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September/October 2013
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She Hears
Voices
(and actually
listens)
page 34

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Beyond Self-Esteem

During most of my teenage years, I was plagued by acne—serious acne. Those scarlet interlopers, and my acute awareness of them, crippled my self-esteem. Only later did I wonder why in the midst of all this anxiety, the main thing I still thought about was me. The problem, as it turns out, was an inability to turn my focus outward.

In fact, you should just get *over* yourself, psychologists Jennifer Crocker and Jessica J. Carnevale advise in this issue's cover story, "Letting Go of Self-Esteem," starting on page 26. Focusing on the well-being of others may ultimately offer the greater reward, both inside and outside your head. In Head Lines, our writers elaborate on this concept, too—see pages 8 and 9 for the surprising benefits of generosity.

Other ideas about ourselves have also slid past their prime, notably in education. We explore several fresh approaches in our special report entitled "How We Learn," starting on page 44. For example, I was startled to discover that underlining and re-reading passages are poor methods of internalizing a text. Instead techniques such as self-quizzing have emerged as winners—turn to page 46 for "What Works, What Doesn't," by psychologist John Dunlosky and his colleagues. Similarly, in mathematics, new teaching strategies can help students discover an affinity for numbers. On page 60, mathematician John Mighton shares his experiences.

As we venture through life, the best opportunities for learning often come as a surprise—and not always a welcome one. Consider Eleanor Longden, a doctoral student in psychiatry who weathered a seismic shock to her sense of self: the sudden manifestation of auditory hallucinations. She chronicles her own unraveling and ultimate triumph in "Listening to Voices," on page 34. While learning to make peace with the voices in her head, she embarked on a mission to infuse more compassion into mental health care—another place where an external focus can do the most good.

Knowing that helping others flourish is also the optimal strategy for us individually is a welcome message. As the saying (almost) goes, no mind is an island.

Sandra Upson
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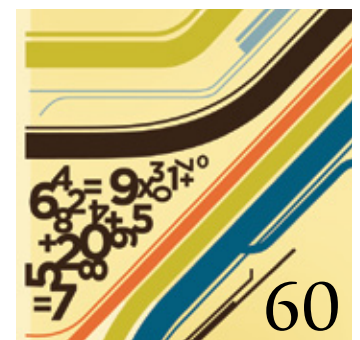
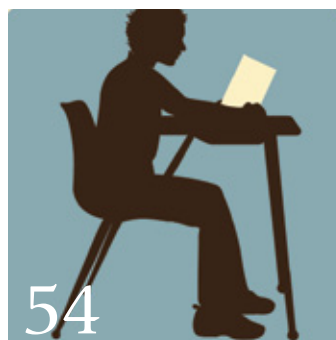
As we jettison the pen and pencil in a digital world, we are changing the way our brain thinks about writing.

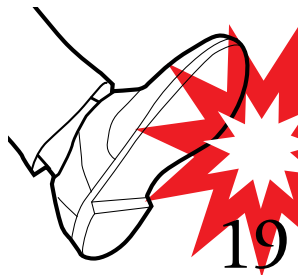
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A SOCIAL MALADY

The article “Why We Cheat,” by Ferric C. Fang and Arturo Casadevall, attempts to link cheating and deception to the natural sciences. In my opinion, this topic of study is much better suited to the social sciences. Fish, mammals and bacteria cannot cheat, although they may employ various creative tactics that resemble “dishonesty” to get what they want, such as food or a mate. These behaviors are only “wrong” once there is a *social* determination that the tactics being used allow for some kind of *undue* advantage.

For people, we allow a wide range of creative deception in our everyday lives (for instance, flattery or lying about one’s age), but those behaviors are seen quite differently once they break an agreed-on moral/legal ethic, such as when an accountant engages in insider trading or a student cheats on a test.

By equating the natural aspects of our behavior with their social outcomes, the article conflates what is ultimately a social and moral choice with a natural trait. Only at the end of the article is the point correctly made by describing the social reasons why people choose to act dishonestly: anxiety over loss, copycat behavior, hypermotivation, and so on.

Severin Wirz
 Annapolis, Md.

EASING EXISTENTIAL TERROR

I don’t doubt that listening to Brahms is a nice trip, as Erica Rex described in “Calming a Turbulent Mind,” but I am betting that listening to Jimi Hendrix is even better. More seriously, I have long believed in giving the option of psychotropic drugs to terminal patients to alleviate the sheer terror of dying that many experience.

To do less, in my opinion, is simply cruelty. Those people who believe, for religious or other reasons, that such suffering has moral worth, are free to do without when their time of dying comes. But I am betting that, given the choice, most won’t.

“Mr. Mxyzptlk III”
 commenting at
 Mind.ScientificAmerican.com

AN APPEALING TIME

I’ll be honest. I don’t always make time to read magazines, and it was pure impulse when I purchased the May/June issue of *Scientific American Mind* to accompany my two-hour train ride from Connecticut to New York City. Yet many of the topics in this issue appealed to me as a failed premed major—in particular, “Perfectly Timed Advertising” [Illusions], by Stephen L. Macknik, Leandro Luigi di Stasi and Susana Martinez-Conde. As a museum curator, I spend a lot of time looking and inviting other people to look at works of art. I read this article and appreciated the discussion of the aesthetics of watch imagery. After the reference to the Marc Chagall painting, I vowed to look more closely at clocks and watches in art.

The next day I made a brief visit to the Metropolitan Museum of Art before a meeting. In one of the galleries of modern American art, far removed from the crowds flocking to the major exhibitions, was Florine Stettinheimer’s *The Cathedrals of Broadway*, 1929. It was a beautiful coincidence that in this painting, the clock reads 10:10. Perhaps the time is a “real” reference to when Broadway performances let out, or perhaps it looks pleasing to the eye, which it does.

Thank you for this intriguing and in-

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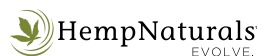


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formative article, which I hope will foster an appreciation for these relics of the predigital era.

Erin Monroe
Wadsworth Atheneum
Hartford, Conn.

Many years ago I had heard that hands on display clocks were set at 8:20, not because they didn't want to hide the company name, usually on the bottom of the face, but to frame and point at the name. Hands in the horizontal position would not do this. (And why not reverse it to 3:40? Probably convention.)

Jack Thompson
East Lansing, Mich.

FIELDS REPLIES (in an online comment): *The brain is complex, but we want to get it right. You just can't leave out half the parts and expect to get an understanding that goes beyond one's preconceptions. I understand that the Europeans have added glia to their brain-mapping initiative.*

SLEEP-DEPRIVATION THERAPY?

In "A Fast-Acting Antidepressant" [Head Lines], David Levine explains why sleep deprivation can temporarily ease the symptoms of major depression. Given that sleep deprivation can trip a bipolar person into mania (and when someone is in a manic cycle, they do not

someone has finally studied the effect of guided imagery and demonstrated its therapeutic benefits after surgery, as Tori Rodriguez detailed in "Healing the Body with the Mind" [Head Lines].

We need to continue to learn from experience and not let our beliefs stop us from exploiting the power of the mind and its hypnotic effect on the body. At times I have called this effect "deceiving people into health," because people's beliefs manifest in the body and the beliefs can be positive or negative as related to treatment.

Bernie Siegel
Woodbridge, Conn.

HAPPINESS BRINGS AGE

Older people become more content, according to "Age Brings Happiness" [Head Lines], by Karen Schrock Simring. I will be celebrating my 60th high school reunion this year. I've noticed that in my age cohort the really unpleasant people have died off faster. I suspect that folks with paranoid or narcissistic tendencies tend to get mad a lot, thus giving themselves lots of stress and shortening their lives. In addition, people who do not acquire tools for acceptance of their self and of adversity also experience more life-shortening stress. These factors might contribute toward a correlation between happiness and age in the population.

At the individual level, a long life provides opportunities to develop the tools for mitigating the damaging emotional effects of adversity. Even an atheist like me can relate to the serenity prayer, which I have secularized: "Let us strive for the serenity to accept the things we cannot change; the courage to change the things we can; and the wisdom to know the difference."

The longer you work at internalizing this aphorism, the more you will be able

to reduce stress and improve the possibility of enjoying a long life.

"Pazuzu"
commenting at
Mind.ScientificAmerican.com



Could psychotropic drugs make the prospect of dying less terrifying?

EMBRACE THE COMPLEXITY

I agree with R. Douglas Fields's comments in "A Push to Map All the Brain's Neurons" [Head Lines], by Karen Schrock Simring, about glial mapping being an indispensable part of the government's brain-mapping initiative, but we have to start somewhere. Adding glia into the mix at this early stage would increase the complexity exponentially and most likely kill the project before it even gets off the ground.

"NeuroJoe"
commenting at
Mind.ScientificAmerican.com

sleep), I hope researchers will also look into how regulating adenosine might be used to short-circuit manic swings.

"Suzanne2000"
commenting at
Mind.ScientificAmerican.com

MIND OVER MATTER

After 30 years of using drawings and imagery to help patients have a therapeutic and healing response to surgery, chemotherapy and radiation, I was very pleased to see that

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Head Lines

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NEWS FROM OUR WEB SITE A tendency to pursue numerous richly stimulating activities strongly predicts creativity.

» Social Medicine How interacting with the people around us makes us healthier,

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Kind Hearts Are Healthier

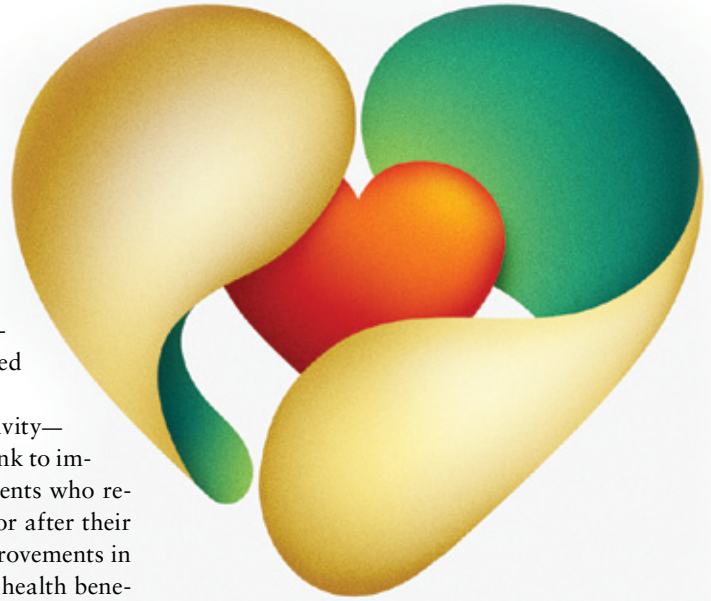
Volunteering improves cardiovascular health

Doing good for others warms the heart—and may protect the heart, too. Psychologists at the University of British Columbia asked 106 high school students to take part in a volunteering study. Half of the students spent an hour every week for 10 weeks helping elementary students with homework, sports or club activities. The other half of the students did not participate in volunteer work.

Using questionnaires and a medical examination both before and after the 10-week period, the researchers found that students who volunteered had lower levels of cholesterol and inflammation after the study. Those who did not volunteer showed no such improvements.

The health benefits did not correlate to a specific volunteer activity—such as sedentary homework help versus athletics—nor did they link to improvements in self-esteem. But the researchers did find that students who reported the greatest increases in empathetic and altruistic behavior after their volunteering experience also exhibited the most pronounced improvements in heart health. Although more research is needed to untangle how health benefits and altruistic behavior are intertwined, psychologist and study author Hannah Schreier hypothesizes that their findings may reflect a “spillover” effect. “Keeping others motivated could improve your own motivation for healthy behaviors,” Schreier says.

—Daisy Yuhas



Even Small Talk Helps

Social isolation, not loneliness, is linked with earlier death

Loneliness is bad for our health, according to a robust body of research. And isolation is known to shorten lives—but experts were not sure if the real culprit was the pain and stress of loneliness, as opposed to a lack of social connectedness. Now psychologists have untangled the two factors and discovered that even superficial contact with other people may improve our health.

Led by Andrew Steptoe of University College London, the study surveyed 6,500 people aged 52 or older about their social contacts and experiences of loneliness. After seven years, the researchers followed up to see who had died. Initially, people rated as highly lonely seemed to die at a higher rate than those with low or average scores. Yet this difference disappeared when taking into account a person’s health. Greater social isolation, however, came with an increased incidence of death: 21.9 percent of people ranked

as highly isolated died compared with 12.3 percent of less isolated people. After taking into account health and other demographic factors, this difference amounted to a 1.26-fold increase in mortality associated with high social isolation.

The findings, published online on March 25 in the *Proceedings of the National Academy of Sciences USA*, suggest that even brief social contact that does not involve a close emotional bond—such as small talk with a neighbor or a bus driver—could extend a person’s life. Although the results hint that city living or group homes may be beneficial, Steptoe says they do not negate the downside of loneliness. “There’s ample evidence that loneliness relates to well-being and other health outcomes besides death,” he says. “But our study suggests a broader view of beneficial social relationships. They’re not simply to do with close emotional relationships.”

—Michele Solis

Nice at Every Age



IN CHILDHOOD
Behaving kindly—cooperating, sharing and consoling others—may predict academic success years later, in adolescence.

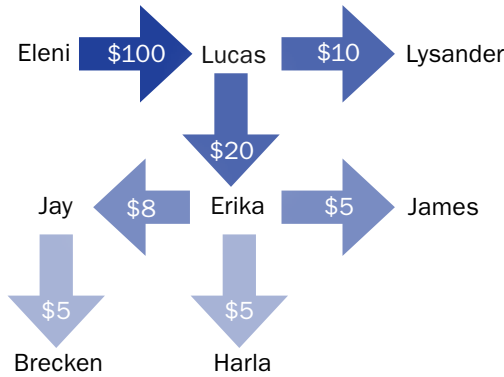
AS A PRETEEN
Performing acts of kindness may boost happiness and popularity—and reduce the chances of being bullied.

IN ADULTHOOD
Spending money on others is linked to greater increases in a person’s happiness than spending on oneself.

THINKSTOCK (people)

M Your “roaming entropy,” or the frequency and variety with which you get out and about, likely affects your brain health.

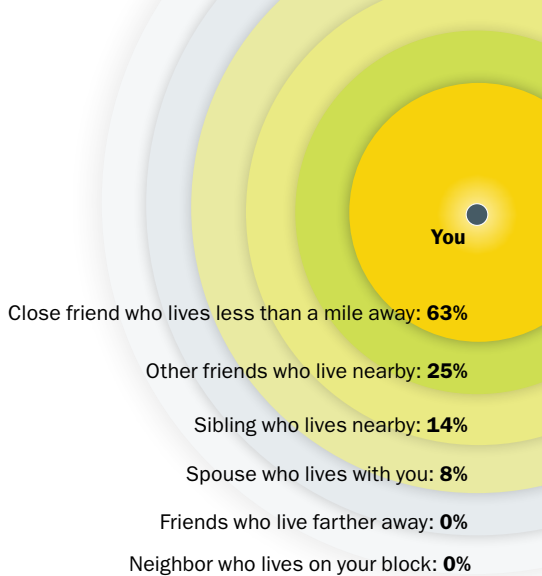
Contagious Altruism



Altruism inspires more altruism, according to many studies. In one experiment, an initial act of kindness prompted others to donate, but in progressively smaller amounts. Yet the total quantity donated was triple the initial gift (only a small portion of the experiment, which involved 24 people, is illustrated here). This cascade, identified by James Fowler, professor of medical genetics and political science at the University of California, San Diego, and Nicholas Christakis, director of the Human Nature Lab at Harvard University, represents one way to map contagious altruism.

