of the environment.*" Researchers have reported similar results in very different experiments. When a subject hears an unexpected remark—"I take my coffee with cream and dog," for example—a similar brain-wave response erupts at about the same time.

Finding the Way to Speech

Learning our native language through everyday experience is very much like unsupervised learning of a new space. Despite the complexity of language, we all master our spoken tongue as children, simply by experiencing it. "We know that in utero, fetuses are already starting to learn about the properties of their language," says Chantel S. Prat, an associate professor of psychology at the University of Washington and a leading researcher on changes in the brain during language learning. According to a 2011 study led by psychologist Lillian May, while at the University of British Columbia, newborns can recognize their mother's voice and prefer their native language. Psychologist Barbara Kisilevsky and her colleagues at Queen's University in Ontario found that even fetuses at 33 to 41 weeks of age show startle responses to their mother's voice and to a novel foreign language, which means that these sounds capture their attention amid the surrounding buzz.

We often fail to appreciate the complexities of language because we use it constantly every day in conversation and in our thoughts. But when we try to learn a second language, the challenges become obvious.

Prat and her colleagues have been monitoring brain-wave activity of subjects learning a second language to see how we meet these challenges. Remarkably, they have found that the brain-wave patterns themselves indicate how well the students are doing. As in Poizner's research, the changes Prat observed during this learning were in specific frequencies of brain-wave activity in particular regions of the brain. After eight weeks of foreign-language training, the power of brain waves increased not only in Broca's area, the language region of the brain located in the left hemisphere, but also in the beta waves (with a frequency of 12 to 30 Hz) of the right hemisphere—a surprise because language is not typically associated with that side of the brain. "The bigger the change, the better they learned," she said. It was a surprise that would prove to be significant.

Reading Minds

If thoughts are the essence of being, some scientists are preparing to peer into our souls. That is, they can now tell a great deal about what someone is thinking by observing their brain activity, which has intriguing implications for how unsupervised learning works. Marcel Just and his colleagues at the Center for Cognitive Brain Imaging at Carnegie Mellon University can reliably say

Faster than the blink of an eye and before our mind can grasp it, our brain knows that something has changed.

whether a person is thinking of a chair or a door, or which number from 1 to 7 a person has in mind, or even what emotion the person may be feeling—anger or disgust, fear or happiness, lust or shame—simply by looking at a functional MRI scan. Specific clusters of neurons throughout the brain increase activity with each of these concepts or emotions, and these clusters appear in the same places from one person to the next.

In research to be published this year, Just is demonstrating that he can read minds even when people are learning ab-

stract concepts. As students review material from a college physics course, the researchers are able to identify which of 30 concepts a person is focusing on from fMRIs of the student's brain. What is more, the data show that different abstract scientific concepts map onto brain regions that control what might be considered analogous, though more concrete, functions. Learning or thinking about the way waves propagate, for example, engages the same brain regions activated in dancing—essentially a metaphor for rhythmic patterns. And concepts related to the physics of motion, centripetal force, gravity and torque activate brain regions that respond when people watch objects collide. It seems that abstract concepts are anchored to discrete physical actions controlled by specific circuits in the brain.

These investigators are beginning to unravel the secret of how the human brain represents and retains information. And this insight is helping scientists transmit information from brains to machines. For instance, researchers in many labs around the world are developing prosthetic limbs controlled by a person's thoughts. Computers detect and analyze brain waves associated with limb movements and then activate electric motors in a robotic limb to produce the intended motion.

The next step sounds a little like induced telepathy or Vulcan mind melding. "We've found that you can use brain signals from one person to communicate with another," Prat says. "We can en-

code information into a human brain." In a fascinating study published in 2014, she uses a technique called transcranial magnetic stimulation to modify a subject's brain waves so that they take the shape of the brain waves she had observed in a different person—in effect downloading information from one brain into another.

Prat's motive in this futuristic research is not to figure out how to transmit

the contents of my mind into yours; we already have very effective means for accomplishing that goal. In fact, I am doing so right now as you read these patterns of type and reproduce my thoughts in your brain. Rather they are trying to test their findings about learning and encryption of information in the brain.

"If I stimulate your visual cortex and you see," Prat says, "you are seeing with your brain, not with your eyes." That achievement will prove she has indeed cracked the brain's coding of visual information. And she will have written part of a new chapter in our neuroscience textbooks, alongside the one about Pavlov and his dogs.

Predicting Your Future

In her latest research, Prat has used EEG analysis to an even more exceptional end: to accurately forecast which students will be able to learn a new language rapidly and which ones will struggle. What our brain does at rest tells researchers a great deal about how it is wired and how it operates as a system. Mirroring her discovery of beta-wave activity in the right hemisphere during language learning, Prat found that the higher the power of beta waves in a per-

Just by monitoring brain waves in a resting state, researchers can predict if you are good or bad at learning languages.

son's resting-state EEG in the right temporal and parietal regions, the faster the student will be able to learn a second language. The reasons are not clear, but one possibility is that if most neural circuits in the region were fully engaged in a variety of other tasks, many small groups of neurons would be oscillating at their own slightly different frequencies, so high power at any one frequency suggests a large untapped pool. "They are sort of

Brain Waves and Learning
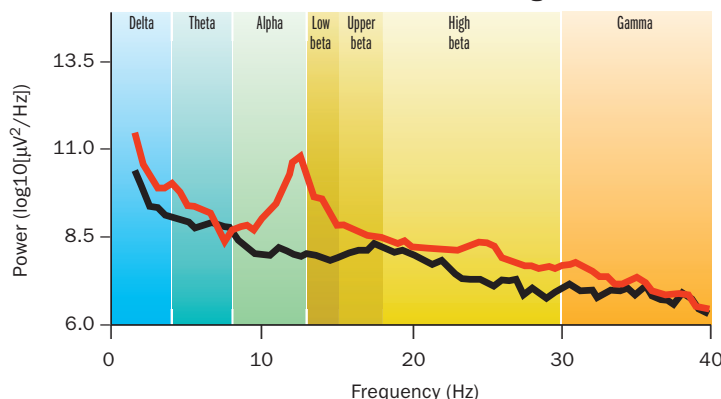
Brain waves recorded while the eyes are closed and mind is adrift reveal our aptitude for specific types of learning. The peak in the alpha band of psychologist Chantel S. Prat (*red*) indicates the relaxed state, which the author (*black*) was unable to achieve. According to her research, Prat's greater power in beta waves suggests she can learn languages more quickly.

waiting to learn a language," Prat theorizes. That propensity is significant because mastering a new language is associated with many cognitive benefits, including improved skill in mathematics and multitasking. But, she warns, our brain cannot be good at everything: "When you get better at one thing, it comes at a cost to something else."