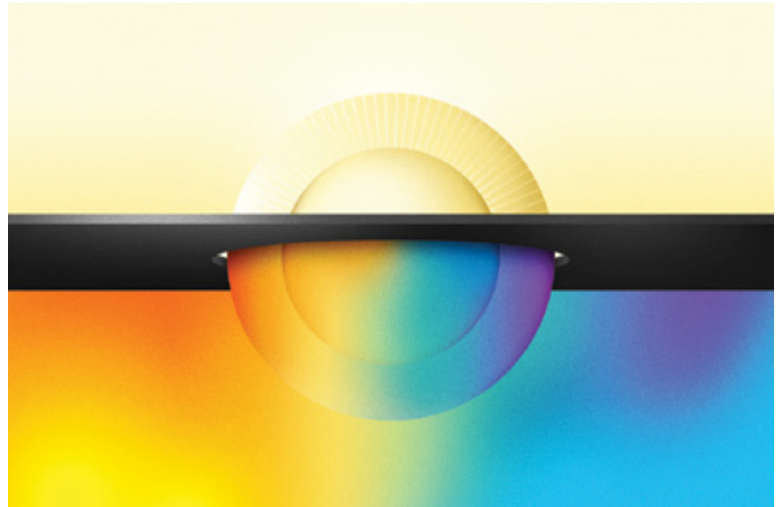
You Make Me Happy

Imagine yourself at the center of this circle. The people whose rings are closer to yours have a greater chance of boosting your mood if they are happy. The percentages indicate the chance their happiness will rub off on you, as indicated by a study of adults in Framingham, Mass.



Generosity Is Its Own Reward

People around the world are happier the more they donate to charity



Most of us have felt the satisfaction that comes from spending money on another person, whether it be a gift for a friend or a donation to disaster victims. Now an international team of psychologists report that the relation between generous spending and happiness holds around the world, even in countries as impoverished as India and Uganda. “Here in North America we might think we have the luxury of extra money to spend on others, whereas people in poorer places might be better off spending their limited resources on themselves,” says the study’s lead author, Lara Aknin of Simon Fraser University in British Columbia. “But we see that generosity is rewarding in rich and poor countries.”

This conclusion comes in part from a sweeping survey of 200,000 adults in 136 countries, who answered questions about both their charitable donations and their subjective well-being. After household income and other demographic factors were taken into account, a positive link between donations and happiness emerged in 120 of these countries, rich and poor alike, and the boost in well-being from having given in the past month was as high as it would be if the respondent’s household income were to double, according to the survey responses.

The researchers then ran several experiments to test if giving actually caused the happiness boost. For example, participants in Canada and South Africa, the latter a nation with much lower per capita GDP, were randomly assigned to buy a goody bag either for themselves or for a sick child in a local hospital; in both countries, those who had spent the money on the anonymous child reported feeling happier than those who had spent the money on themselves.

The experiments yielded a robust cross-cultural consistency, according to the studies published in May in the *Journal of Personality and Social Psychology*, supporting the idea that the relation between giving to others and our own well-being is a universal human trait. Indeed, other recent research agrees. In an experiment Aknin and her colleagues published in January in *PLOS ONE*, toddlers too young to talk or to have been taught to share smiled more when sharing a treat than when receiving a gift. Moreover, in a set of studies published last year in *Nature*, researchers showed that giving was more spontaneous than greed, which required more thought.

Aknin believes giving feels good the world over for the same reason that eating and sex do: we have in our brain a naturally selected system of short-term rewards for behavior that aids long-term survival. None of our ancestors could survive on their own, Aknin points out, “so if generosity fostered social connections, then it might have been a really adaptive strategy.”

—Marina Krakovsky



How to Be a Better **student**

A few years ago, after writing a self-help book for young women with binge-eating issues, I played around with the idea of getting a social work or family therapy degree. How wonderful to help people for a living! But the nitty-gritty of going back to school and having to study again scared me to death. I used to be a darned good student—but now? I'm so wiped from earning a living and keeping up with my toddler that my brain feels like Swiss cheese. Still, educators and researchers say that you do not need the carefree mind of a grade-schooler or the late-night stamina of a teenager to be a good student. All you need is the determination to learn something new and the right tools. Read on:



#1 Get visual. Apparently, learning via graphic novels is about to become the next big thing. In a recent study in *Business Communication Quarterly*, University of Oklahoma professor Jeremy Short found that comic books were better at helping business majors remember things word for word than traditional textbooks. It makes sense, when you think about it. “I can recite lines from movies and literature, but I can’t walk around quoting textbooks,” Short says. He used the graphic-novel approach himself to brush up on math when he was getting his Ph.D.: “I bought the *Cartoon Guide to Statistics*. It was a really interesting book and got me back on track with what I should’ve already learned.” Such graphic guides exist for just about anything you might want to learn more about—genetics, the environment, the history of the universe. Kaplan even has an SAT vocabulary study guide in comic-book form.

#2 Join a gym. Study after study has confirmed that regular exercise improves cognitive function, memory and even students’ grades. Cardiovascular exercise sends more oxygen to the brain in the moment and as you age, and some research suggests the cumulative effect may benefit neuron health. In one particular-

ly fascinating bit of research, scientists at the University of Illinois at Urbana-Champaign set up rats’ habitats in a variety of ways—some with bright colors and lots of activities and toys, some with lots of different foods and smells, others with a running wheel. In the end, the only factor that mattered to the rats’ brainpower was the wheel, and the rats that exercised did better on cognitive tests and had healthier brains than the others.

#3 Share your progress. Recopying my class notes or writing out questions and answers always helped me do better on tests when I was in school. Composing updates about what you are learning and posting on social networks such as Twitter could be the 2013 version of that practice. Researchers at Michigan State University recently found that students who regularly tweet as a part of their classes are more engaged with the course material and get better grades. Part of the improvement may have also come through connecting and talking with other tweeters interested in the same subjects.

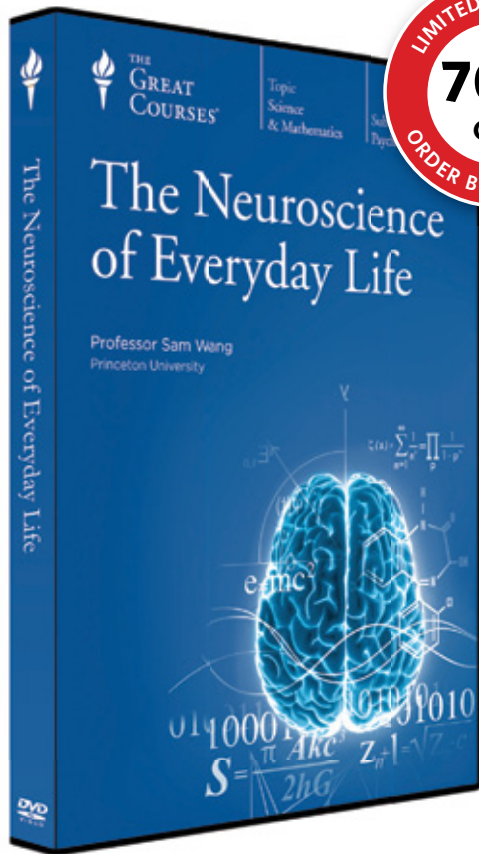
#4 Test yourself before you study. Psychologists have known for decades that taking a test helps people

retain what they have learned better than if they simply spend more time studying. But recent research has revealed a surprising twist: it works even better if you take the test before you know anything about a subject, so you are all but guaranteed to get the answers wrong. One experiment from 2009, for instance, found that students who tried to answer neurology test questions before reading up on the topic recalled more information a week later than students who were given a list of keywords and topics beforehand and even students who were given the same test questions and told to memorize them. The experts haven’t figured out quite yet why this counterintuitive learning trick works, but it appears that trying—and failing—to recall the information is key. If you don’t have a practice test handy, use the questions that are often at the end of textbook chapters or turn topic headings into questions by asking yourself what the keywords mean. Take your best guess—when you find out the real answer, you may never forget it.

See our special report “**How We Learn**” on page 44 for more.

—Sunny Sea Gold

JAMES YANG (Illustration); PAUL PANTAZESCU (Stockphoto) (world icon)



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» Bird Brains Impressive feats of avian intelligence

Social Skills to Crow About

New findings on crows' intelligence lend perspective on how social smarts evolve

The intelligence of the corvid family—a group of birds that includes crows, ravens, magpies, rooks and jackdaws—rivals that of apes and dolphins. Recent studies are revealing impressive details about crows' social reasoning, offering hints about how our own interpersonal intelligence may have evolved.

One recent focus has been on how these birds respond to the sight of human faces. For example, crows take to the skies more quickly when an approaching person looks directly at them, as opposed to when an individual nears with an averted gaze, according to a report by biologist Barbara Clucas of Humboldt State University and her colleagues in the April issue of *Ethology*. The researchers walked toward groups of crows in three locations in the Seattle area, with their eyes either on the birds or on some point in the distance. The crows scattered earlier when the approaching person was looking at them, unlike other animals that avoid people no matter what a person is doing.

Clucas speculates that ignoring a human with an averted gaze is a learned adaptation to life in the big city. Indeed, many studies have shown that crows are able to learn safety behaviors from one another. For example, John Marzluff of the University of Washington (who co-authored the aforementioned paper with Clucas) used masked researchers to test the learning abilities of crows. He and his colleagues ventured into Seattle parks wearing one of two kinds of masks. The people wearing one kind of mask trapped birds; the others simply walked by. Five years later the scientists returned to the



parks with their masks. The birds present at the original trapping remembered which masks corresponded to capturing—and they passed this information to their young and other crows. All the crows responded to the sight of a researcher wearing a trapping mask by immediately mobbing the individual and shrieking.

Although humans take it for granted, this type of social learning is cognitively complex and rare in the animal kingdom, according to Marzluff. "It's one thing to learn from one's own experience and another to observe that happening to other individuals and infer it could happen to you," he explains.

A crow recognizes human faces using the same visual pathways in the brain as humans do. A 2012 study using PET scans found that when crows viewed human faces that they associated with threat or care, the birds had increased activity in the amygdala, thalamus and brain stem—areas related to emotional processing and fear learning. In response to threatening faces, areas that regulate perception, attention and fleeing also lit up.

The similarity to human brain activity and the parallels in social intelligence in general are significant because they may have evolved after our last common ancestor existed 300 million years ago. That would make our species' similarities a case of convergent evolution, when two vastly different organisms develop the same traits independently. "Evolution has arrived at the same solution again and again," says Alex Taylor, a crow expert at the University of Auckland in New Zealand. —Harvey Black

Remarkable Abilities of Birds

TOOLMAKERS

The **woodpecker finch** from the Galápagos Islands can use a twig to pry insects out of bark.

► **Kea parrots** are keen problem solvers and can use sticks and string to push or pull food into reach.



BIRD COMMUNICATION

◀ An **African grey parrot** named Alex learned a vocabulary of more than 100 words and the labels of more than

35 objects. He could use words correctly in a sentence, saying "no," "come here," "I want a banana," and "wanna go back," when he was tired of testing and wanted to go to his cage to rest. **Siberian jays** can modulate their alarm calls to warn their peers whether a nearby hawk is perched, searching for prey or attacking.

FOOD HABITS

► **Ravens** can share information about the location of a carcass.

African honeyguides direct humans to bees' nests, which contain honeycomb. When their unwitting accomplices crack open the nests, the birds scavenge leftover treats.

Scrub jays have strong spatial memory and can relocate food they have witnessed others hiding.

VISUAL SKILLS

Pigeons can learn to distinguish a painting by Picasso from one by Monet.



As with crows, ◀ **magpies** can recognize a specific face out of thousands.

IVAN BLIZNETSOV / iStockphoto (raven); THINKSTOCK (various birds)

M How moral is your money? In a new study, people valued their earnings less when the source was ethically dubious.



Online Dating May Lead to Better Marriages

Couples who met on the Internet are more satisfied and less likely to break up

In recent years people have increasingly been using the Internet to search for compatible partners—and a new study reveals that marriages that begin this way may be stronger.

In a study that was by far the largest of its type, social neuroscientist John Cacioppo of the University of Chicago and his colleagues reported in June in the *Proceedings of the National Academy of Sciences USA* that more than a third of 19,131 American adults who married between 2005 and 2012 met their spouse online. Using an Internet survey, they found that an online meeting was associated with a lower rate of marital breakup than offline venues (5.96 versus 7.67 percent) and a higher rate of marital satisfaction. “That breakup and marital satisfaction follow the same pattern suggests that something about meeting online is associated with better outcomes,” Cacioppo says.

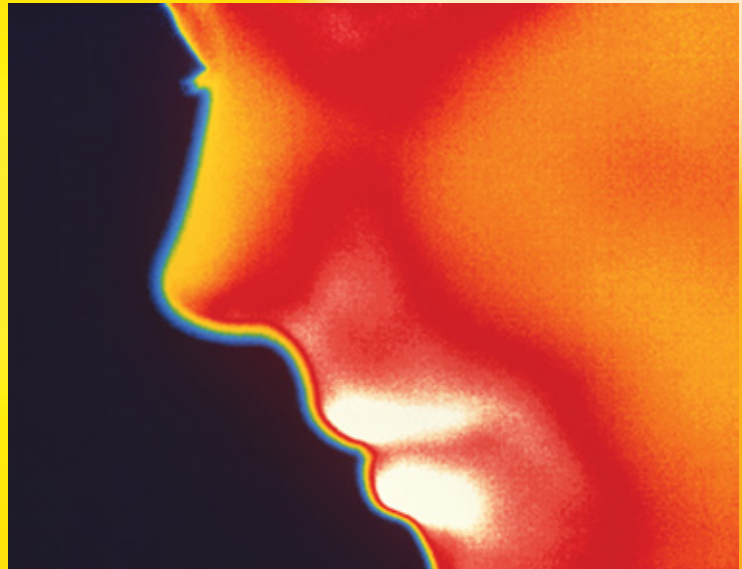
The study was not designed to address what that “something” might be, but possibilities include access to more potential partners online and the fact that communicating electronically has, in other studies, led to greater self-disclosure and liking of the other person. The results cannot be explained by demographic factors such as education or employment, because the scientists controlled for those influences. They could, however, stem from personality factors such as being a better decision maker or more ready for commitment.

The research was funded by eHarmony.com, which could make the results suspect. But Cacioppo, who is a member of the company’s scientific advisory board, insisted on safeguards. Two independent statisticians oversaw and verified the analysis of the data. In addition, the company agreed from the beginning that the results would be published no matter what they were. “There has been very little government funding for research about love, marriage and relationships in the past several decades,” Cacioppo points out. “It’s really important for us to understand because we aren’t doing it very well.” Industry, he says, may be the relationship scientist’s only partner.

—Ingrid Wickelgren

THINKSTOCK (computer mouse); SCOTT DUNLAP/Stockphoto (sun icon); TONY MCCONNELL Science Source (face); ISTOCKPHOTO (orange background)

ON THE HORIZON



Implants That Enhance Our Senses

Our world is determined by the limits of our five senses. We can’t hear pitches that are too high or low, nor can we see ultraviolet or infrared light—even though these phenomena are not fundamentally different from the sounds and sights that our ears and eyes can detect. But what if it were possible to widen our sensory boundaries beyond the physical limitations of our anatomy? In a study published recently in *Nature Communications*, scientists used brain implants to teach rats to “see” infrared light, which they usually find invisible. The implications are tremendous: if the brain is so flexible it can learn to process novel sensory signals, people could one day feel touch through prosthetic limbs, see heat via infrared light or even develop a sixth sense for magnetic north.

Miguel Nicolelis, a neurobiologist at Duke University, and his colleagues trained six rats to poke their nose inside a port when the LED light above it lit up. Then the researchers surgically attached infrared cameras to the rats’ head and wired the cameras to electrodes they implanted into the rats’ primary somatosensory cortex, a brain region responsible for sensory processing. When the camera detected infrared light, it stimulated the animals’ whisker neurons. The stimulation became stronger the closer the rats got to the infrared light or the more they turned their head toward it, just as brain activation responds to light seen by the eyes. Then the scientists let the animals loose in their chambers, this time using infrared light instead of LEDs to signal the ports the rats should visit.

At first, none of the rats used the infrared signals. But after about 26 days of practice, all six had learned how to use the once invisible light to find the right ports. Even after months of doing so, the rodents were able to respond to whisker neuron stimulation in addition to the infrared light, which suggests that sensory neurons can, when necessary, respond to multiple types of cues. This approach could help scientists create “sensory channels” for prosthetics users that provide constant sensory feedback to and from artificial limbs, facilitating control. The findings also suggest that the human brain can handle an expanded sensory repertoire—that we might one day be able to see, hear, touch and smell what we now cannot.

—Melinda Wenner Moyer

Contagious yawning emerges in children at the age of five or six. It may relate to empathy, which also develops around this time.

» Cycles of Change How reproductive hormones affect women's behavior

Fertile Women Have a Heightened Sense of Smell

Reaction to male pheromones is especially high

A woman's mood and appetite are clearly tied to her menstrual cycle, but other, more subtle changes in thinking and behavior also occur. In particular, her sense of smell sharpens as fertility peaks in the latter half of her cycle.

A study published in March in *Hormones and Behavior* compared the smell sensitivity of 16 women taking oral contraceptives and 17 naturally cycling women during two different phases of the menstrual cycle—around the time of ovulation and during the luteal phase, immediately after ovulation. Participants sniffed odors of lemon, peppermint, rose, musk and the male pheromones androstenone and androsterone. Naturally cycling women near ovulation were more sensitive to musk and the pheromones than the women on contraceptives. The effect may not be limited to male scents: a study in March in *Physiology and Behavior* suggests that women have a sharpened sense of smell in general during their luteal phase, as measured by their ability to detect the subtle odor of the alcohol n-butanol.

These results are typical of research in this area; effect sizes are small, and not all studies agree on the details. Even so, the findings support a popular hypothesis that hormone levels in a woman's body influence her senses and preferences in a way that promotes reproduction.



"I believe these variations in olfactory sensitivity are closely tied to the functions of the reproductive system, where the capacity to identify certain odors increases at times when procreation is more likely," says Jessica McNeil, a doctoral student in psychology at the University of Ottawa's School of Human Kinetics, who co-authored the *Hormones and Behavior* study. She cautions, however, that some studies have found conflicting results. The physiological mechanisms that cause these effects also remain unclear, as her research has not found a relation between levels of specific hormones and olfactory sensitivity.

—Tori Rodriguez

DAVID POHL (Illustration); ISTOCKPHOTO (pills icon)

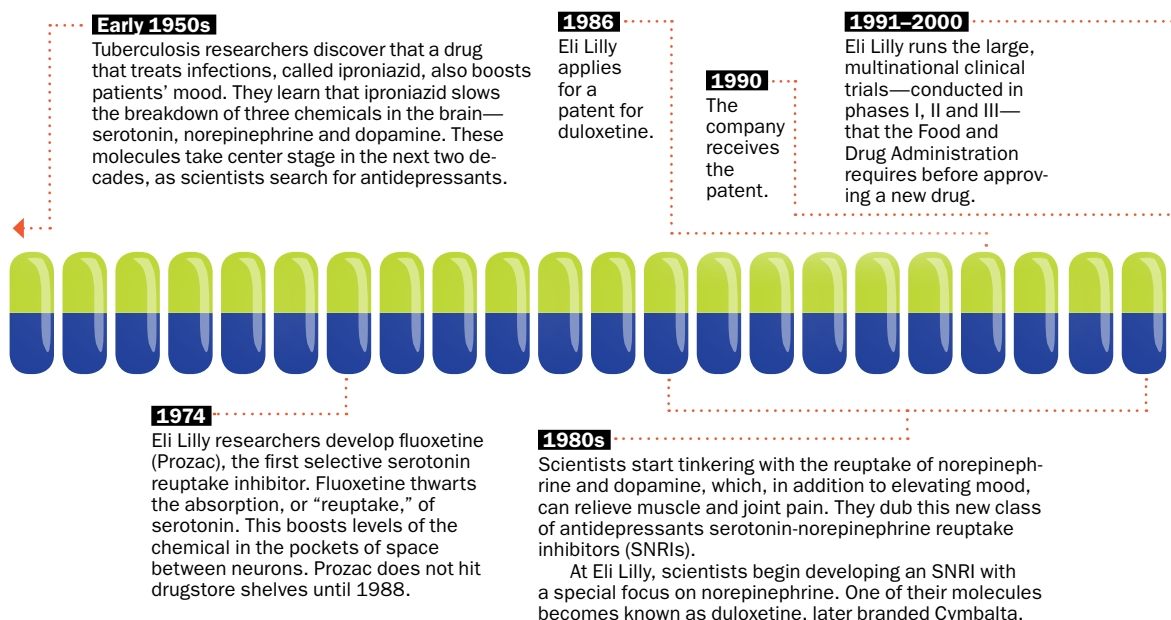


(PHARMA WATCH)

LIFE OF A DRUG

Decades of research and billions of dollars go into developing and marketing drugs. Here's the life span of a typical brain drug—Cymbalta, a popular antidepressant.

—Sarah Amandolare



M Do you tend to second-guess your choices? To commit to a decision, place barriers between you and the roads not taken.

Ovulating Women Are Less Trusting

When women approach their most fertile time of the month, they tend to prefer potential sexual partners with more outward signs of genetic fitness, such as facial symmetry, according to past research. Now scientists find that women behave differently toward strangers in a nonsexual context, too. A paper in the April *Biological Psychology* showed that women near ovulation were less willing to trust strangers in an investment game, especially if the strangers were male and even more so if they were attractive men. Higher levels of the hormone estradiol, which peaks just before ovulation, were associated with less trust—a sign that the women's heightened wariness has roots in the physiology of the menstrual cycle. The finding supports the idea that at ovulation, women may unconsciously temper their increased attraction to masculine men by interacting with them more cautiously.

—Tori Rodríguez

That Judgmental Time of the Month

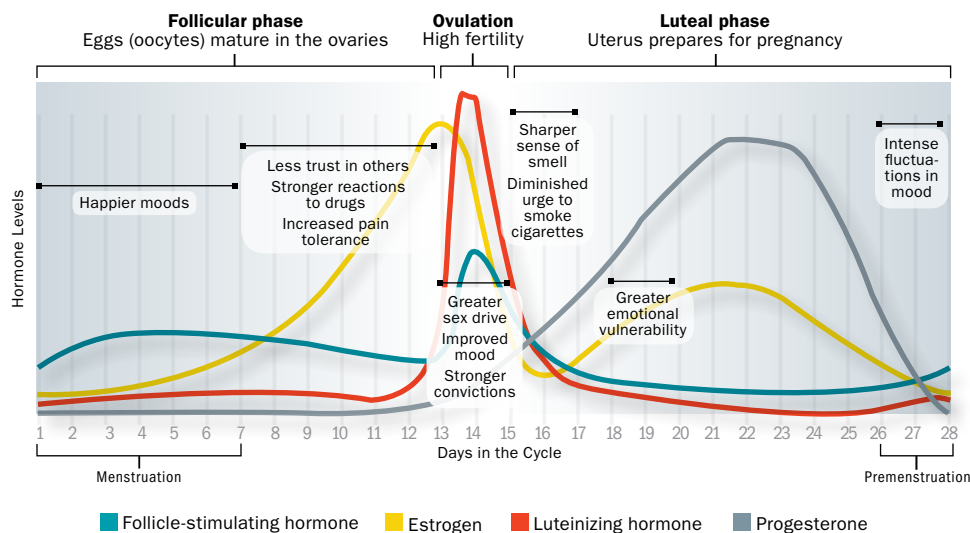
Women's feelings toward their partners shift subtly during peak fertility

Women at peak fertility tend to have a stronger preference for sexually desirable men, many past studies have shown. An open question, however, is whether these variations affect women's long-term relationships. Psychologists at the University of California, Los Angeles, gave 65 women in committed relationships a questionnaire to assess their feelings about their partnerships at different times of the month. Results indicate that on high-fertility days, women who considered their partners less sexually desirable felt less close to them and were more critical of their faults. Women with more sexually desirable partners, on the other hand, felt more satisfied with their relationship and closer to their partner on high-fertility days. Women do not seem to act on these fluctuating feelings, however: the surveys revealed no change in their intention to stay in the relationship depending on the time of month.

The researchers say their results are consistent with the well-supported theory that women select mates by balancing their desires for men with "high-fitness" genes—the sexy guys who are also more likely to stray—and men who are more reliable and likely to be committed fathers. Many men have a combination of both qualities, so a lot of women probably experience only subtle changes in attraction and satisfaction during their menstrual cycle.

—Tori Rodríguez

Fluctuations in Fertility and Mood



2000–2002

Eli Lilly wraps up phase I, which tests a drug's safety, and phase II, which looks at its efficacy. In a 2002 study, for example, 267 depressed adults took either duloxetine or a placebo for nine weeks. Those taking duloxetine had fewer symptoms of depression and less physical pain.

2002–2004

Eli Lilly completes phase III trials at 21 sites in Europe and Russia. In this step, scientists compare duloxetine to drugs on the market and attempt to identify the correct dosage. In a 2004 study of 367 depressed patients, for instance, they found that daily duloxetine doses of 40 and 80 milligrams offered more relief than a 20-mg daily dose of paroxetine (Paxil).

2013

Cymbalta goes off patent at the end of the year. In July, Eli Lilly is expected to lay off up to 1,000 sales workers in anticipation of the revenue loss. Cymbalta and osteoporosis drug Evista together bring in \$5 billion annually for Eli Lilly; Evista goes off patent in early 2014.

2001

Eli Lilly makes its first attempt at FDA approval of duloxetine. The FDA asks the company to do more clinical trials.

2003

The FDA recommends against approval of duloxetine because of violations at Eli Lilly's Indianapolis plant, where the drug would be manufactured. The agency also cites potential liver toxicity.

2004

The FDA reviews more liver health data and approves duloxetine for depression and diabetic neuropathy (pain), based on another set of clinical trials. Serotonin and norepinephrine can stifle pain signals traveling from the brain to the rest of the body.

2005–present

Cymbalta continues to be studied as a treatment for various mood and pain disorders.

| Marijuana use may harm the teenage brain. Recent research suggests that smoking pot at younger ages drives down IQ.

» The Mysteries of Pain

New insights into enigmatic headaches and other maladies

Sex Matters in Migraines

Female migraineurs may need different treatments than male sufferers

Halos, auras, flashes of light, pins and needles running down your arms, the sudden scent of sulfur—many symptoms of a migraine have vaguely mystical qualities, and experts remain puzzled by the debilitating headaches' cause. Researchers at Harvard University, however, have come at least one step closer to figuring out why women are twice as likely to suffer from chronic migraines as men. The brain of a female migraineur looks so unlike the brain of a male migraineur, asserts Harvard scientist Nassim Maleki, that we should think of migraines in men and women as “different diseases altogether.”

Maleki is known for looking at pain and motor regions in the brain, which are known to be unusually excitable in migraine sufferers. In one notable study published in the journal *Brain* last year, she and her colleagues exposed male and female migraineurs to painful heat on the backs of their hands while imaging their brains with functional MRI. She found that the women had a greater

Migraine Looks Different in Women and Men

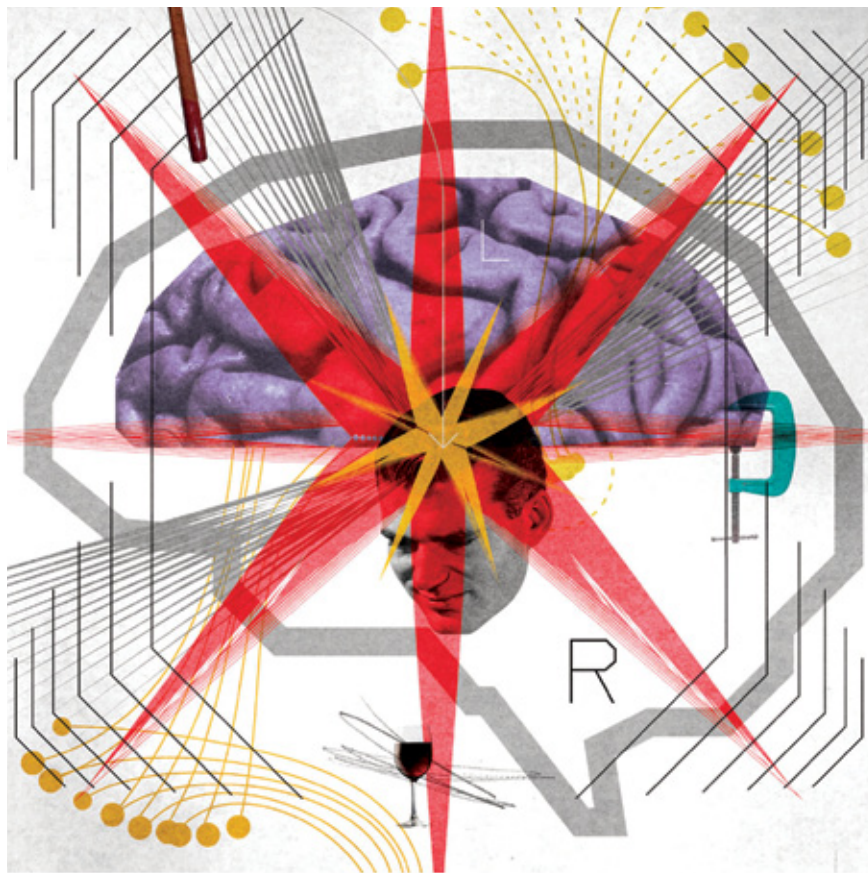
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Ratio of the prevalence of migraines in women to men in a one-year period.

During a migraine:

Women experience more intense emotional responses to pain.

Men are more sensitive to heat, such as from a hot cup of coffee or a steamy shower.



response in areas of the brain associated with emotional processing, such as the amygdala, than did the men. Furthermore, she found that in these women, the posterior insula and the precuneus—areas of the brain responsible for motor processing, pain perception and visuospatial imagery—were significantly thicker and more connected to each other than in male migraineurs or in those without migraines.

In Maleki's most recent work, presented in June at the International Headache Congress, her team imaged the brains of migraineurs and healthy people between the ages of 20 and 65, and it made a discovery that she characterizes as “very, very weird.” In women with chronic migraines, the posterior insula does not seem to thin with age, as it does

for everyone else, including male migraineurs and people who do not have migraines. The region starts thick and stays thick.

We don't know yet whether the thickening of the insula is something the brain is doing to protect itself or something that worsens women's migraines, Maleki says. Yet the evidence is mounting that when it comes to migraines, men's and women's brains are structurally and functionally different. For treatment, that knowledge could make a huge impact: not only should researchers be better about testing potential migraine drugs on men and women separately, Maleki says, but they may be able to design new treatments based on these brain differences—giving both sexes a better chance at relief. —Cat Bohannon

STUART BRADFORD (top); ISTOCKPHOTO (bottom)



Watch out for “e-mail apnea.” Some 80 percent of people may briefly stop breathing or breathe shallowly when looking at a screen.

Deciphering Cluster Headaches

Researchers continue to turn up clues to the most painful headaches of all

Migraines are not the only culprits when it comes to extraordinary head pain. Cluster headaches have long puzzled researchers, too, although studies are slowly revealing the parts of the brain involved when those punctuated bursts of pain occur.

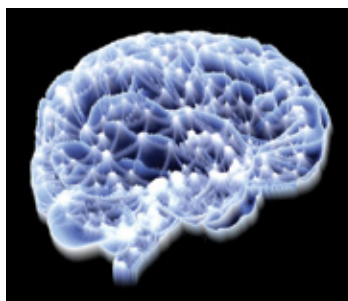
The excruciating headaches tend to turn up in bouts lasting six to eight weeks. During these cycles, afflicted individuals—more often men—experience intense daily headaches on one side of the head, each lasting an hour or two, explains headache expert Peter Goadsby, a neurologist at the University of California, San Francisco.

In the late 1990s Goadsby and his colleagues linked cluster headaches to heightened synaptic activity falling in or near the hypothalamus, a brain region that mediates hunger, thirst, sleep, sex drive and more. Yet researchers are still trying to understand how activity in this hypothalamus-adjacent area could conjure the condition—and to determine what other glitches in brain structure, metabolism or interactions contribute to sufferers' throbbing noggins.