I challenge Prat to measure my brain waves to see if she can predict how quickly I can learn a second language. She eagerly agrees. Prat and her graduate student Brianna Yamasaki apply electrodes to my head, moistening each one with a salt solution to improve conduction of the tiny signals from my brain. As she tests each electrode, it appears on a computer monitor, changing color from red to green when the signal strength is strong. Once they are all green, Prat says, "Close your eyes. It'll be five minutes. Remain still." As she dims the lights and slips out the door, she says, "Just relax. Clear your mind."

I try, but my mind is racing. Can this contraption really tell Prat how easily I could learn a new language while I sit here doing nothing? I recall a similar boast Poizner had made to me in his VR lab—that he could predict how well people would perform in his spatial-learning experiment from an fMRI scan of their brain activity as they sat and let

their mind wander. This so-called resting-state fMRI of the brain's activity while people are doing nothing but letting their mind drift is different from the familiar fMRI studies of the brain's response to a specific stimulus. Indeed, months after taking such readings of a group of people, Poizner brought them for a VR trial and found that those who learned the layout of the virtual storeroom faster had resting-state fMRI recordings that showed tighter functional integration of the brain networks responsible for visuospatial processing.

The five minutes pass. Prat and Yamasaki return. "Did you get good data?" I ask.

"This is a little lower than average," Prat says looking at my feeble beta

waves. She then pulls up a recording of her own brain waves, which shows a sharp peak in the alpha-frequency band. It looks something like a spike in a stock-market chart. My brain instead shows a power shift to higher frequencies, characteristic of information processing in the cerebral cortex. I clearly was not able to zone out and let my mind rest.

"Am I a good second-language learner?" I ask.

"No," Prat says. "Your slope is about 0.5, and the average is about 0.7."

It's true. I took Spanish in high school and German in college, but they didn't really stick. This is creepier than tarot cards. "There must be something good about it," I say.

"Sure … plenty of things."

"Tell me one."

"You are very entrenched in your first language."

I groan. Then she adds, "The relation of beta power to reading is the opposite. You are probably an excellent reader."

A few days after returning to my lab, a new paper by Tomas Folke of the University of Cambridge and his colleagues reports that monolinguals are superior to bilinguals at metacognition, or thinking about thinking, and that they excel at correcting their performance after making errors.

I feel a little better. Thinking about thinking and learning from failed experiments: that is exactly what I do as a neuroscientist. You could have read that in my bio—and in my brain waves, too. **M**

MORE TO EXPLORE

■ **Human Cortical Θ during Free Exploration Encodes Space and Predicts Subsequent Memory.** Joseph Snider et al. in *Journal of Neuroscience,* Vol. 33, No. 38, pages 15,056–15,068; September 18, 2013.

■ **Decoding the Representation of Numerical Values from Brain Activation Patterns.** Saudamini Roy Damarla and Marcel Adam Just in *Human Brain Mapping,* Vol. 34, No. 10, pages 2624–2634; October 2013.

■ **A Direct Brain-to-Brain Interface in Humans.** Rajesh P. N. Rao et al. in *PLOS ONE,* Vol. 9, No. 11, Article No. e111332; November 5, 2014.

■ **A New Mechanism of Nervous System Plasticity: Activity-Dependent Myelination.** R. Douglas Fields in *Nature Reviews Neuroscience,* Vol. 16, pages 756–767; December 2015.

■ **A Bilingual Disadvantage in Metacognitive Processing.** Tomas Folke et al. in *Cognition,* Vol. 150, pages 119–132; May 2016.

From Our Archives

■ **When Two Brains Connect.** Rajesh P. N. Rao and Andrea Stocco; November/December 2014.

GENERATION Z

"I'm going to kill you while you are both asleep," the wild-eyed 13-year-old girl said as she flailed and kicked her father before biting his arm. This was the second time in less than a week that "Heidi" had flown into a violent rage because her parents had taken away her Chromebook and her access to social media. It would also be the second time that she would have to be taken to the psychiatric emergency room.

When her parents, "John" and "Melanie," first called me for help, they described Heidi as a sweet, happy, loving girl whose teachers had always declared their favorite student. With a tendency to gravitate toward overachievers, she loved playing soccer, hiking and taking mountain bike rides with her dad—the man she bit.

John and Melanie, supportive suburban New Jersey parents with college degrees and their own tech business, were blindsided by Heidi's social media addiction. "It all started when she came home in seventh grade with a Chromebook that the school had given her," they told me. Ostensibly given for school purposes, the Chromebook came loaded with Google Classroom—which also, unfortunately, included Google Chat and various Google Chat communities.

Once this educational Trojan horse entered their home, John and Melanie found that Heidi was more and more preoccupied with its
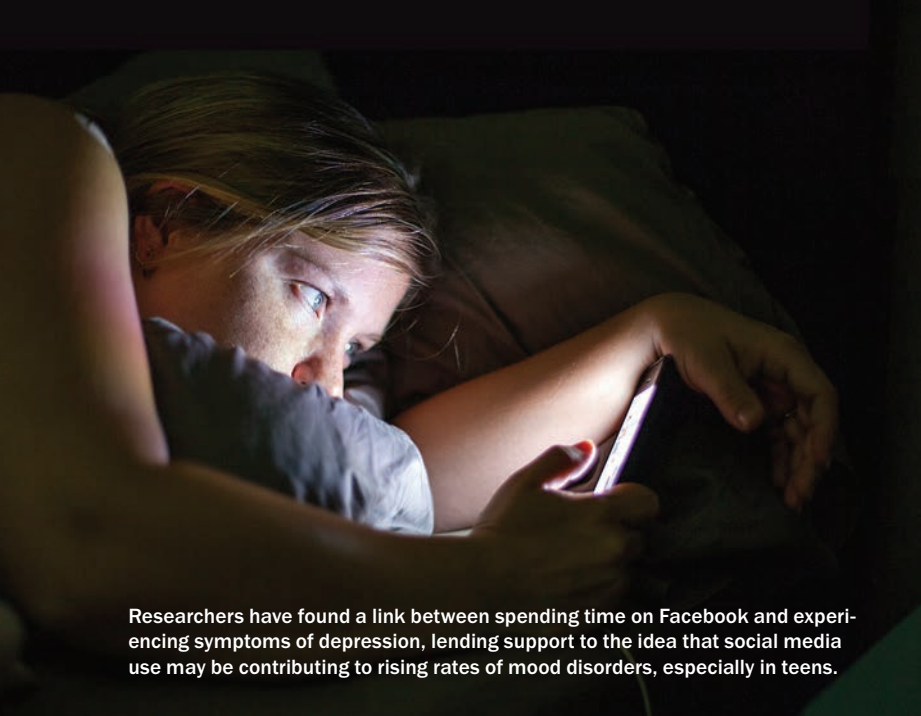
:ONLINE AN