At least one study suggests that in cluster headache sufferers this hypothalamus-adjacent region may differ not only in its electrical activity but also in its interactions with other parts of the brain. In *PLOS ONE* in February, a Beijing-based team imaged the brains of a dozen men in the midst of cluster headache bouts. The researchers traced blood flow—and, with it, functional connections—between the hypothalamus and other parts of the brain. Compared with unaffected men, the cluster headache sufferers did have unusual hypothalamic connections. When headaches hit, these altered interactions often involved parts of the brain associated with pain processing. But hypothalamic connections were off-kilter between headaches, too, pointing to more persistent brain differences in those prone to cluster headaches. —Andrea Anderson

Agony in the Brain

Brain scanning homes in on a neural signature for physical pain



Like truth and beauty, pain is subjective and hard to pin down. What hurts one moment might not register the next, and our moods and thoughts color the experience of pain. According to a report in April in the *New England Journal of Medicine*, however, researchers may one day be able to measure the experience of pain by scanning the brain—a much needed improvement over the subjective ratings of between one

and 10 that patients are currently asked to give.

Led by neuroscientist Tor Wager of the University of Colorado at Boulder, researchers used functional MRI on healthy participants who were given heated touches to their arm, some pleasantly warm, others painfully hot. During the painful touches, a scattered group of brain regions consistently turned on. Although these regions have been previously associated with pain, the new study detected a striking and consistent jump in their activity when people reported pain, with much greater accuracy than previous studies had attained. This neural signature appeared in 93 percent of subjects reporting to feel painful heat, ramping up as pain intensity increased and receding after participants took a painkiller.

The researchers determined that the brain activity specifically marked physical pain rather than a generally unpleasant experience, because it did not emerge in people shown a picture of a lover who had recently dumped them. Although physical pain and emotional pain involve some of the same regions, the study showed that fine-grained differences in activation separate the two conditions.

A brain-based marker of pain might someday help doctors assist people who have difficulties communicating, such as the very young or victims of stroke. Yet Wager does not see this neural signature as a pain “lie detector.” “There are many psychological and physiological ingredients that go into a person’s report of pain, and we’ve discovered just one ingredient here,” he says. Many states of brain activity very likely give rise to pain, Wager adds, “pain is not just one thing.” —Michele Solis

TOP MIGRAINE TRIGGERS

■ Overuse of painkillers

■ Foods:

Processed, fermented, pickled or marinated foods

Chocolate, nuts, peanut butter and dairy products

Foods containing tyramine: red wine, aged cheese, smoked fish, chicken livers

Fruits and vegetables: avocados, bananas, citrus fruits, onions

Meats containing nitrates: bacon, hot dogs, salami, cured meats

■ Changes in hormones, such as menstruation

■ Sex

■ Atypical sleep patterns

PAIN'S MANY IDIOSYNCRASIES

Even as researchers make strides in understanding and treating pain, new discoveries raise many more questions. These recent findings reveal the deep connections between pain and many essential physical and mental processes.

- Patients with chronic back pain tend to be impaired at emotional learning but have increased sensitivity to taste.
- Chronic pain shrinks the brain, up to 11 percent in some cases.
- Those with chronic pain can learn to control their perception of pain by imagining pleasant scenarios or believing a particular stimulus to be harmless.
- Memory of a pain can cause that pain to persist for life, even after the initial injury has healed.
- Chronic pain sufferers can learn to associate a place with their pain. Returning to this space can reinforce the negative association.

Bad news for bexarotene, a cancer drug touted as a boon for Alzheimer's disease: four labs have failed to replicate earlier effects.

» Concussions' Lingering Effects Linked to Hormone Deficiency

The finding may explain why even seemingly mild concussions can give rise to persistent maladies

When a blast rattles the brain, the resulting concussion sometimes leads to unremitting psychological problems such as depression, anxiety, irritability, sleep disorders, pain, and learning and memory problems. Tens of thousands of American veterans are estimated to suffer from this postconcussive syndrome (PCS), formerly associated with shell shock. Now evidence suggests that a hormone imbalance may underlie the chronic symptoms—meaning hormone replacement therapy could spur a dramatic recovery.

At least since World War I, scientists have tried to figure out why about 10 percent of adults' concussions—from any cause, including accidents, falls and sports injuries—lead to persistent psychological and physical complaints. Endocrinologist Charles Wilkinson of the VA Puget Sound and the University of Washington and his colleagues were intrigued by studies that found pituitary hormone deficiencies, which affect only 1 percent of the general population, in many people who had had a concussion. No one had investigated whether a blast concussion could disrupt hormones as well, so Wilkinson's team tested 35 soldiers who had been near a bomb explosion. They found that a whopping half of the soldiers had undergone a precipitous drop in growth and sex hormones compared with other deployed soldiers without any concussions. The data were presented in April at the Experimental Biology 2013 meeting in Boston.

The researchers hypothesize that the force of a blast physically disrupts the pituitary gland's ability to either produce or transport its hormones. Receptors for growth hormone and its by-product hormone IGF-1 are found throughout the brain. The



receptors' locations—in areas such as the amygdala, prefrontal cortex, putamen and hippocampus—correspond with functions that are disturbed in PCS, including mood, sleep and memory. In addition, hormones are thought to affect plasticity, maintenance and protection of the brain. Wilkinson and his colleagues plan to test soon whether hormone replacement therapy could benefit patients with PCS—he is optimistic because such therapy has been shown to improve the same symptoms in people with hormone deficiencies from other causes. “There is considerable evidence that the cognitive and mood problems of growth hormone deficiency can be treated successfully with growth hormone replacement,” Wilkinson says. —Stephani Sutherland

ISTOCKPHOTO

» Neurons Fire Backward in Sleep

Unusual brain cell activity may underlie memory strengthening

Researchers have long known that sleep is important for forming and retaining memories, but how this process works remains a mystery. A study published in March suggests that strange electrical activity, involving neurons that fire backward, plays a role.

Neuronal activity typically requires sensory input—for example, a taste or smell—that gets received by neurons' dendrites and then transmitted as an electrochemical message to other cells via long axons. Yet the brain is mostly closed off to sensory input during sleep. Instead evidence suggests that during sleep, neurons are controlled by electrical impulses that ripple through the brain like

waves. In 2011 researchers found that these waves of electricity cause neurons in the hippocampus, the main brain area involved with memory, to fire backward during sleep, sending an electrical signal from their axons to their own dendrites rather than to other cells. The new work, published in the *Proceedings of the National Academy of Sciences USA*, confirmed this unusual behavior and suggested that firing in reverse weakens the dendrites' ability to receive input from other neurons.

Weakening neural connections may serve a dual purpose, says R. Douglas Fields, a laboratory chief at the National Institutes of Health and co-author of the

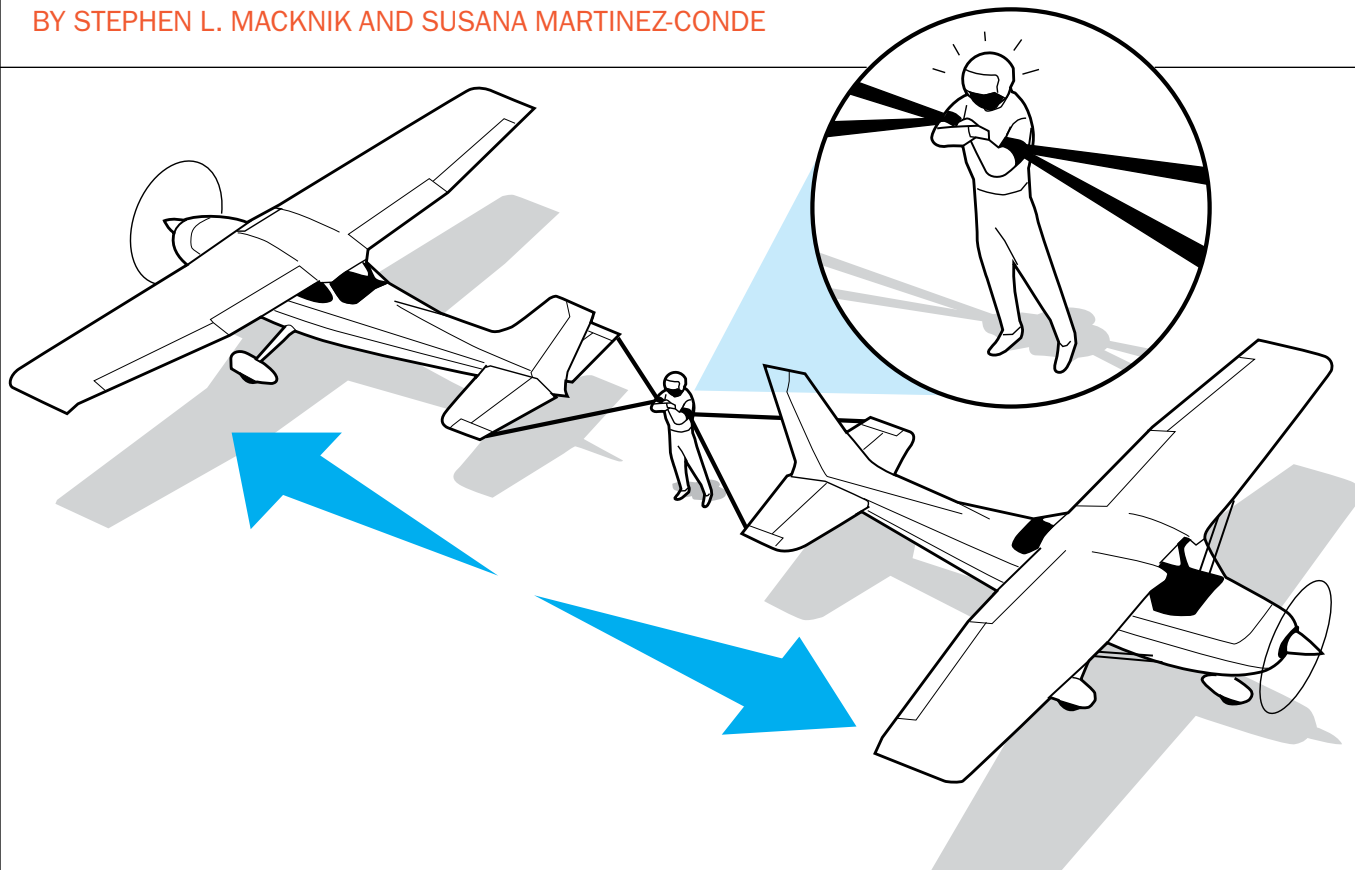
study with neuroscientist Olena Bukalo and other colleagues. The authors suggest that firing backward helps to strengthen the electrical signals of neighboring cells, necessary to solidify memories, as well as freeing up space in the brain to store new memories on waking.

This study was conducted in samples taken from rat brains, but sleep is thought to induce backward firing in human neurons, too. In fact, Fields says, this bizarre electrical behavior may underlie the positive effects of deep-brain stimulation, which, though not well understood, has been shown to improve the symptoms of Parkinson's disease and other neurological disorders. —Erica Westly

No Brain, No Pain

Pain is an emotion

BY STEPHEN L. MACKNIK AND SUSANA MARTINEZ-CONDE



We are more often frightened than hurt; and we suffer more from imagination than from reality.

—Lucius Annaeus Seneca

DENNIS ROGERS is an unassuming guy. He's on the short side. And though muscular, he doesn't come across as the kind of towering Venice Beach, muscle-bound Arnold that you might expect from someone billed as the World's Strongest Man. Rather he has the kind of avuncular intensity you find in a great automobile mechanic—a mechanic who happens to be able to lift an engine with one hand while using the fingertips of

the other hand to wrench the spark plugs out. Like it's nothing. Rogers, who has been known to keep two U.S. Air Force fighter planes from blasting away in opposite directions by holding them back with his bare hands, performed at the most recent Gathering for Gardner—a conference that celebrates the interests of one of *Scientific American's* greatest columnists, the late mathematician Martin Gardner. We asked Rogers about the source of his incredible powers after the show, and we were surprised to learn that he did not know. Bill Amonette of the University of Houston—Clear Lake found that Rogers could recruit an abnormally high number of

STRONGMAN

Dennis Rogers holds two planes still as they attempt to fly away in opposite directions. Do not try this stunt at home!

muscle fibers. But was this ability because of a freak genetic mutation? Another possibility, which Rogers thinks is more likely, is the way he processes pain when he strains those muscles.

What if, instead of superpowered muscles, Rogers has a normal—though extremely well exercised—body, and his abilities arise because he can withstand more pain than most mere mortals? He claims that he does feel pain and is actu-

ILLUSTRATIONS BY JASON LEE

(What if, instead of from **superpowered muscles**, his abilities arise because he can withstand more muscular pain?)

(illusions)

ally scared of dentists. In fact, during one stunt in which he held back four souped-up Harley motorbikes with straps, he bit down so hard he split a tooth from top to bottom. Rather than taking his chances at the dentist, he reached into his mouth, clamped his viselike fingertips onto the broken tooth, and extracted it, root and all.

Rogers reasons that, unlike in the dentist's office—where he has no control over the pain that is inflicted on him—he has direct executive control over pain that he inflicts on himself. “I know it's coming, I have an idea of what to expect and I can decide to ignore it,” he says. Confronted with severe pain, most people fear that they will damage their body permanently if they persist, so they stop well before they are in real danger, Rogers explains. He does not

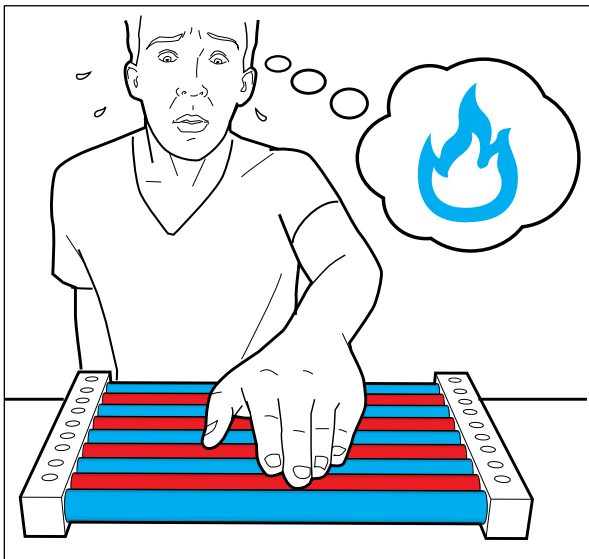
stop and only rarely gets seriously hurt.

Maybe Rogers's muscle cells are normal, and he experiences pain as most of us do but chooses to disregard it when he feels in command. If so, he has become strong not because he was born on a planet with a red sun like Superman or was trained in the Danger Room of Charles Xavier's School for Gifted Youngsters like an X-Man but because, when he has a job to do, he *doesn't care* that it hurts.

An illusion is a perception that does not match the physical reality. Is pain, then, as with illusions, a mind construct that some people can decide to turn off? As you will see in the studies that follow, pain varies as a function of mood, attentiveness and circumstances, lending support to the theory that pain is an emotion. These studies show that empa-

thy also extends to pain, just as it does to other emotions, even when the victims are fake strangers. And the research indicates that people can experience pain for the wrong reasons or fail to experience it when it would be very reasonable to do so. Moreover, when pain is disconnected from the physical reality, it is an illusion, too. **M**

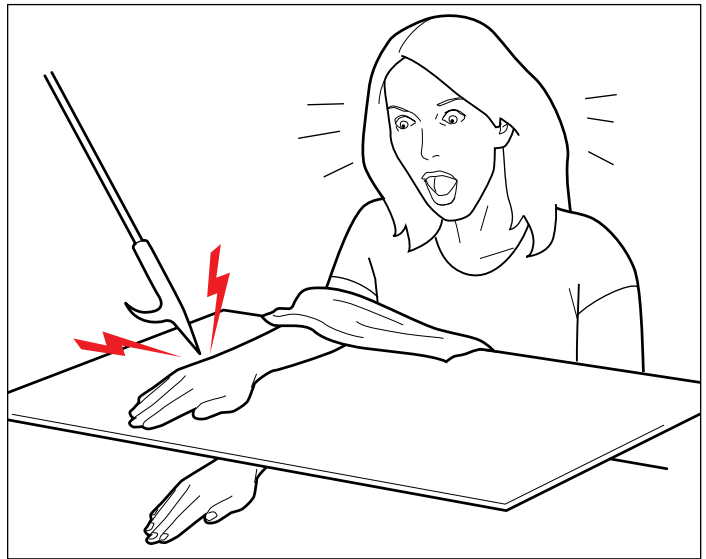
STEPHEN L. MACKNIK and SUSANA MARTINEZ-CONDE are laboratory directors at the Barrow Neurological Institute in Phoenix. They serve on *Scientific American Mind's* board of advisers and are authors of *Sleights of Mind: What the Neuroscience of Magic Reveals about Our Everyday Deceptions*, with Sandra Blakeslee, now in paperback (<http://sleightsofmind.com>). Their forthcoming book, *Champions of Illusion*, will be published by Scientific American/Farrar, Straus and Giroux.



PAIN IS RELATIVE

Our colleague at the Barrow Neurological Institute, Arthur “Bud” Craig, is a pain neuroscientist who discovered the neural mechanisms underlying the terrifying “thermal grill illusion,” in which no damage occurs, but it feels as if it does. Think of it as waterboarding wired directly into your pain system. The device consists of a grill in which every odd horizontal tube is cold (not painful but cold), and every even tube is hot (not painful but very warm). When a subject's hand rests simultaneously on both sets of tubes (cold plus hot), excruciating pain results. This is an illusion; the hand is not damaged, and its actual temperature remains unchanged because the cold and hot tubes cancel out each other thermodynamically. The effect occurs in part because the hand's heat-burn sensors cancel the cold-freeze sensors, creating an imbalanced and painful sensation of burning cold within the brain. But by themselves, the coldness and hotness are not painful, so the subjective perception of hurt is simply incorrect: no damage, high pain.

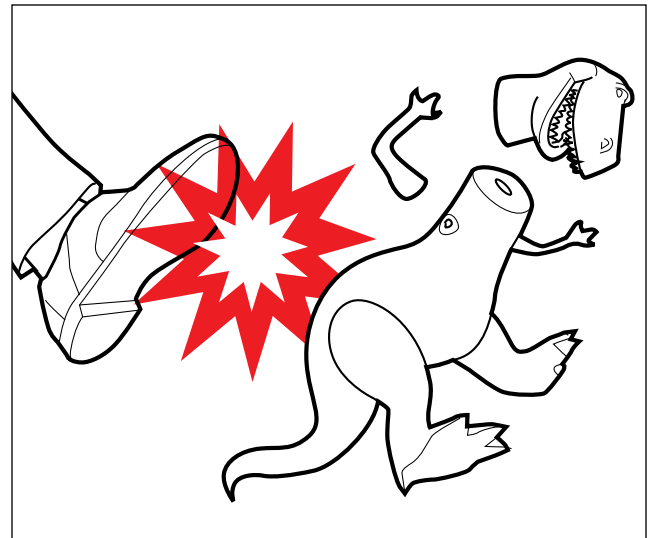
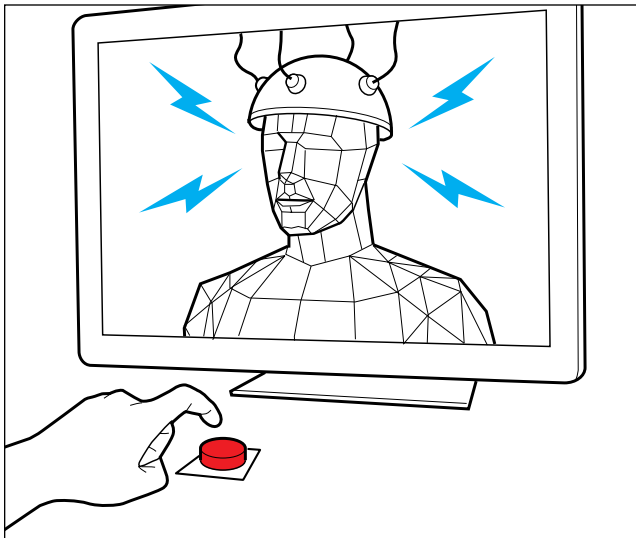
Craig has put forward the revolutionary proposal that your brain processes pain like an emotion. If you are tackled while playing the annual family football game before Thanksgiving dinner, it can be fun. But the same tackle, out of the blue, while crossing the park on the way to your promotion review, can hurt like you-know-what: same damage, different pain.



THIS IS GONNA HURT

Henrik Ehrsson and his colleagues, then at the Institute of Neurology and the University of Oxford, scanned the brains of subjects while threatening a fake hand that appeared attached to the participants. The anterior insula, a brain area that is critical to awareness of your body and, Craig argues, is also critical to all emotional awareness, lit up like crazy in brain imaging. The threat of damage, even to a fake appendage, causes brain activity that predicts pain.

When the turning of a dial gave an electric shock to a virtual character, observers experienced great stress.



HURTS ME MORE THAN YOU

Brothers Elliot and Michael motivated their sister, Gertie, in the movie *E.T. the Extra-Terrestrial* by twisting her doll's arm behind its back until Gertie submitted. Why did she care? Two research groups have explored this question recently, both with computer-generated characters and with toy robots. Mel Slater and his colleagues at University College London had subjects turn a dial at the command of an authority figure. The turning of the dial gave an electric shock to a virtual character, who appeared to react in

pain. The experimental subjects experienced great stress from inflicting this fictional pain.

Astrid Rosenthal-von der Pütten and her group at the University of Duisburg-Essen in Germany scanned people's brains as they watched movies of toy robot dinosaurs being mistreated by a human actor. Scientists found significant activity in the limbic areas of the brain, which presumably underlie the feeling of empathy. The same areas lit up even more when research subjects watched movies of humans being abused.



ILLUSION DIMINISHES PAIN

Severe burn victims must have their healing skin pulled and prodded daily to keep it from shrinking like plastic wrap, thus maximizing their mobility. Hunter Hoffman, David Patterson and Sam Scheerer of the University of Washington developed a virtual-reality game called *Snow World*, in which patients in burn units who are undergoing such painful treatments are distracted as they shoot Frosty and his penguin minions with a snowball BB gun. Virtual immersion in the frozen environment reportedly works better than morphine at counteracting the pain: massive damage, low pain.

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Managing Your Digital Afterlife

Your online persona and possessions can help assuage grief over your passing

BY CARRIE ARNOLD

AFTER THEIR SON'S suicide, one Wisconsin couple was desperate for answers. They tried to log into his e-mail and Facebook accounts but failed. The grieving parents finally got a court order to access these online records, arguing that just as their son's death gave them ownership of his tangible assets, so it also gave them rights to his digital contributions.

In courtrooms around the country, the online legacies of the departed are becoming the subject of painful battles for mourning families. People have long made plans for delivery of their possessions after they die, including family heirlooms, photograph albums, old letters and other memorabilia. Many people design this disbursement to help those left behind deal with their demise. Our possessions are part of us and traditionally are the main tangible part that remains after our death.

In the modern world, however, another echo of us exists that will outlast our physical existence: our writings and records in the digital realm. Our digital "selves" are composites of mementos such as images on Shutterfly or Flickr, books on e-readers, and our musings and correspondence on e-mail, blogs and social-media accounts. This full array of data deposits, legal experts say, is your digital legacy.

The increasing importance of our online identities adds a new layer to grief and mourning. Growing evidence suggests a person's contributions to the cloud can be dear to mourners and, because they are easily accessible, potentially lasting and interactive, can help them cope with the loss. Yet many of us have given little thought to what will happen to our online accounts after we die. "People don't realize that they need



to make plans for these assets," says Georgetown University lawyer Naomi Cahn. "The first step is getting people to think about this."

Sites of Solace

Many people want to maintain their online privacy. In addition, preserving the Facebook page of a dead person could be considered a touch macabre.

Yet as with your old physical photos and letters, creations by you in the digital world can be a comfort to those you leave behind. For an article now in press, information scientist Jed Brubaker of the University of California, Irvine, and his colleagues interviewed 16 Facebook users about their experiences after the loss of a friend or family member. They found that all the respondents were emo-

ALEX WILLIAMSON

tionally attached to the digital trappings of the deceased. “People tend to go back to these pages on anniversaries, birthdays and holidays” as a way to keep a part of their loved one alive, says cyber anthropologist Michaelanne Dye of the University of Georgia.

Mourners may even set up new online venues such as memorial Web sites or Facebook pages. These sites also can serve as effective emotional outlets. In her doctoral dissertation at Antioch University, psychologist Jordan C. Fearon asked 68 founders of Facebook memorial groups about their experiences with grieving through social media.

sets. Only six states have laws that allow next-of-kin access to those resources. The lack of legislation means that the ownership of your profile can revert back to the company who owns that site after your death unless you specify otherwise, Dye says. (Forthcoming legislation may soon prevent anyone except a court-appointed person or a designee of the deceased to gain access to that individual’s online information.)

Dye says she is working on inserting a clause into her will spelling out exactly what she wants done with her digital life after her death. “My online profiles are a part of who I am,” she confesses. Wheth-

native e-mail addresses and cell phones in one last attempt to get in touch. “Inactive Account Manager allows people to be proactive with their digital assets,” says Nadja Blagojevic, a manager of privacy and security at Google. “It’s important for the people you leave behind.”

You cannot similarly decide the fate of your Facebook profile. In this case, once you die, the choice lands on your friends and family. They can leave the page as is, open to friend requests, Facebook advertisements and photo tags. If someone can provide an obituary or death notice, Facebook will memorialize the page, meaning that no new

(Nearly 60 percent of the respondents said that **online grieving** was more helpful and valuable than traditional grief rituals.)

All but one of the founders said they would recommend creating a Facebook group to anyone who had recently experienced a loss. Like holding a wake or sitting shivah, a virtual memorial provides the bereaved with social support, a sense of connection with both the deceased and the living, and meaningful activity. “It was very beneficial to my grieving process to physically see via my computer that my friends were feeling the exact same emotion,” wrote one of the individuals Fearon surveyed. In addition, nearly 60 percent of the respondents said that online grieving was more helpful and valuable than traditional grief rituals. Memorial sites, after all, can be made accessible to a broad array of individuals and can last for as long as participants need support.

Taking Care of Business

Although you have no say in how others remember you, the existence of memorial Web sites underscores the importance of deciding what to do with your digital persona when you are no longer around. If you leave it to chance, you may have little control. The legal system has yet to establish a coherent system governing the inheritance of digital as-

er or not you adjust your will, Cahn recommends creating a locked paper document or secure database that has passwords and security questions for your e-mail, banking and other online accounts so friends and family can access or deactivate your profiles, notify e-mail correspondents of your passing, and take care of any financial concerns.

For any accounts you have on Google, you now have a more automated option. In April, Google added a free service called Inactive Account Manager (nicknamed “Google Death”) that allows you to decide what happens to your Google-operated accounts after you die.

One option is to delete these accounts. Another is to have Google allow a designated person to view them if you do not log on for a specified period, ranging from three months to a year. Before Google authorizes this transfer, however, the company will send reminders to alter-

friends will be added and the person’s name will not appear in news feeds. Loved ones can also request that the deceased person’s page be deleted.

In most cases, your heirs and close friends will not be in a hurry to wipe out all digital traces of you. And although you could try to instruct Google, among others, to erase you from the Internet, making the digital “you” invisible is probably impractical, and even if it were possible, doing so may deepen the pain of those you care about. It makes more sense, then, to construct a path so that those who love you can follow at least some of your online trail and gain access to the digital deposits they might need or want. **M**

CARRIE ARNOLD is a Virginia-based science writer and author of *Decoding Anorexia: How Breakthroughs in Science Offer Hope for Eating Disorders* (Routledge, 2012).

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The Conscious Infant

A new study finds a possible brain signature of consciousness in infants as young as five months

BY CHRISTOF KOCH



HOW DO YOU KNOW that your cute five-month-old infant is truly aware, that she is fully sentient, capable of having a phenomenal conscious experience of her mother's face or voice? Let me hasten to add that the question here is not whether or not normal, healthy babies can selectively identify their mom's face or voice; of course, they can turn their head and fixate with their eyes onto the face and eyes of their mother even very soon after birth. The question I am after is whether such visuomotor or audiomotor behavior goes along with the kind of subjective experiences you or I have when we look at our mother or hear her voice. It is a legitimate question for two reasons.

For one, babies can't speak. They can't tell us whether or not they are seeing faces or hearing voices. It is a different matter once they mature enough to be able to talk to us about their inner experiences. So we have to trust our intuitions, which are deeply colored by our biases about when life starts, when consciousness begins, and who is or is not conscious. The second reason the question is valid is that 150 years of psychology experimentation has shown time and again that adults are perfectly capable of carrying out a range of complex tasks unconsciously.

For instance, subjects can distinguish between a face that looks angry or one that has a neutral expression even if those faces are rendered "invisible" by flashing them only very briefly onto a screen and by adding distracting images just before and just after the picture to effectively mask or erase the picture from the mind's eye. People can also unconsciously detect gender, do simple adding problems when "invisible" numbers are flashed onto the screen, or distinguish between depictions of inappropriate and appropriate actions (for example, discerning between an invisible image of an



athlete batting a ball with a baseball bat and an image that has been doctored to show the player swatting at the ball using a flower bouquet). Perhaps babies' behaviors also rely on unconscious, rather than on conscious, processes?

So it becomes critical to find ways to distinguish conscious from unconscious processing in preverbal infants. What is a psychologist to do? One answer is to measure the brain's electrical activity using a common tool we call the electroencephalogram (EEG).

Using such tools, a group in Paris led by cognitive neuroscientist Stanislas Dehaene of the Collège de France has argued for several years that a hallmark of conscious visual perception is a particular type of electric wave, called P300, that occurs whenever an adult subject is attending to a consciously perceived picture

or a sound. These signals start roughly around 300 milliseconds after the onset of the image or sound, can be long-lasting, are depolarizing (positive) relative to a reference electrode, and are particularly prominent above the frontal lobe. Most important, they are not present when, for instance, the image is flashed on the screen but is not consciously seen because it is masked. Looking at an image produces a host of faster electrical responses, which are thought to relate to the processing of the image that occurs prior to conscious recognition. Assuming that the P300 slow wave is one of the brain signatures of conscious perception, can they be found in young children?

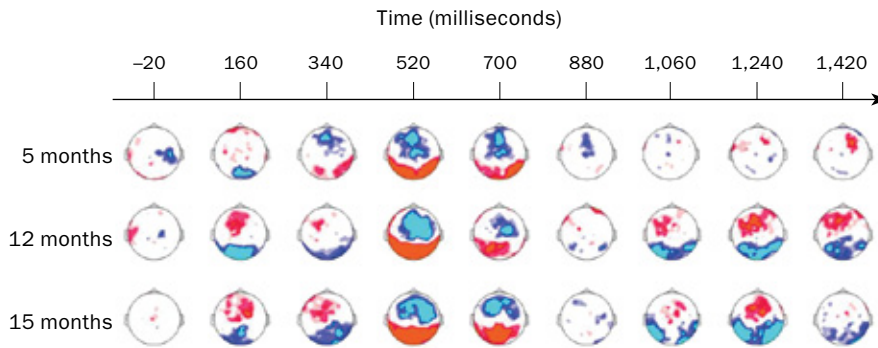
Recording Brain Waves in Infants

Psychologist Sid Kouider of the Laboratory of Cognitive and Psycholinguistics

CHRISTOF KOCH (Koch); EVAN KAFKA/Getty Images (baby)

Thinking Like Adults?