ND **AT RISK?**

Researchers have found a link between spending time on Facebook and experiencing symptoms of depression, lending support to the idea that social media use may be contributing to rising rates of mood disorders, especially in teens.

social media chat rooms, spending hours on them every night. Because the chat rooms were part of the Chromebook platform, they were not able to disable them. Then Heidi started becoming preoccupied with raunchy YouTube videos and also began playing Squarelaxy, an addictive progression game similar to Minecraft, which allowed her to be online with other Squarelaxy players.

Over the course of a year John and Melanie saw their daughter transform from a sweet, innocent girl who loved spending time with her parents into a sexualized, foul-mouthed and violent terror. And sadly, she became a girl in need of psychiatric treatment.

Early adolescence is a time of dramatic change for most kids, and arguably, Heidi may have been headed for trouble with or without her Chromebook. It is also true that many kids use social media responsibly and without issue. But a growing body of evidence shows that social media and immersion in the digital world can be contributing factors in the development of an array of psychological problems—from addiction to depression—and young people may be especially vulnerable.

A Perfect Storm

Social connection is not only the most essential part of being human, it is also a key ingredient in happiness and health. Thanks to social media, we are the most connected society that has ever lived: each second people in the U.S. send more than 7,500 tweets, 1,394 Instagram photographs, and two million e-mails; they also view more than 119,000 YouTube videos. We keep texting as if our lives depended on it: As of 2012, Americans sent about 69,000 texts a second, with more than six billion sent every day. Globally, that number is 23 billion daily texts and 8.3 trillion annually.

Predictably, the younger you are, the more you text. According to a 2011 Pew Research Center poll, cell-phone owners between the ages of 18 and 24 send or receive an average of 109.5 messages on a normal day, whereas all adults (18 and older) exchange a daily average of 41.5 messages, with a median of only 10 texts daily. As for social media, a 2015 report compiled by the marketing agency We Are Social estimated that more than two billion people—over a quarter of the world's population—have active social media accounts.

For a species hardwired for social connection, that should be a wonderful thing. And yet the rise of social media and technology has coincided with an apparent decline in mental health. In 2014 psychologist Jean M. Twenge of San Diego State University analyzed data from nearly seven million teenagers and adults across the U.S. and found that more people reported symptoms of depression in recent years than they did in the 1980s. Teens, in particular, are now 74 percent more likely to have trouble sleeping and twice as likely to see a professional for mental health issues. According to a 2016 fact sheet from the World Health Organization, depression is now the leading cause of disability globally, affecting 350 million people worldwide.

There are certainly many intervening factors that may be driving this global trend, but we do have preliminary research linking depression with social media usage. In 2014 Mai-Ly Steers of the University of Houston and her colleagues surveyed 180 college students and found that the more time these subjects spent on Facebook, the more likely they were to experience mild depressive symptoms. The researchers attributed the link to the psychological phenomenon known as social comparison—and comparing our lives to others can seem particularly harsh online, where people tend to post only the highlights. In a 2014 study, social psychologists Christina Sagioglou and Tobias Greitemeyer, both at the University of Innsbruck in Austria, found another reason why people can feel down after Facebook sessions: they feel that the time spent is not meaningful.

In addition, online socializing may be interfering with our face-to-face encounters. That is troubling because we know that we can get physically and psychologically ill without real human contact. In-

FAST FACTS
A BIG DISCONNECT?

❶ The rise of social media has made us the most connected society to date, but it has also coincided with an apparent decline in our mental health.

❷ Social media use is proving addictive for some people, and this new digital way of connecting may not satisfy our deep-seated need for true human contact.

❸ Teens may be particularly vulnerable to developing hypertexting habits and what is known as Facebook depression.

DIGITAL MEDIA FEEDS OUR INTERSECTING HUMAN NEEDS FOR CONNECTION, REWARD AND NOVELTY—LEAVING US VULNERABLE TO SCREEN ADDICTIONS.

deed, several studies have shown that people can go insane if cut off from human interaction. The reason is that, as social creatures, we find purpose and meaning and bolster our emotional states largely through the social and cultural context created by contact with others. Not getting the right kind of human contact and

A 2012 survey found that only 35 percent of 12- to 17-year-olds said they regularly socialzed face-to-face, compared with 63 percent who said they communicated mostly via text messages.

nurturing support at key developmental periods in childhood can lead to profound emotional and psychological problems.

Social media has an impact on other basic psychological needs—including our need for novelty, called neophilia. As writer Winifred Gallagher points out in *New: Understanding Our Need for Novelty and Change,* our human brain is biologically primed for novelty, which, in turn, has helped us to survive cataclysmic environmental change. Unfortunately, this hardwired thirst can be overwhelming in the information age, in which every hyperlink, tweet, text, e-mail and Instagram photograph can be an opportunity to experience something new. As with an alcoholic in a liquor store or a

chocolate lover at Willy Wonka's, the multitude of opportunities for novelty can be exhaustingly hyperstimulating.

And what about the human need to experience reward? We know that humans like activities that release the neurotransmitter dopamine in the brain—a lot. Evolution has given us incentives via a "dopamine tickle" to pursue certain life-sustaining activities, such as eating and sex, because dopamine made us feel good. But we have discovered that digital stimulation feels pretty good, too, and similarly lights up our dopamine-reward pathways.

So then where does modern digital technology, which plays off these intersecting human needs for connection, reward and novelty, leave us? Short answer: addicted or, at the very least, potentially vulnerable to screen addiction. Many adults and kids have developed compulsive texting and social media habits precisely because such predilections quench our thirst for novelty while tickling our dopamine-reward pathways. And like addicts, they can go into withdrawal without it.