How can you tell whether infants are consciously aware? One way is to see if their brains respond as adult brains do to visible and “invisible” pictures. In an experiment, EEG recordings were made from 80 five- to 15-month-old infants as they looked at photographs flashed briefly (for 17 to 300 milliseconds), either of faces or of random patterns (as a control). These face/random images were preceded and followed by other random patterns. If the face photo is present for longer than 50 milliseconds, adults—who can tell us about their experiences—can report that they briefly saw a face. The EEG recordings of one-year-old children resembled those of the adults consciously seeing something, although they were only a half or a third as fast. In these processed EEG signals, red indicates that the face signal evokes a stronger brain activity than random patterns; blue indicates the opposite.



tic Sciences at the Ecole Normale Supérieure in Paris, together with Dehaene and other French and Danish researchers, undertook the difficult task of measuring brain waves in 80 infants. Difficult because, unlike undergraduate research subjects, very young children (just like puppies) wiggle around, don't pay attention for long and can't easily be instructed. Their head covered by an EEG cap, the infants sat on the lap of their parents, who were blindfolded so that they would not influence their children's responses. They had to look at streams of images, some that contained photographs of a smiling young woman and some that were only random patterns. What varied across experiments was the duration for which the face was exposed, from barely a glimpse—unlikely to be seen at all—to a sizable fraction of a second that, at least in older children, is invariably associated with the conscious sight of a smiling young woman.

The scientists then subtracted the EEG signals taken in response to a face sequence from those of a pattern-only sequence to

extract the unique signature associated with the face stimulus and tracked how this electric signal evolved over time. Segregating these signals according to the age of the infant into groups of five, 12 and 15 months old, and expressed in terms of statistical significance, yields the colored plots, overlaid onto an outline of the head [see box above].

All the kids showed the expected early response that develops in brain regions located at the back of the head, above the visual cortex. This response is proportional to the visual contrast and other image parameters, reflecting neuronal processing of the actual stimulus, whether or not the stimulus was actually consciously perceived. Subsequently, a sustained depolarization (relative to a reference electrode) develops over the front of the brain, in particular in in-

fants 12 months or older. This component of the signal has a more all-or-none character, reflecting the all-or-none character of conscious experience. The data reveal that one-year-old children, at least, do have a brain signature similar to that associated with conscious perception in adults. The electrical signal is perhaps a third of the speed it is in an adult, reflecting the delayed myelination (myelin is the covering of the axon that speeds up transmission of long-distance electrical communication) and immaturity of the young brain.

Of course, the extent to which they truly do have a subjective experience of a smiling face is difficult to ascertain for now. Clever scientists in the future will likely develop some fancy technique to read out the content of these young minds.

The evidence for an even further delayed slow potential is less compelling in very young infants. This finding raises the general question of when does conscious sensation begin? In the infant's first year of life, at birth, in its last trimester in the womb or even earlier? Research on animal and human fetuses suggests that the baby in the womb is partially sedated, even though it can move around, as mothers can certainly attest to [see “When Does Consciousness Arise?” *Consciousness Redux*; *SCIENTIFIC AMERICAN MIND*, September/October 2009].

Indeed, it may well be that the fetus feels as much as we do when we are in a deep, dreamless sleep. It may be that the dramatic events attending birth, including drawing its first breath, are the triggers for its first conscious experience of life. This, too, we shall know one day. **M**

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

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LETTING GO OF SELF- ESTEEM

If your self-worth depends on success, you may be in for a fall. To feel good about yourself, think less about you and more about others

**By Jennifer Crocker
and Jessica J.
Carnevale**

Photoillustrations
by Aaron Goodman

Florence Cassassuce, a project coordinator for a Mexican non-profit group, should have been having the best year of her life. It was 2007, and her work on water purification in Mexico had been credited with curbing the well contamination that leads to waterborne illness. She received widespread recognition for her endeavors, having been named a CNN Hero finalist and World Bank award winner. Although Cassassuce could hardly have achieved more, she did not feel the kind of inner satisfaction that most of us think accompanies such great strides. “I did not want to continue living life like this,” Cassassuce recalls, “searching for external sources of gratification to very temporarily boost my self-esteem.”

Self-esteem, or a person’s overall sense of self-worth, is generally considered to be critical to healthy functioning. Its darker side, however, has been largely overlooked. As Cassassuce’s experience suggests, the quest for greater self-esteem can leave people feeling empty and dissatisfied. Recent research bolsters the case. Even when we achieve goals we anticipate will make us feel

good about ourselves, high self-esteem may still elude us because self-esteem that is contingent on success is fragile.

It turns out that *having* self-esteem, as a fairly stable personality trait, does have a few modest benefits. High self-esteem also has drawbacks, however, and is mostly irrelevant for success. Further the *pursuit* of self-esteem is clearly detrimental to well-being. When people chase after a stronger sense of self-worth, it becomes their ultimate goal, leading them to sacrifice other aspirations, such as learning or doing what is good for others.

The hunt for self-esteem through a focus on achievement makes us emotionally vulnerable to life's inevitable travails and disappointments. It also causes us to engage in behaviors that can actually

sure this value using self-report scales, including statements such as "I take a positive attitude toward myself," indicating a positive evaluation of oneself, or "All in all, I am inclined to feel that I am a failure," denoting a more negative self-appraisal. Someone with a highly favorable overall self-evaluation has high self-esteem; a person who judges himself or herself unfavorably has low self-worth.

Back in the 1980s, many academic psychologists, policy makers and others became concerned about low self-esteem among the populace. They argued that solving this problem would create more productive citizens and lead to fewer social ills such as crime and school failure. The self-esteem movement began. Schools and other institutions poured resources into interventions designed to raise self-

When it comes to your brain surgeon (or spouse, for that matter), prefer that person to have **a realistic view of his or her abilities learn from mistakes**—rather than high self-esteem.

harm our chances of success, our competence and our personal relationships. A far better way to bolster your sense of self-worth is, ironically, to think about yourself less. Compassion toward others and yourself, along with a less self-centered perspective on your situation, can motivate you to achieve your goals while helping you weather bad news, learn from your mistakes and fortify your friendships.

Rocky Road

Scientists define self-esteem as the amount of value people place on themselves—an inherently subjective assessment. Researchers typically mea-

esteem, particularly in children. These programs typically centered on lots of positive feedback—irrespective of performance—and exercises in which individuals expounded on their positive qualities. In "I Love Me" lessons, for example, students were encouraged to complete the phrase "I am ..." with positive words such as "beautiful" or "gifted." Those performing below grade level were taught to focus on their potential rather than their shortcomings. In 1986, for example, California allocated \$245,000 a year to its Task Force to Promote Self-Esteem and Personal and Social Responsibility, under the assumption that the money would be repaid through lower rates of crime, welfare dependency, unwanted pregnancy, drug addiction and school failure.

Yet even as the self-esteem movement gained momentum, scientific research began to undermine some of its major assumptions. For one, the data did not show that many of us suffer from low self-esteem. On the contrary, most of us already feel pretty good about ourselves. In a study published in 1989 psychologist Roy F. Baumeister and his colleagues Dianne M. Tice and Debra G. Hutton, all then at Case Western Reserve University, found that the average American's self-esteem score is well above the conceptual midpoint of self-esteem scales—the point that denotes a moderate or decent view of the self. Like the children in Garrison Keillor's Lake Wobegon, most of us have decided we are above average.

FAST FACTS

The Ego Trap

- 1» Having high self-esteem has a few modest benefits, but it can produce problems and is mostly irrelevant for success.
- 2» The pursuit of self-esteem through a focus on greatness makes us emotionally vulnerable to life's disappointments—and can even lower our chances of success.
- 3» Compassion, along with a less self-centered perspective, can motivate us to achieve while helping us weather bad news, learn from our mistakes and fortify our friendships.

What is more, our egos seem to be expanding, not contracting. In a study published in 2008 psychologists Jean M. Twenge of San Diego State University and W. Keith Campbell of the University of Georgia concluded that high school students like themselves more now than they did in the 1970s, even though they do not see themselves as more competent than previous generations did. That is, the students do not consider themselves better at math, music, sports or other activities than adolescents did in the past, but they think more highly of themselves anyway.

While documenting a plethora of self-esteem, researchers began to discount its importance. In a comprehensive review of the literature published in 2003 Baumeister, now at Florida State University, and his

most of us likely would and a willingness to

colleagues stated that people with high self-esteem perform only slightly better academically and at work than do those with low self-esteem. Likewise, self-esteem is only weakly related to children's popularity in school and tenuously tied to the quality of a person's relationships in general. It also has little effect on how likely someone is to be violent or engage in risky behaviors such as smoking and drug use.

High self-esteem does have some benefits. It seems to make people more persistent, Baumeister and his team found. Those with high self-esteem also reported feeling happier and less depressed. Yet whether high self-esteem causes pleasant feelings, or vice versa, remains unclear.

High self-esteem seems to have at least one serious drawback: difficulty in seeing your own shortcomings. A great deal of research conducted for several decades shows that people with high self-esteem tend to have unrealistically positive views of themselves. They think they are more attractive, successful, likable, smart and moral than others do—and are unaware of their deficits or incompetence. When they get negative feedback, they tend to be defensive, blaming the test or the messenger, rather than owning up to a mistake or deficiency. In this way, high self-esteem can impede learning and growth and impair personal relationships. When it comes to your brain surgeon (or spouse, for that matter), most of us would most likely prefer that

person to have a realistic view of his or her abilities and a willingness to learn from mistakes—rather than high self-esteem.

“I Didn't Try Hard”

The studies Baumeister analyzed measured the trait of self-esteem with questions that get people to reflect about themselves in general, over time. When people are asked to indicate how they feel “right now” or “today,” self-esteem scores can fluctuate dramatically in response to events. These ups and downs affect motivation, because boosts to self-esteem feel good and drops feel lousy. Like mice looking for crumbs of cheese while steering clear of the mousetrap, people look for opportunities to inflate their self-esteem and avoid situations that could lower it.

One way to get those increases is to succeed or excel; likewise, we can try to avoid the drops by circumventing failure. Because we cannot succeed at everything, people tend to invest their self-esteem in one or a few traits or endeavors, say, academics,



sports or beauty. These *contingencies* of self-esteem represent the areas in which people's self-worth is on the line; they are worthy if they succeed and worthless if they fail. In 2003 one of us (Crocker), then at the University of Michigan, and our colleagues Riia Luhtanen and Alexandra Bouvrette, along with Lynne Cooper of the University of Missouri, developed a questionnaire assessing such contingencies as academic success, appearance, others' approval and moral virtue. People who base their self-esteem on academics, for example, say that their self-esteem goes up when they get good grades but that they feel worthless, anxious and ashamed when their grades are poor.

People who become so personally invested in certain domains are highly motivated to succeed in those realms, which often leads them to work hard. For example, Crocker and Luhtanen found that students whose self-esteem is contingent on academics report studying more than do students who depend less on such reports. On the other hand, putting

ic performance experienced markedly less extreme fluctuations in their self-worth; they were better able to weather the storm of positive and negative feedback. Studies show that a similar vulnerability afflicts those whose self-esteem is contingent on appearance or career achievement.

In addition, an uptick in self-esteem is short-lived. Our research shows that changes in self-esteem typically do not last more than a few days. Even after major accomplishments, self-esteem quickly returns to its average level. As a result, they are a relatively transient source of happiness. The instability that results from ups and downs of self-esteem, on the other hand, has significant costs to our mental health. In particular, it can lead to symptoms of depression. For example, the fluctuations in self-worth experienced by the graduate school applicants we studied were associated with increases in depressed mood, feelings of hopelessness and helplessness, disruptions in appetite and sleep, and loss of motivation.

The students whose self-esteem was tightly bound to their academic on days when they received an acceptance notice but large drops **the pain of failure far outweighed the joy of success.**

your self-worth at the mercy of achievement in this way creates emotional vulnerability to setbacks. Even the most successful people sometimes fail or fall short, even at what they do best. Trading off occasional feelings of worthlessness for motivation and the highs of achievement might seem reasonable. Yet the exchange is not even: dips in self-esteem following setbacks appear to be much larger than the increases stemming from success.

In a study published in 2002 Crocker and our colleagues asked 37 college seniors applying to graduate school to fill out a questionnaire to assess how much they based their self-worth on their academic track record, personal appearance, and love of family and friends, among other areas. These students then completed measures of their self-esteem twice a week during the two-month season of graduate school admissions. We found that students whose self-esteem was tightly bound to their academic success experienced small boosts on days when they received an acceptance notice but large drops on days they were rejected. For them, the pain of failure far outweighed the joy of success. The students whose self-esteem did not depend on academ-

Perhaps the most pernicious cost of basing self-esteem on achievement is that it can sometimes lead people to focus on avoiding failure rather than reaching for success—a mind-set that can *increase* the chances of falling short. For example, to protect their self-esteem, people may create excuses for poor performance such as “I didn’t try hard” or “I was tired, sick or upset,” believing that such explanations suggest they could have done well under other circumstances. Yet to work, the excuse must be believable, so a person may stay up late before a test so that the “tired” excuse will be valid in the event they do badly or put off studying until the last moment so they can claim they were underprepared. Social psychologists Edward E. Jones of Princeton University and Steven Berglas of Harvard Medical School coined the phrase “self-handicapping” to describe such behavior.

Pursuing self-esteem also undermines intrinsic motivation, the type driven by interest in the task itself. Psychologists Edward Deci and Richard Ryan of the University of Rochester and their colleagues have argued that contingent self-esteem is a form of ego involvement, in which people focus on how successes and failures reflect on the self. Their research, con-



success experienced small boosts in self-esteem on days they were rejected. For them,

ducted over several decades, shows that individuals who are ego-involved do things such as studying and exercising because they feel that they have to, rather than because they want to. This sense of obligation and pressure takes away the satisfaction that can come from working hard at something difficult.

Personal relationships also suffer from the quest for self-esteem. People focused on boosting their own self-esteem tend to put their own needs before those of others. Because they are preoccupied with questions about their own value, their friends, family and acquaintances serve mainly as potential sources of validation or invalidation, making their interactions with others ultimately all about themselves.

Not all contingencies of self-esteem are equally damaging. Staking self-esteem on personal values such as religious faith or virtue seems to have fewer negative consequences than letting it ride on traits or skills such as appearance or prowess at math that others can measure or judge. The reasons for this discrepancy are not fully understood, but it may result from the fact that those who are driven to prove that they are virtuous or faithful to a

religion may be more likely to engage in helpful, collaborative or philanthropic activities that others appreciate. Nevertheless, all such contingencies leave us somewhat vulnerable to the consequences of letting our self-esteem depend so heavily on the particulars that define us.

The Greater Good

Although the pursuit of self-esteem has many negative consequences, it also serves an important purpose: motivating us to action. Without the urge to prove our worth, might we turn into slackers? Fortunately, we can adopt another approach. Instead of focusing on our own status, we can focus on others or the collective good. For example, an in-

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If we were to design a new self-esteem movement, it would teach because actions designed to enhance self-esteem are motivated

dividual might work just as hard at the office, but with the primary goal of contributing to the team's mission or supporting his or her family rather than earning individual recognition. Goals directed at being constructive, supportive and responsive to others lead to feelings of connectedness, closeness to others, social support and trust, as well as reduced feelings of conflict, loneliness, fear and confusion.

Compassionate goals appear to engender a sense of worth and connectedness without the devastating drops that come after feedback suggestive of failure. In a study published in 2011 Crocker and Amy Canevello, now a psychologist at the University of North Carolina at Charlotte, examined the consequences of compassionate goals in college freshmen and their same-sex roommates. Every roommate rated the extent to which they had compassionate goals such as "be supportive of my roommate" and "be aware of the impact my behavior might have on my roommate's feelings"; they also answered a self-esteem questionnaire at the beginning and end of the semester and each week in between. In addition, participants rated their regard for their roommate, how responsive they viewed themselves as being to their roommate's needs and how responsive they perceived their roommate to be to their own needs.

Students with compassionate goals were more receptive to their roommates' needs, according to both the student and the roommate. Their roommates noticed and responded in kind, creating a virtuous cycle that solidified the relationship. Furthermore, the more responsive students were, the more their self-esteem increased during the three-month semester. Their roommates' self-esteem also rose, suggesting that having compassion for others may be an effective strategy for boosting self-esteem over the long run. In contrast, the roommates who were primarily concerned with what their roommates thought about them were less responsive to their roommates, a pattern of behavior that undermined their self-esteem and that of their roommate.

You can be compassionate toward yourself and others. If you find yourself upset by a mistake or downfall, self-compassion can make for a softer landing for your fall. People with self-compassion treat themselves kindly, as they would a close friend. They are patient with themselves, nonjudgmental and understanding of their own imperfections, according to work by psychologist Kristin Neff of the University of Texas at Austin. They also avoid harsh self-critiques or negative generalizations about self-worth following one negative experience. Self-com-

passion helps you accept life's inevitable setbacks as simply part of what it means to be human. It allows you to see failure as a learning opportunity rather than a threat, something that can motivate you to work toward your goals.

Compassion for the self seems to be linked to compassion for others. In experiments presented at the 2012 Society for Personality and Social Psychology conference, psychologists Juliana Breines and Serena Chen of the University of California, Berkeley, boosted compassion for others by asking research participants to write a note designed to make a friend feel better after causing a minor car accident. Those participants then rated themselves as higher in self-compassion than participants who recalled a fun time or read about others' suffering.

A further way to reduce an obsession with the self, and the problems that fixation generates, is to use a technique called self-distancing. Using this strategy, you see yourself from the perspective of a

can temper the unpleasant emotions that accompany a critical evaluation. And our recent work suggests that this kind of affirmation works best if the value transcends you. For example, thinking about how science can create a better world for all of us has a larger payoff than focusing on how science can win you wealth or status.

All these alternatives to pursuing self-esteem reduce the tendency to judge the self. By focusing on others, having self-compassion or adopting a distanced view of yourself, you can work toward your goals without constant self-evaluation and self-criticism. If we were to design a new self-esteem movement, it would teach people to reduce focus on the worth of the self altogether because any action designed to enhance self-esteem is destined to have, at best, temporary benefits and most likely will fail because such actions are motivated by a toxic preoccupation with self-judgment.

Such a preoccupation explains why Cassas-

people to **reduce focus on the worth of the self altogether**, by a toxic preoccupation with self-judgment.

third-party observer, the proverbial "fly on the wall," rather than from inside your own head. In a 2012 study psychologist Ethan Kross of the University of Michigan and his colleagues asked participants, on each of seven nights, to consider and answer questions about emotional events that had occurred during the previous day. In addition to noting the frequency, intensity and duration of the episodes, the subjects rated to what extent they had adopted a self-immersed versus distanced perspective when reflecting on each one. Those who adopted the distanced viewpoint recovered more rapidly from their negative feelings but also experienced briefer positive emotions than those who adopted the more self-centered outlook. The results suggest that creating mental distance from an emotional situation buffers us from the slings and arrows of fortune.

Another means of alleviating the sting of self-evaluation is self-affirmation, in which people restore their feelings of worth following negative feedback by reflecting on a value in a different realm that is important to them. For example, if someone gets cut from a basketball team, she might protect her self-esteem by, say, writing a paragraph about why science is personally meaningful to her or by simply donning a white lab coat. Such behaviors

sue's many accomplishments left her feeling empty rather than full, wanting rather than satisfied. Cassasue's work helped those in desperate need but did not lead to contentment when viewed through the lens of personal achievement. We suspect that Cassasue did feel a genuine desire to help others. But she also had a goal that backfired: to prove that she was worthy through her noble deeds. Helping others may make you feel good about yourself but only if you let go of what this means about you. If you are wondering, "Do I have worth?" "Do I have value?" the answer is not yes, no or maybe. The answer is simpler: change the subject. **M**

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LISTENING TO VOICES VOICES

A STUDENT'S JOURNEY FROM "NORMAL"
TO "SCHIZOPHRENIC" AND BACK HIGHLIGHTS
SHORTCOMINGS IN HOW OUR SOCIETY
DEALS WITH MENTAL HEALTH

BY **ELEANOR LONGDEN**
PHOTOGRAPHS BY TREVOR RAY HART

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WHEN I LEFT HOME FOR THE FIRST TIME

in 1999 to go to university, I was brimming with hope and optimism. I'd done well in school, expectations for me were high, and I gleefully entered the campus life of lectures and parties. To all appearances, I was a feisty, energetic and capable person with everything to hope for and aspire to.

Beneath that veneer, however, I was deeply unhappy, insecure and frightened—frightened of other people, of the future, of failure, of falling short of the punishingly high expectations that I had placed on myself. And, possibly most of all, I was frightened of the emptiness that I felt was inside me. I was skilled at hiding all this, of course. This aura of invulnerability I had created was so complete that I had even deceived myself. There was no way anyone could have predicted the catastrophe that was about to unfold.

It started during my second semester. I was leaving a seminar, humming to myself, fumbling with my bag—just as I'd done a hundred times before. Suddenly, I heard a voice: "She is leaving the building." It was a calm utterance, just an observation. I looked around. No one was nearby, but the voice had a clarity and decisiveness that made it clearly separate from myself. Shaken, I left my books on the

stairs and hurried home. When I arrived, I heard it again: "She is opening the door."

The Voice had arrived.

I didn't know at the time, but this was only the beginning of a horrific personal journey for me. I was eventually diagnosed with schizophrenia, which brought the full burden of societal disapproval on my shoulders, and initiated a downward spiral into despair and hopelessness. Eventually, with the help of a supportive doctor and friends and family, I did recover. But along the way, I learned a great deal about myself, about how mental distress is stigmatized and misunderstood in our society and in the medical profession and how the stigma can be an obstacle to recovery as challenging as the voices themselves.

My Life with the Voice

After its first appearance, the Voice would stay with me for a few days at a time and then disappear. Gradually it came back more frequently and remained longer, ultimately persisting for weeks at a time, narrating everything I did in the third person. "She is going to a lecture." "She is going to the library." It was neutral and impassive. After a while, it even began to feel strangely companionate and reassuring. I noticed, however, that once in a while its calm exterior slipped, and it would mirror whatever emotion I might have been experiencing at the time, but which I hadn't expressed. For example, if I was angry and tried to hide it—which I often did—then the Voice would sound frustrated. For the most part, though, it was neither sinister nor disturbing. It seemed to have something to show me about my own true emotions—particularly those that were remote and inaccessible.

After two months or so I confided in a friend about the Voice. This was my first mistake. Her reaction—suspiciousness and fear—was a powerful sign of how hearing voices in your head is taboo in our society. The notion that "normal" people don't hear voices, and the fact that I did, implied that something was seriously wrong. From this initial encounter onward, other people's attitudes toward the fact that I was hearing voices had the effect of conditioning me to adopt a hostile attitude toward what was essentially part of myself.

The fear and mistrust I was picking up from my friend had an immediate and deleterious effect on me. Suddenly, the Voice didn't seem quite so benign. When my friend insisted I immediately seek medical help, I duly complied. That was mistake number two.

I didn't tell the college doctor about the Voice right away. Instead I talked about what I thought

FAST FACTS

Living with Schizophrenia

1>>> Hearing voices is commonly linked with schizophrenia. Yet treating the voices as a symptom rather than an experience can worsen the condition.

2>>> For some patients, learning that these internal voices are a meaningful response to traumatic events from the past can facilitate healing.

3>>> Society has a long way to go before it fully shakes the stigma associated with schizophrenia. One place to start is by asking not "what's wrong with you?" but rather "what's happened to you?"

my real problems were: anxiety, feelings of low self-worth, fears about the future. He seemed to be deeply bored by the whole thing. When I mentioned the Voice, however, he nearly dropped his pen, swung round in his chair and began to pepper me with questions. I had his attention now. And let's be clear: I craved this attention—desperate to have people take an interest in me, to try and help me.

I told the doctor all about my strange commentator. During my explanation, the Voice was silent. If it had spoken, it probably would have said: "She is digging her own grave."

Medical Circus

The college doctor referred me to a psychiatrist, who likewise took a grim view of the presence of the Voice. In effect, she interpreted everything I said through a lens of latent insanity. For example, during one appointment, which was running very late, I told the doctor that I had to go because "I'm reading the news at six." Her notes, which made their way into my permanent medical record, include the observation: "*Eleanor has delusions of being a television news broadcaster.*" What she didn't know is that I was part of a student TV station that broadcast news bulletins around the campus. I really did have to read the news. But the doctor never bothered to explore this statement. She simply assumed I was mad.

At this point, events finally overtook me. A hospital admission—the first of many—followed. Next came a diagnosis of schizophrenia. Worst of all, I began to feel a toxic, tormenting sense of hopelessness, humiliation and desolation about myself and my prospects. Having been encouraged to see the Voice as a *symptom*, rather than an *experience*, my fear of it and resistance to it intensified. I began to take an aggressive stance toward what was basically part of my own mind. I was engaged in a kind of psychic civil war.

The more antagonistic I became toward the Voice, the more hostile it became in turn. Soon it wasn't just one voice, but many. And they began to grow progressively more menacing.

Helplessly and dejectedly, I began to retreat into this nightmarish inner world, in which the voices were destined to become both my persecutors and my only perceived companions. They told me, for example, that if I proved myself worthy of their help, they could change my life back to how it was. They set a series of increasingly bizarre tasks. These started off quite small—for example, "pull out three strands of hair." But they gradually grew more demanding and extreme, culminating in commands to harm myself. One day I received a particularly

dramatic instruction: "You see that tutor over there? You see that glass of water on his desk? You have to get it and throw it over him." I actually did it. It did not endear me to him or to the rest of the college faculty.

In effect, a vicious cycle of fear, avoidance and mistrust had been established, a battle in which I felt powerless and incapable of establishing peace or reconciliation.

Two years after my initial conversation with the college doctor, the deterioration had been dramatic. By then I had developed a frenzied repertoire of terrifying voices, grotesque visions and bizarre delusions. In the interim, my diagnosis had become a brand, a kind of social stigmata, that marked me out as disturbed and different—and vulnerable. I became a target for vicious bullying by a group of peers that began with ostracism, verbal taunts and culminated with physical and sexual assault.

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AS DISTURBED AND DIFFERENT—
AND VULNERABLE.

The life I'd expected to have seemed effectively over. "Eleanor," my psychiatrist told me one day, "you'd be better off with cancer because cancer is easier to cure than schizophrenia." I'd been diagnosed, drugged and discarded and was now so tormented by the voices that I informed my grieved and horrified parents of my intention to drill a hole in my head to "get them out." Fortunately I was prevented, but it was a devastating sign of my desperation at the idea of being condemned to the life of a voice hearer.

Recovery

As I look back on the wreckage and misery of those years, it seems to me now as if someone died in that place. And yet someone else was saved. A

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Eleanor Longden ceased to be tormented by voices after she learned to interpret them in a constructive way.

broken, haunted person began the journey, but the person who emerged was a survivor and would eventually grow into the person I was destined to be.

Many people have harmed me in my life, and I remember them all. But the memories grow pale and faint in comparison with those who have helped me. The fellow survivors, the fellow voice hearers, the comrades and collaborators. My mother, who never gave up on me, who knew that one day I would come back to her and who was willing to wait for me for as long as it took. The doctor who worked with me for only a brief time but who believed that recovery was not only possible but inevitable, and during a horrible period of relapse told my terrified family: “Don’t give up hope. Eleanor can get through this. Sometimes, you know, it snows as late as May, but summer always comes eventually.”

Those good and generous people fought with me and for me and waited to welcome me back from that agonized, lonely place. And together they forged a blend of courage, creativity and an unwavering belief that my shattered self could become healed and whole. I used to say that these people saved me, but I now know that they did something even more important: they empowered me to save myself.

Crucially, they also helped me understand what I had always suspected: that the voices were a meaningful response to traumatic events, particularly childhood events, and as such were not my enemies but a source of insight into emotional problems that were solvable.

At first this was difficult to believe. The voices appeared powerful and intimidating. In this respect, a vital step was my realizing that the voices

had meaning, but the meaning was often metaphorical rather than literal. For example, voices that threatened to attack my home were not to be taken as an objective danger but as an expression of my own feelings of insecurity and fear in the world.

This process of “decoding” the voices took a long time. Initially I could not interpret them in this constructive way. I remember sitting up all night on guard outside my parents’ room to protect them from what I believed was a genuine threat that the voices had conveyed. Because I’d had such bad problems with self-injury, much of the cutlery had been hidden in the house. I improvised by arming myself with a plastic fork, ready to spring into action should anything happen. (“Don’t mess with me, I’ve got a plastic fork.”) Later, I dispensed with plastic forks and instead tried to deconstruct the message behind the words. When the voices warned me, say, not to leave the house, I would thank them for drawing my attention to how unsafe I felt, but then I would reassure them and myself that we were safe and didn’t need to feel frightened anymore.

I would set boundaries for the voices. I would try to interact with them in a way that was assertive yet respectful, establishing a slow process of communication and collaboration in which we could learn to work together. Ultimately I learned that each voice was closely related to aspects of myself and that each of them carried overwhelming emotions that I had never had an opportunity to process and resolve—memories of sexual trauma and abuse, of shame, anger, loss and low self-worth. The voices took the place of this pain and gave words to it.

Possibly one of my greatest revelations was that the most negative, aggressive voices actually represented the parts of me that had been hurt the most. Correspondingly, it was these voices that needed to be shown the greatest compassion and care. By vilifying and rejecting them, I’d prolonged my suffering. My voices were actually the solution, an inextricable part of the healing process that drew attention to emotional conflicts that I needed to deal with. Armed with this knowledge, I began to gather together the pieces of my shattered self, each fragment represented by a different voice. Gradually I withdrew from my medication. And in time, I returned to psychiatry—not as a patient but as a student. Ten years after the Voice first came, I finally earned my psychology degree, with high honors. A year later I was awarded a master’s degree, also with the highest ever grade score, and I am currently in the final year of my Ph.D.

Not bad for a mad woman.

As I emerged from this difficult journey, the

voices never stopped. But my relationship with them changed beyond recognition. As I learned to accept them, they grew less hostile, more benign. Sometimes they were even helpful. During one of my exams, one of my voices dictated the answers. (Does this count as cheating?)

To be honest, I sometimes have enjoyed their attention as well. As Oscar Wilde said, the only thing worse than being talked about is not being talked about. The voices have also honed my skills in listening to two conversations at once, which comes in handy for eavesdropping. So it's not all bad.

Lessons in the Voices

What has become clear to me as a student of psychology is that my personal story is supported by a growing scholarly literature about the experiences considered indicative of schizophrenia. There is evidence that a proportion of the 1.5 million people who are diagnosed each year with schizophrenia are not victims of chemical imbalance or genetic mutation. Rather they are exhibiting a complex response to abuse, loss, neglect or other past trauma. That was the case for me. To the extent that the mental health profession acknowledges as much, it will more effectively help these patients in their recovery.

My own working life now fuses the personal and the professional to promote these ideas. For the past few years I have been working in mental health services, speaking at conferences, publishing book chapters and academic articles and arguing the relevance of the following concept: that an important question in psychiatry shouldn't be "what's wrong with you?" but rather "what's happened to you?"

And all the while, I have listened to my voices, with whom I have at last learned to live with peace and respect—and which in turn reflect my growing sense of compassion, acceptance and respect toward myself. One of the most moving and extraordinary moments in my recovery came when I was supporting another young woman who was being terrorized by her voices. Helping her made me become fully aware for the first time that I was no longer in that position myself but that I was finally able to help someone else who was.

I am now very proud to be a part of Intervoice (www.intervoiceonline.org), the organizational body of the international Hearing Voices Movement, an initiative inspired by the work of Marius Romme and Sandra Escher. They view voice hearing not as an aberrant symptom of schizophrenia to be endured but as a complex, significant and meaningful experience to be explored. Hearing voices is

a survival strategy—an individual's sane reaction to insane circumstances.

Together we have begun to envisage a society that understands and respects voice hearing, supports the needs of those who hear voices and values them as full citizens. This type of society is not only possible, it is already on its way.

For me, the achievements of the Hearing Voices Movement are a reminder that empathy, fellowship, justice and respect are more than just words, they are convictions and beliefs. And that beliefs can change the world. As labor activist Cesar Chavez said, "Once social change begins, it cannot be reversed.... You cannot humiliate the person who feels pride. You cannot oppress the people who are not afraid anymore."