Teenage Hypertexting

In 2010 journalism professor Susan Moeller and her colleagues at the University of Maryland asked 200 students to give up all media, including texting, for 24 hours. Many showed signs of withdrawal, craving and anxiety. "Texting and IM'ing my friends gives me a constant feeling of comfort," one student said. "When I did not have those two luxuries, I felt quite alone and secluded in my life." Another put it in even more direct terms: "I clearly am addicted, and the dependency is sickening." According to a 2015 study of millennial communication

habits by psychologist Kelly Lister-Landman, now at Delaware County Community College, and her colleagues, "text messaging has increased dramatically among adolescents over the past 10 years," and many teenage texters share addictlike symptoms and behaviors. In fact, the researchers indicated that such teens have a lot in common with compulsive gamblers, including lost sleep because of the activity, problems cutting back and a tendency to lie to cover up the amount of time they spend doing it.

The study clarified that the frequency of texting does not by itself equate to compulsion. The key is its effect on a person and his or her life. As Lister-Landman explained in a press release: "Compulsive texting ... involves trying and failing to cut back on texting, becoming defensive when challenged about the behavior, and feeling frustrated when one can't do it." Based on those criteria, although boys texted with the same frequency as girls, the study determined that girls were four times more likely to have texting-related problems.

Perhaps even more shocking, a 2012 Pew survey by researcher Amanda Lenhart—which involved a nationally representative sample of 799 12- to 17-year-olds—found that only 35 percent said they regularly socialized face-to-face anymore, compared with a whopping 63 percent of teens who said they communicated mostly via text messages and averaged 167 texts a day.

Beyond addictive tendencies and an erosion of face-to-face socialization, Lister-Landman and her colleagues also found a link between compulsive texting

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THE AUTHOR

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Girls may struggle more than boys to limit their use of text messaging. Studies have found an association between compulsive texting habits and poor academic behavior.

and poor academic behavior. And a 2010 research study at the Case Western Reserve University School of Medicine that looked at the texting habits of 4,257 high school students revealed that 20 percent of those teens engaged in hypertexting, or sending more than 120 daily texts; these hypertexters were twice as likely to have tried alcohol, 41 percent more likely to have used illegal drugs, nearly three and a half times more likely to have had sex, and 90 percent more likely to have had four or more sex partners.

What are we to make of all of these statistics that link more texting with more behavioral problems? I would look at these data a couple of different ways. First of all, if a person is a compulsive or addicted texter, it indicates to me that he or she has an impulse-control problem. People who have a harder time controlling their impulses also naturally tend to be more impulsive in other areas of their lives: trying drugs, drinking excessively, having sex. But here we also have the age-old chicken-or-egg question: Are people who are impulsive to start with gravitating toward digital excess, or is the digital excess creating or reinforcing the impulsivity? Possibly both.

We can also view problematic behavior linked to excessive social media usage through another lens. According to social learning theory, we model our behavior after our peers. What if I have hundreds of peers who text and use social media? I then increase the likelihood of getting exposed to certain problematic behavior. For example, if I hang out with five kids, and one of them smokes marijuana and has multiple sex partners, the influence on my own behavior might be minimal. Now, through social media, I am hanging out with several hundred kids—and what if 30 or 40 of them have multiple sex partners? Or are taking Vicodin or Xanax? The impact of that larger—and potentially more troublesome—group on my own behavior is now greater.

The Illusion of Real Connection

Apart from the addictive nature of our new digital way of connecting, it does not seem to satisfy our deep-seated need for true human contact. Instead what it seems to have spawned is the illusion of social connection via a medium that has our dopamine receptors on perpetual high alert as we anticipate, like Pavlovian dogs, the next "ping" that promises to of-

fer us the novelty and pleasure of a text, instant message, tweet, Facebook update or Instagram photograph.

More than two decades ago anthropologist and evolutionary psychologist Robin Dunbar, now at the University of Oxford, proposed the theory that a person can maintain about 150 acquaintances but only five or so close relationships—our brain cannot handle more. The figure of 150, also known as Dunbar's number, was, as he put it, a measurement of the "cognitive limit to the number of individuals with whom any one person can maintain stable relationships." Amazingly, Dunbar discovered that these numbers have remained more or less constant throughout history.

Social media has not really affected this dynamic. When data scientist Bruno Gonçalves and his colleagues, all then at Indiana University Bloomington, looked at whether Twitter had changed the number of relationships that users could maintain, they found that people could still manage to follow between 100 and 200 stable connections. But the Dunbar number represents a continuum, with the most intimate, and perhaps most important, figure being five, or the number of truly close friends whom we see often and call in serious situations.

Researchers have attributed the benefits of these face-to-face relationships to the "shared experience" effect: when you laugh or cry with someone, when you go to a social event or have dinner together, when you experience life together, there is a deepening of the social bond that cannot be replicated by social media. In social media, you can "share" and "like" something with your Facebook friends, or you can watch the same hysterical YouTube clip of a dancing chimp, but it is not the same as if you had done something together.

There may also be a physiological aspect of friendship that Facebook friends can never replace. Over the past several years Dunbar and his colleagues have been looking at the importance of physical contact. He already knew that in primate grooming, touch activates the endorphin system; now we know that the same

is true for humans. In a series of studies, Dunbar and his colleagues showed that light touch triggers an endorphin response that is important for creating a personal bond. According to Dunbar, our skin has a set of neurons, common to all mammals, that respond to light stroking but not to any other kind of touch.

"We think that's what they exist for, to trigger endorphin responses as a consequence of grooming," Dunbar explained in an interview with the *New Yorker.* Just

not have those real-life connections and is already feeling a bit alienated and sad? In those instances, the illusion of connection created by social media may actually do more harm than good.

Consider the phenomenon known as Facebook depression, whereby the more "friends" one has on Facebook, the higher the likelihood of depression. There is also, as mentioned, the double whammy that the more time spent on social media and the more texting a person

more risky behavior, hypernetworking teens were also found to be 69 percent more likely to have tried sex, 60 percent more likely to report four or more sexual partners, 84 percent more likely to have used illegal drugs and 94 percent more likely to have been in a physical fight.

"This should be a wake-up call for parents," warned the study's lead researcher, epidemiologist Scott Frank, in a Case Western press release. They should "not only help their children stay safe by

WHEN YOU LAUGH, CRY AND SHARE EXPERIENCES WITH OTHER PEOPLE, IT DEEPENS THE SOCIAL BOND IN A WAY THAT CANNOT BE REPLICATED WITH "FRIENDS" ON SOCIAL MEDIA.

as dopamine incentivizes eating and procreating, it seems that endorphins released with physical touch encourage human bonding. Facebook friends just cannot replicate that; they cannot pat us on the back, rub our knees or give us hugs.

Dunbar is also concerned about the negative developmental effect that our new digital world will have on children. From past research on social interaction, we know that early childhood experiences are crucial in developing those parts of the brain that are dedicated to social interaction, empathy and other interpersonal skills. If we deprive children of interaction and touch early on because they mostly socially interact via screens, those brain areas may not fully develop.

Facebook Depression
What would such a "glow kid"—raised on mostly digital social interactions—look like as an older person? "This is the big imponderable. We haven't yet seen an entire generation that's grown up with things like Facebook go through adulthood yet," Dunbar said in the same *New Yorker* interview. "It's quite conceivable that we might end up less social in the future, which would be a disaster because we need to be more social—our world has become so large." What then happens to a person—particularly a kid—who does

does, the higher the likelihood of not just depression but tech addiction as well. While it is hard to say which way the causality goes (does depression drive more time on social media or the other way around, or both?), this much is clear: more screen time only further amplifies the isolation and disconnection from healthier activities and meaningful face-to-face social contact.

The previously mentioned Case Western hypertexting study also looked at "hypernetworking"—defined as more than three hours per school day on social networking sites. The 11.5 percent of students who met the criteria were subject to higher rates of depression, substance abuse, poor sleep, stress, poor academic performance and suicide. Perhaps not so shockingly, hypernetworkers were also found to have more permissive parents. Just as the hypertexting kids engaged in

not texting and driving, but by discouraging excessive use of the cell phone or social websites in general."

I think that most reasonable people can understand that texting as a way to communicate and social media as a way to stay connected both have a place in our society. But if you want healthy and happy kids, it is vitally important that they have supportive, caring relationships with flesh-and-blood people. If they must have Facebook accounts or phones with texting capability—although some parents now opt for nontexting "dumb" phones—at least wait until the children are far enough along developmentally that they are less vulnerable to tech addiction, Facebook depression or hypertexting. Even then, the research shows that monitoring your child's digital habits and virtual friends is critical in the new social media and texting landscape. **M**

MORE TO EXPLORE

■ **Hyper-Texting and Hyper-Networking: A New Health Risk Category for Teens?** Scott Frank et al. Presented at the American Public Health Association's 138th Annual Meeting and Exposition, Denver, November 6–10, 2010.

■ **Seeing Everyone Else's Highlight Reels: How Facebook Usage is Linked to Depressive Symptoms.** Mai-Ly N. Steers et al. in *Journal of Social and Clinical Psychology,* Vol. 33, No. 8, pages 701–731; October 2014.

■ **Time Period and Birth Cohort Differences in Depressive Symptoms in the U.S., 1982–2013.** Jean M. Twenge in *Social Indicators Research,* Vol. 121, No. 2, pages 437–454; April 2015.
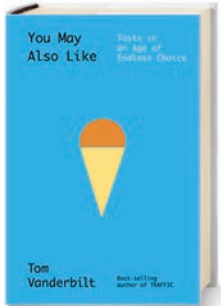
From Our Archives

■ **The Social Power of Touch.** Lydia Denworth; July/August 2015.

You May Also Like: Taste in an Age of Endless Choice

by Tom Vanderbilt. Knopf, 2016 ($26.95; 320 pages)

How does a book whose very title telegraphs "noncommittal" still end up feeling like it doesn't do what it says on the tin? As I loped through writer Vanderbilt's breezy chapters, I struggled to categorize *You May Also Like* among things that I *knew* I liked, in hopes of getting a sense of where the book was taking me. Was it a vivid collection of social science parables à la Malcolm Gladwell's best sellers? A cerebral diagnosis of our technocultural anxieties, as in Nicholas Carr's *The Shallows*? A first-person mystery tour, to be shelved with Mary Roach's *Stiff, Gulp* and *Bonk* in bookstores? The answer: Yes, all of the above. But also, no. Kind of?

Vanderbilt does not seem too concerned to impress any organizing theory on his subject, the vagaries of human preference. "The picture of taste I have presented is hardly reassuring," he writes in the book's conclusion. "We often do not seem to know what we like or why we like what we do." Remember, that's the *end* of his book. While many pop-sci authors unspool their epiphanies with logical, airtight precision, Vanderbilt offers up a kind of book-length "shruggie"—that modern ideogram for affable bemusement: ¯_(ツ)_/¯. You end up rather where you started; *comme ci, comme ça.*

That said, the scenes, hypotheses and musings that Vanderbilt shares are informative in their own free-associative ways. He explains that when we "like" an experience, especially a conspicuously affective one such as a taste or smell, it seems to emerge from cross talk among cognition and emotion, expectation and adaptation. Some preferences, he notes, may be biologically "hardwired": even babies born tragically without a fully developed brain prefer sugary substances to neutral ones. "No one living really dislikes sweetness," as Vanderbilt puts it. But memories and stories can exert a tidal pull on taste, too. Scientists at the Department of Defense's Combat Feeding Directorate, for example, know

that soldiers prefer Green Giant–branded corn to an identical military ration—just because most of them expect rations to taste terrible.

The book roams through other intriguing anecdotes on topics ranging from cat fancier conventions to search engine results. My favorite section came in the final pages, where Vanderbilt provides a "field guide to liking" that synthesizes the "small themes [and] little signposts" in his book. Some of these "tasting notes," as he wryly calls them, may sound pro-

found and vacuous at the same time— "liking is learning," says one; "do not trust the easy like," warns another— but they do deliver a Zen Buddhist–like payload of unity and sense that, after ambling pleasantly but aimlessly along for 300 pages, I took as blessed relief.

That's just a reflection of what I like. Your mileage, as the Internet expression goes, may vary. But I suspect that is Vanderbilt's point: to investigate, accept and ultimately celebrate the unbearable shruggie-ness of being. *—John Pavlus*

The Fate of Gender: Nature, Nurture, and the Human Future

by Frank Browning. Bloomsbury, 2016 ($28; 320 pages)
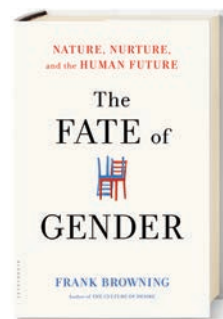
In 2015 Caitlyn Jenner became one of the world's most famous transgender women, gracing the cover of *Vanity Fair* and making the short list for *Time* magazine's "Person of the Year." Jenner's public transition from Bruce to Caitlyn—along with a new focus on gender fluidity in mainstream television programs, such as *Transparent*—has helped build awareness of the trans community. But greater acceptance has not proved universal. Some segments of society have expressed a fear that these recent developments mark the "death of gender"—in which the distinctions between men and women will simply vanish.

In his new book, former NPR reporter Browning buries that idea. He argues that rather than disappearing, gender categories are morphing to fit our biological reality. He relays the science of gender while acquainting readers with the turbulent history of gender politics. Through this exploration, he makes the case that gender has always existed along a spectrum: "We are all of us both male and female, and the way we express our 'masculinity' and 'femininity' depends on the circumstances in which we find ourselves living."

He further dismantles the idea that gender ambiguity is unnatural, noting that transsexual and homosexual plants and animals abound. The California sheephead fish, for example, begins life as an egg-bearing female and may transition to a male. Among humans, about one in every 2,000 babies is born with ambiguous genitals, such as undescended testes or an enlarged clitoris that could be considered a micro penis. In the past, physicians routinely chose one sex for these "intersex" individuals and performed gender-assignment surgeries. But pediatricians are increasingly opposing such interventions as growing evidence suggests they can cause psychological trauma and gender confusion.

Regardless of their genitalia, children experience gender stereotypes from the minute society labels them a boy or girl. These influences, along with hormonal ones—such as levels of estrogen and testosterone—affect brain development, shaping male and female differences in physiology and behavior that continue to unfold as we age. Gender, Browning explains, emerges through the dynamic interaction between our biology and environment. Kids start to form their gender identities early, and many transgender individuals report gender dysphoria, or unease with their apparent sexual identity, well before puberty.

Browning introduces us to people who routinely challenge gender norms. He interviews transgender individuals who have struggled for acceptance in conservative Mormon-dense communities; women who act as surrogates for gay couples; sociologists who are working to break the taboo of female masturbation in China. He also describes educators who have discovered that in gender-neutral classrooms, where children take on both male and female roles, gender stereotypes largely disappear.

The Fate of Gender is a fascinating read. One quibble is that Browning overlooks some recent research on transgender brains. But overall the book will make readers think hard about how, as a society, we have shaped gender identity and are reshaping what it means to be male and female, either and both. *—Diana Kwon*

Unbroken Brain: A Revolutionary New Way of Understanding Addiction

by Maia Szalavitz. St. Martin's Press, 2016 ($27.99; 352 pages)
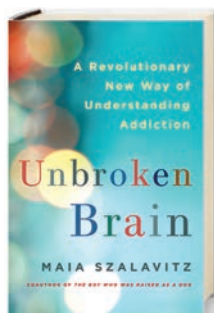
Forget everything you think you know about drug addiction. In this book, award-winning journalist Szalavitz dispels a range of common myths about drug abuse and presents an altogether fresh take: addiction, she maintains, is not a moral failing or even a medical disease, as it is so often portrayed. Instead, she writes, "addiction is a developmental disorder—a problem involving timing and learning, more similar to autism, attention deficit hyperactivity disorder (ADHD), and dyslexia than it is to mumps or cancer." Although we cannot discount the role our genes play, she suggests that addiction can be largely credited to life experiences—significant traumas or daily stresses that alter the brain and cause us to prioritize substances offering temporary relief.

Szalavitz makes a forceful case for addiction as a learned behavior, weaving together research from genetics, psychology and biology, along with insights into our less than laudable history of deficient, often racist, drug policies and inadequate treatment protocols. The book really sings, however, when Szalavitz delves into her own history of drug abuse.

Bullied throughout childhood, Szalavitz always felt like an outsider. In high school, she used hallucinogens in an attempt to connect with others and by college had found a new way to fit in. She began selling cocaine to her peers and soon became hooked herself. She finally felt wanted, popular even. After being suspended from school, she began supplementing her coke habit with heroin, and her life quickly spiraled out of control. At age 23, facing 15 years in prison for selling drugs, Szalavitz entered rehab. Fortunately, a sympathetic judge dropped the case against her, and she got her life back on track.

Inspired by this tumultuous period, Szalavitz dedicated herself to understanding it—what triggered her own abuse and what helped her recover. From her research, she concludes that the idea of a general "addictive personality" is a myth and that addiction is essentially a kind of coping mechanism gone awry. She asserts that her struggle with depression and social anxiety are what left her more vulnerable to pursue chemical outlets that offered at least some measure of relief.

This perspective has broad ramifications. If we understand addiction as a learned behavior, then many existing rehabilitation programs seem somewhat counterproductive. Alcoholics Anonymous, one of the largest treatment providers for addiction, frames the disorder as a kind of character defect—one that can be fixed and forgiven through willpower and spirituality, not science. Even more dangerous may be the common idea that an addict must hit "rock bottom" before recovery is possible: it encourages helplessness and dissuades addicts from taking agency over their lives, Szalavitz argues. As she puts it: drugs impair self-control, but they do not eliminate free will.

Szalavitz offers several alternative policy solutions and intervention strategies. She acknowledges the progress made by reducing brutal mandatory sentencing and zero-tolerance interpretations of the law but believes we have further to go by increasing research funding and expanding treatment programs. Ultimately, she hopes that a true portrait of addiction will help more people, like her, leave it behind them.   —Roni Jacobson

Read an excerpt of this book online at ScientificAmerican.com/ unbroken-brain-excerpt

Searching for compelling reads about the brain and how it works? Two recent titles might pique your interest

"Imagine a society where smartphones are miniaturized and hooked directly into a person's brain," writes philosophy professor Michael P. Lynch in his new book **The Internet of Us: Knowing More and Understanding Less in the Age of Big Data** (Liveright, 2016; 256 pages). With one thought, we could retrieve information on anything. We would not need to remember facts or figures, as we tapped into "the collective wisdom of the ages." Now imagine that our electrical grid goes dark, and we lose this wealth of information in an instant. This scenario may sound like science fiction, but Lynch asserts that it is actually not so far from our current reality. **The Internet of Us** explores how information technology has come to dominate our abilities to think, communicate, reason and remember and provides a slightly chilling look at what that means for us as independent thinkers and human beings.

Why is the human brain special? Compared with our fellow mammals, we do not have the largest brain. Yet our unique noggins pull off what are arguably the most impressive cognitive feats. In **The Human Advantage: A New Understanding of How Our Brain Became Remarkable** (MIT Press, 2016; 272 pages), neuroscientist Suzana Herculano-Houzel unravels what really sets the human brain apart from that of other primates, tracing our evolutionary history and describing her efforts to tally our individual neurons. Her conclusion is deliciously surprising: the pivotal development was learning to control fire and cook, thereby enabling our species to get more energy from food in less time. "We cook what we eat: this is the exclusively human activity," Herculano-Houzel writes, "one that allowed us to jump over the energetic wall that still curbs the evolution of all other species and put us on a different evolutionary path from all other animals."   —Victoria Stern

Q

How does exercise benefit cognition?
—via e-mail

David R. Jacobs, a professor in the division of epidemiology and community health at the School of Public Health at the University of Minnesota, and **Na Zhu,** a researcher in the same department, reply:

We all know that exercise improves our physical fitness, but staying in shape can also boost our brainpower. We are not entirely sure how, but evidence points to several explanations. First, to maintain normal cognitive function, the brain requires a constant supply of oxygen and other chemicals, delivered via its abundant blood vessels. Physical exercise—and even just simple activities such as washing dishes or vacuuming—helps to circulate nutrient-rich blood efficiently throughout the body and keeps the blood vessels healthy. Exercise increases the creation of mitochondria—the cellular structures that generate and maintain our energy—both in our muscles and in our brain, which may explain the mental edge we often experience after a workout. Studies also show that getting the heart rate up enhances neurogenesis—the ability to grow new brain cells—in adults.

Regardless of the mechanism, mounting evidence is revealing a robust relation between physical fitness and cognitive function. In our 2014 study, published in *Neurology,* we found that physical activity has an extensive,

long-lasting influence on cognitive performance. We followed 2,747 healthy people between the ages of 18 and 30 for 25 years. In 1985 we evaluated their physical fitness using a treadmill test: the participants walked up an incline that became increasingly steep every two minutes. On average, they walked for about 10 minutes, reaching 3.4 miles per hour at an 18 percent incline (a fairly steep hill). Low performers lasted for only seven minutes and high performers

for about 13 minutes. A second treadmill test in 2005 revealed that our participants' fitness levels had declined with age, as would be expected, but those who were in better shape in 1985 were also more likely to be fit 20 years later.

Ultimately, though, we wanted to know how physical fitness might affect mental acuity in middle age. Thus, five years later, in 2010, we subjected our participants to a battery of cognitive tests, assessing memory, processing speed and executive function—measures of our abilities to learn, reason and problem solve. We found that the people who were more physically fit in 1985 performed about 10 percent better on the tests compared with their less fit counterparts, a modest but important difference. The message is clear: for generally healthy people, exercising regularly can enhance brain function over a lifetime—not just after a workout.

Are some kids more likely to become narcissists?
—via e-mail

Aaron L. Pincus, a professor of psychology at Pennsylvania State University, answers:

Some individuals are indeed more susceptible to developing a narcissistic personality. Narcissism is characterized by self-centeredness ("It's all about me!"), grandiosity ("I'm better than you!") and vanity ("Look at me!"). It involves multifaceted psychological traits, motives and needs that influence how a person thinks, feels and behaves. Given this complexity, developing this form of extreme self-love is not as simple as inheriting a particular gene or experiencing a specific event. Instead becoming a narcissist likely involves an intricate mix of genetic and psychological or environmental factors.

Currently we know more about the psychological side of the equation. So far researchers have identified two major trajectories that can lead to narcissistic tendencies. The first scenario involves children who receive unconditional positive feedback from a family member, teacher or coach, despite not displaying the attributes deserving of such praise. Social-learning theory, when applied to the development of narcissism, suggests that a person who receives constant admiration, regardless of his or her actual ability, will come to expect such feedback from everyone. Such a child may fail to acquire a realistic self-concept, one that acknowledges both their flaws and their virtues.

The second trajectory involves the opposite scenario. Children who grow up in families that are cold and depriving may also develop narcissistic personalities. Re-

Are tablet devices a good teaching tool?
—**Galina Ivanova** Spain

Daniel T. Willingham, a professor of psychology at the University of Virginia and author of *Raising Kids Who Read: What Parents and Teachers Can Do,* responds:

As you might guess, scientists do not have a complete answer to this question, and the partial answer is complicated. The advantages offered by tablets or, more generally, electronic textbooks seem legion: they are portable; publishers can easily update the content; students can get immediate feedback; and the text can be supplemented

ceiving inadequate validation and support can be painful and frustrating. To cope with this dejection, children may protect themselves by repressing negative feelings and replacing them with a distorted, grandiose self-concept. Similar to the first trajectory, the children's self-concept can then become unrealistically inflated and inconsistent with their true skills and accomplishments. To support this view, they may also come to expect constant admiration from others.

These patterns can be hard to change. Narcissists frequently make good first impressions, but they struggle to maintain long-term relationships—both personal and professional. And although researchers have begun to develop psychotherapy-based interventions to curb narcissistic traits, narcissists often will not acknowledge that they need them.

with videos and audio—imagine not just reading about the Battle of Britain but seeing a newsreel as well.

Unfortunately, there are downsides, too. Sometimes this technology fails, leaving teachers to scramble for a backup plan. Some students do not have access to tablets outside of school. Disadvantaged students may not have Internet connectivity at home. And most problematic, studies show that kids typically understand less and take longer when they are reading from electronic textbooks as compared with printed materials.

This difference in comprehension and reading time is not huge, but it is pretty consistent, which probably explains why most students say they dislike electronic textbooks. Even students experienced in using digital technologies prefer paper.

What is going on? For starters, the cool features of electronic textbooks—if they are not carefully implemented—do not guarantee a better grasp of the material. For instance, an educational video that distracts from, rather than complements, the text will actually hurt comprehension.

Also, the look and feel of an e-book matter. Despite ongoing advances in technology, users still experience more eye fatigue when they read from a screen. We also know that readers tend to understand better when they flip virtual pages; comprehension declines if they scroll, perhaps because flowing text can disrupt visual attention, and they more often lose their place.

Companies are working to make electronic pages look more like paper, although they are still figuring out which design features are critical to improving a user's experience.

Theoretically, if the main problem is design-based, it should affect our grasp of anything we

peruse on a screen. Research suggests, however, that the impact of e-readers on comprehension is smaller when we read for pleasure. It is easy to see why it may be less perceptible for recreational reading. Most people read light fiction and nonfiction for enjoyment, so a small hit to our understanding is no big deal (even though you would likely follow the latest John Grisham thriller better on paper). Textbooks, however, serve up more challenging material, on

> " Studies show that kids typically understand less and take longer when they are reading from electronic textbooks, which probably explains why most students dislike them. "

which students know they will be tested. As a result, they are careful to observe how well they grasp what they are reading.
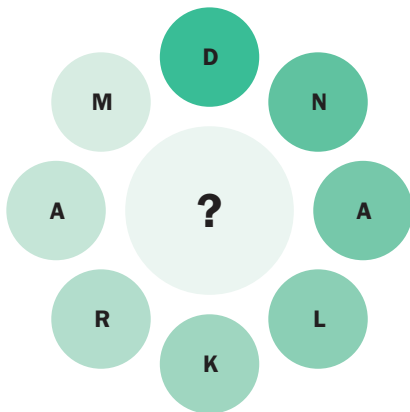
Software and hardware companies are trying to overcome these learning issues, but for the time being, the word on e-readers at school should be: "Proceed with caution." **M**

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

Send it to MindEditors@sciam.com

1 WORD WHEEL

Can you spot the eight-letter word wrapped around the question mark?

2 CALENDAR CONUNDRUM

If today is Monday, what is the day after the day before the day before tomorrow?

3 ALPHABET ARITHMETIC

Substitute a different number for each letter so that the math works. (Hint: Each letter equals the same number each time.)

$$\begin{array}{r} A\,B\,C\,D\,E\,F\,G\,H\,I \\ \times\ I \\ \hline +\ A\,J \\ \hline A\,A\,A\,A\,A\,A\,A\,A\,A\,A \end{array}$$

4 DE-CEEIPR THIS

Which words can you make using each of the letters C, E, E, I, P and R exactly once?
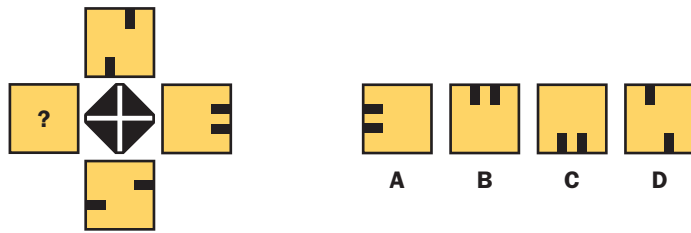
5 MAGIC SQUARE

Fill in this square using the following letters: B, E, E, L, L, M, R, R and U. When placed in the correct cells, they spell out common words in the rows and columns.

C	A	S	T
A	?	?	?
S	?	?	?
T	?	?	?

6 BUILDING BLOCKS

Which of the four blocks, A through D, replaces the one with the question mark?

7 WEATHER WATCH

What weather alert is an anagram of, and possibly described by, the phrase "Radar Noting Now"?

8 NAME THAT PREFIX

What three-letter word can sit in front of each of the following words to make four new words?

_ _ _ **BLED**   _ _ _ **ROW**

_ _ _ **GIN**   _ _ _ **TIN**

9 ORDERS OF MAGNITUDE

Which is greater? The number of seconds in 100 hours or of inches in 100 yards?

10 BOARD GAME

Chad and Hunter need to make five wood boxes fast. Chad must chop for one minute to make one board. Hunter needs one minute to assemble five boards into one box. How long does it take them to make the five boxes?

Answers

1. LANDMARK.
2. Monday.
3. A = 1, B = 2, and so on, and J = 0. Then the puzzle works out to (123456789 × 9) + 10 = 1111111111.
4. RECIPE, PIERCE and PIECER.
5. CAST, ABLE, SLUR, TERM.
6. B. The yellow spaces within the squares form the initials of compass points.
7. TORNADO WARNING.
8. MAR (MARBLED, MARROW, MARGIN, MARTIN).
9. Seconds in 100 hours (360,000 seconds versus 3,600 inches).
10. 26 minutes. Hunter can assemble all but the last box while Chad is chopping the next board.

BY DWAYNE GODWIN AND JORGE CHAM

WHAT YOU SEE IS WHAT YOU GET?

How the brain splits up what your eyes capture

2 UP TO 50% OF OUR OPTIC NERVE FIBERS ARE DEDICATED TO THE CENTRAL PART OF OUR RETINA, WHERE WE HAVE MORE PHOTORECEPTORS AND OUR VISION IS SHARPEST.

3 EACH RETINA DIVIDES THE VISUAL WORLD IN TWO (LEFT AND RIGHT FIELDS) AND SENDS EACH HALF TO THE OPPOSITE SIDE OF THE BRAIN.

4 SIGNALS FROM THE OPTIC NERVE ARE SORTED AND THEN RELAYED BY THE THALAMUS TO THE PRIMARY VISUAL AREAS.

5 THE FIRST CORTICAL AREAS DECODE BASIC FEATURES SUCH AS CONTOURS AND LINES AND THEN DISTRIBUTE THAT INFORMATION.

1 THE LENS IN OUR EYE FLIPS OBJECTS UPSIDE DOWN AND LEFT TO RIGHT AND PROJECTS THEM ONTO THE RETINA.

Where?

6 THE PARIETAL CORTEX TAKES THE VISUAL SIGNALS AND DECODES WHERE OBJECTS ARE IN 3-DIMENSIONAL SPACE.

What?

7 VISUAL INFORMATION ALSO GOES TO THE INFEROTEMPORAL CORTEX, WHICH IS WIRED TO RESPOND TO OBJECTS AND FACES, HELPING US RECOGNIZE WHAT WE ARE LOOKING AT.

LIGHT IS CONVERTED INTO ELECTRICAL SIGNALS BY PHOTO-RECEPTORS IN THE BACK OF OUR RETINA.

PROTEINS INSIDE THESE CELLS, SUCH AS RHODOPSIN, UNFOLD WHEN LIGHT OF CERTAIN WAVE-LENGTHS HITS THEM.

PHOTORECEPTOR

RHODOPSIN ACTIVATION LEADS TO A MOLECULAR CASCADE THAT INTER-RUPTS THE FLOW OF SODIUM AND POTASSIUM IONS IN AND OUT OF THE CELL AND REGULATES THE RELEASE OF NEUROTRANSMITTERS.

PHOTORECEPTORS ARE KNOWN TO ELICIT A RESPONSE EVEN TO A SINGLE PHOTON.

RHODOPSIN MOLECULE

PHOTON

MOM CHAIR CAR BOB

"A" DOG GLASS ...

THE BRAIN PROCESSES ALL OF THIS INFORMATION IN PARALLEL, ALLOWING US TO PERCEIVE THE WORLD AROUND US IN THE BLINK OF AN EYE!

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