In the past 20 years the movement has established Hearing Voices networks in 26 countries across five continents, working together to promote empowerment, dignity and solidarity for individuals in mental distress. We are working to fashion a new language and practice of hope, based on an unshakable belief in the power and resilience of the individual. For members of society, there is no greater honor and privilege than facilitating that healing process for someone—to bear witness, to reach out a hand, to share the burden of someone's suffering and to hold the hope for their recovery. Likewise, it is important for survivors of adversity to remember that we don't have to live our lives forever defined by the damaging things that have happened to us. We are unique, we are irreplaceable. What lies within us can never be truly colonized, contorted or taken away. The light never goes out.

As a wonderful doctor once said to me: "Don't tell me what other people have told you about yourself ... tell me about *you*." **M**

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What a Hoax

Conspiracy theories offer easy answers by casting the world as simpler and more predictable than it is. Their popularity may pose a threat to societal well-being

By Sander van der Linden

Did NASA fake the moon landing? Is the government hiding Martians in Area 51? Is global warming a hoax? The answer to these questions is, “No,” yet a committed subculture of conspiracy theorists vigorously argues the opposite.

Many scholars dismiss conspiracy theorists as paranoid and delusional. Psychological data bolster their case: people who harbor conspiracist thoughts are also more inclined to paranoid ideation and schizotypy, a mild form of schizophrenia. As conspiracy theory expert Timothy Melley of Miami University has put it, these beliefs are often dismissed as “the implausible visions of a lunatic fringe.”

Yet these antiestablishment ideas are surprisingly widely held. According to a national poll released last April by Public Policy Polling, 37 percent of Americans believe that global warming is a hoax, 21 percent think that the U.S. government is covering up evidence of the existence of space aliens and 28 percent suspect a secret elite power is plotting to take over the world. Only hours after the bombing at the Boston Marathon, people suggested, in YouTube videos and elsewhere on the Web, that the attack might

ILLUSTRATION BY MARIO WAGNER

FAST FACTS

Suspicious Minds

1 >> People who believe in one conspiracy theory are likely to espouse others, even when they are contradictory.

2 >> Conspiracy ideation is also linked with mistrust of science, including well-established findings, such as the fact that smoking can cause lung cancer.

3 >> Mere exposure to information supporting various fringe explanations can erode engagement in societal discourse.

have been an inside job and even that the entire event was a hoax.

With so many people ascribing to weakly supported explanations for news events, belief in conspiracy theories cannot be a mere symptom of pathology. The questioning of officialdom is critical to a functioning democracy, as the recent revelations of the National Security Agency's electronic surveillance efforts illustrate. Yet new data suggest that conspiracy theories can diminish public engagement, eroding interest in issues of great political importance. Attaining a better understanding of why these ideas persist can help us devise new ways to combat misinformation.

Bundles of Beliefs

First, a note about the term: a conspiracy theory is not, of course, a theory in the scientific sense of the word. In science, a theory is an explanation of a phenomenon that has been substantiated through experiments and testing and has become accepted by most experts in the relevant field—the theory of relativity, say, or the theory of evolution. Conspiracy theorists propose, without having collected rigorous data to support their case, that powerful people or groups are secretly plotting to accomplish some sinister goal.

One consistent finding in research on conspiracism is that those who lean toward one such idiosyncratic explanation are also likely to espouse others. This observation supports the hypothesis, originally made in 1994 by sociologist Ted Goertzel

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of Rutgers University, that any one conspiratorial belief serves as fodder for further fringe thinking. Once a person has decided that officialdom is deceptive in one case, other disturbing world events may appear to have similarly hushed-up origins.

A case in point is the commentary on the Boston bombings by Alex Jones, an outspoken conspiracy theorist. In discussing the attacks on the marathon, he reminded his audience that two of the hijacked planes on 9/11 had flown out of Boston. Further, he suggested the bombing could be a response to the sudden drop in the price of gold or part of a government plot to expand the Transportation Security Administration's jurisdiction to include sporting events. He not only suspects intrigue in numerous incidents but also draws connections among them.

His willingness to entertain orthogonal explanations for the tragedy in Boston illustrates another facet of conspiracist thinking: a person can end up espousing contradictory beliefs. In a 2011 study psychologists Michael J. Wood, Karen M. Douglas and Robbie M. Sutton of the University of Kent in England

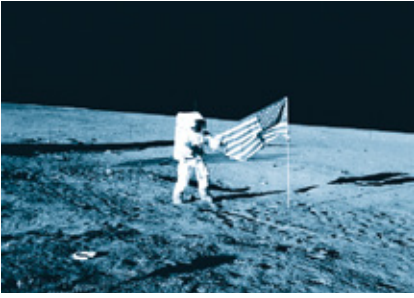
Even cursory defenses of conspiracy theories may sow mistrust and divert attention from critical scientific, political and social issues.

asked college students to rate on a scale of 1 to 7 how strongly they supported the official account of Osama bin Laden's death in a military raid. People who doubted the government's report and thought instead that bin Laden was already dead at the time of the raid were, surprisingly, also more likely than others to claim that he is still alive. An analysis of opinions on the death of Princess Diana yielded a similar logical conflict: believing that she faked her own death was significantly correlated with a suspicion that Dodi Fayed's business enemies had plotted to murder the pair.

The study's analysis concluded that people do not tend to believe in a conspiracy theory because of the specifics of a scheme but rather because they possess higher-order beliefs that support conspiracist thinking in general. A strong distrust of authority would be one such overarching ideological lens. In a belief system in which authorities are fundamentally untrustworthy, alternative—even outlandish and contradictory—explanations for troubling events can seem plausible, as long as they are consistent with a skepticism toward the powers that be.

Suspicious of Science

It might be easy enough to dismiss those who claim that the Federal Bureau of Investigation lied about JFK's assassination or that Roswell, N.M., once hosted extraterrestrial visitors. Yet the deep mistrust of authority that such people harbor also ex-



People who buy into one conspiracy theory—such as the claim that the moon landing was faked—are more likely than others to adopt further fringe ideas, perhaps believing that the government is suppressing evidence of aliens or that the attack on the World Trade Center was an inside job.

tends to the realm of science. When more than a third of the population doubts the veracity of climate scientists' conclusions, as the Public Policy Polling numbers showed, the repercussions for society can be grave. In a paper published last May, psychologist Stephan Lewandowsky of the University of Western Australia and his colleagues investigated the relation between acceptance of science and conspiracist thinking patterns. They recruited their participants from climate blogs and focused their research on the belief systems of this subpopulation. Their results suggest that buying into multiple conspiracy theories predicts the rejection of important scientific conclusions, not only about climate science but also about such well-established facts as that smoking can cause lung cancer and that HIV leads to AIDS.

In addition to sowing doubts about scientific principles, belief in conspiracy theories can lead individuals to become disengaged from topics of social and political importance. In a 2013 publication Douglas and University of Kent graduate student Daniel Jolley presented statements to their study participants that supported various conspiracy theories, including one on climate skepticism. They found that people who received information affirming the idea that global warming is a hoax were less willing to engage politically and to implement behavioral changes, such as reducing their carbon footprint.

This result is alarming because it suggests that even cursory defenses of conspiracy theories can sow mistrust and divert attention from critical scientific, political and social issues. Highly visible books such as Oklahoma senator James Inhofe's recent *The Greatest Hoax: How the Global Warming Conspiracy Threatens Your Future* may subtly erode public support for interventions that would slow climate change—even without being read. Indeed, conspiracy theories are fiendishly difficult to unseat because any effort to rebut them has the unfortunate side effect of legitimizing them at the same time. The solution may simply be to disseminate rigorous scientific evidence as widely as possible in the hope that eventually the public becomes less susceptible to implausible worldviews.

Philosopher Karl Popper argued that the fallacy of conspiracy theories lies in their tendency to describe striking events as planned, thereby grossly underestimating the random nature and unintended consequences of many political and social actions. Popper was describing a cognitive bias that psychologists now commonly refer to as the fundamental attribution error:

the habit of overestimating the intentionality behind the actions of others.

A likely function of this cognitive bias is to help people make sense of the world by offering simple explanations for complex events. A number of studies have shown that belief in conspiracy theories is associated with feelings of powerlessness and uncertainty. For example, a large 2008 study by Jennifer Whitson of the University of Texas at Austin and Adam Galinsky of Northwestern University showed that participants who lacked control were more likely to perceive illusory patterns, including conspiracies. The authors note that observing patterns where there are none fills a need for structure and organization. In other words, adopting conspiracy beliefs recasts the world as a more predictable place. A tangible enemy absorbs the blame for problems that otherwise may seem too abstract.

A good example is climate change. A 2013 analysis of peer-reviewed literature on the topic estimated the scientific consensus at 97 percent in favor of the view that anthropogenic global warming is occurring. Of course, coping with the implications of climate change may entail tremendous upheaval. Discounting the entire phenomenon as a hoax is much more convenient psychologically than making the difficult trade-offs that abating it would require. Yet as Al Gore famously pointed out, the truth is not always convenient. **M**

(Further Reading)

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- ◆ **The Social Consequences of Conspiracism: Exposure to Conspiracy Theories Decreases Intentions to Engage in Politics and to Reduce One's Carbon Footprint.** Karen M. Douglas and Daniel Jolley in *British Journal of Psychology*. Published online January 4, 2013.
- ◆ **NASA Faked the Moon Landing—Therefore, (Climate) Science Is a Hoax: An Anatomy of the Motivated Rejection of Science.** Stephan Lewandowsky, Klaus Oberauer and Gilles E. Gignac in *Psychological Science*, Vol. 24, No. 5, pages 622–633; May 2013.

LEFT TO RIGHT: COURTESY OF ALAN BEAN/NASA; HENNY RAY ABRAMS/Getty Images; RACHID DAHNOUN/Corbis

SPECIAL REPORT

HOW WE LEARN



W

hen we pack our children off to school, we envision them embarking on a life-long career of learning. Yet one thing they typically never study is the art of studying itself. Our intuitions, it turns out, do not always map to reality. In “What Works, What Doesn’t,” by John Dunlosky et al., on page 46, we comb through the vast scientific literature on learning techniques to identify the two methods that work best.

In an increasingly digital world, one shift in learning has largely evaded notice: the decline of handwriting. Different brain activity accompanies a hand scribbling on paper or fingers tapping keys, with the former invoking neuronal circuits of movement and spatial processing more strongly. As we abandon our pens and pencils in favor of the keyboard, is our engagement with words becoming more superficial?

ILLUSTRATIONS BY CELIA JOHNSON



In “The Science of Handwriting,” starting on page 54, Brandon Keim investigates this question.

Yet we need not fear change. As education data illustrate all too well, the number of degrees in mathematics, science and engineering is not keeping pace with demand. To better prepare students for the world they will one day encounter, a dramatic rethinking of how math and science are taught may be in order. “For the Love of Math,” by John Mighton, starting on page 60, describes one approach that has helped struggling students discover an untapped aptitude.

Strong foundations can nurture exploration at all ages, far beyond the classroom. But for an abiding love of learning, the 49-year-old Julia Child would not have published the cookbook that launched her career. Grandma Moses would not have taken up painting in her late 70s. And two octogenarians would not have spent 2013 vying to become the oldest climber to summit Everest. Whatever your quest, the science of learning can help you reach it. —The Editors



$$\frac{\pi}{4}$$



$$v=wy$$

WHAT WORKS, WHAT DOESN'T

Some study techniques accelerate learning, whereas others are just a waste of time—but which ones are which? An unprecedented review maps out the best pathways to knowledge

BY JOHN DUNLOSKY, KATHERINE A. RAWSON, ELIZABETH J. MARSH, MITCHELL J. NATHAN AND DANIEL T. WILLINGHAM

ILLUSTRATIONS BY CELIA JOHNSON



education generally focuses on what you study, such as algebra, the elements of the periodic table or how to conjugate verbs. But learning how to study can be just as important, with lifelong benefits. It can teach you to pick up knowledge faster and more efficiently and allow you to retain information for years rather than days.

Cognitive and educational psychologists have developed and evaluated numerous techniques, ranging from rereading to summarizing to self-testing, for more than 100 years. Some common strategies markedly improve student achievement, whereas others are time-consuming and ineffective. Yet this information is not making its way into the classroom. Teachers today are not being told which learning techniques are sup-

ported by experimental evidence, and students are not being taught how to use the ones that work well. In fact, the two study aids that students rely on the most are not effective. One of them may even undermine success.

One potential reason is that the huge amount of research is overwhelming, making it difficult for educators and students to identify the most practical and advantageous ways to study. To meet this challenge, we reviewed more than 700 scientific articles on 10 commonly used learning techniques. We focused on strategies that seem to be easy to use and broadly effective. We also took a closer look at a couple of methods that are very popular with students.

To receive our recommendation, a technique must be useful in a range of learning conditions, such as whether a student works alone or in a group. It must assist learners of various ages, abilities and levels of prior knowledge—and it must have been tested in a classroom or other real-world situation. Learners should be able to use the method to master a variety of subjects, and their performance should benefit no matter what kind of test is used to measure it. The best approaches also result in long-lasting improvements in knowledge and comprehension.

Using these criteria, we identified two clear winners. They produced robust, durable results and were relevant in many situations. Three more are recommended with reservations, and five—including two popular learning aids—are not advised, either because they are useful only in limited circumstances or because not enough evidence supports a higher rating. We encourage researchers to further explore some of the untested techniques, but students and teachers should be cautious about relying on them.

FAST FACTS

Rating the Best Ways to Study

- 1» Some study methods work in many different situations and across topics, boosting test performance and long-term retention. Learning how to learn can have lifelong benefits.
- 2» Self-testing and spreading out study sessions—so-called distributed practice—are excellent ways to improve learning. They are efficient, easy to use and effective.
- 3» Underlining and rereading, two methods that many students use, are ineffective and can be time-consuming.
- 4» Other learning techniques need further testing and evaluation. In the meantime, students and teachers can put proved study methods to use in classrooms and at home.

THE GOLD STAR WINNERS

1. SELF-TESTING Quizzing Yourself Gets High Marks



HOW IT WORKS: Unlike a test that evaluates knowledge, practice tests are done by students on their own, outside of class. Methods might include using flash cards (physical or digital) to test recall or answering the sample questions at the end of a textbook chapter. Although most students prefer to take as few tests as possible, hundreds of experiments show that self-testing improves learning and retention.

In one study, undergraduates were

asked to memorize word pairs, half of which were then included on a recall test. One week later the students remembered 35 percent of the word pairs they had been tested on, compared with only 4 percent of those they had not. In another demonstration, undergraduates were presented with Swahili-English word pairs, followed by either practice testing or review. Recall for items they had been repeatedly tested on was 80 percent, compared with only 36 percent for items they had restudied. One theory is that practice testing triggers a mental search of long-term memory that activates related information, forming multiple memory pathways that make the information easier to access.

WHEN DOES IT WORK? Anyone from preschoolers to fourth-year medical students to middle-age adults can benefit from practice testing. It can be used for all kinds of factual information, including learning words in foreign languages, making spelling lists and memorizing the parts of flowers. It even improves re-

tention for people with Alzheimer's disease. Short, frequent exams are most effective, especially when test takers receive feedback on the correct answers.

Practice testing works even when its format is different from that of the real test. The beneficial effects may last for months to years—great news, given that durable learning is so important.

IS IT PRACTICAL? Yes. It requires modest amounts of time and little to no training.

HOW CAN I DO IT? Students can self-test with flash cards or by using the Cornell system: during in-class note taking, make a column on one edge of the page where you enter key terms or questions. You can test yourself later by covering the notes and answering the questions (or explaining the keywords) on the other side.

RATING: High utility. Practice testing works across an impressive range of formats, content, learner ages and retention intervals.

WE REVIEWED MORE THAN 700 SCIENTIFIC ARTICLES ON 10 COMMON LEARNING TECHNIQUES TO IDENTIFY THE MOST ADVANTAGEOUS WAYS TO STUDY.

2. DISTRIBUTED PRACTICE

For Best Results, Spread Your Study over Time



HOW IT WORKS: Students often “mass” their study—in other words, they cram. But distributing learning over time is much more effective. In one classic experiment, students learned the English equivalents of Spanish words, then reviewed the material in six sessions. One group did the review sessions back to back, another had them one day apart and a third did the reviews 30 days apart. The students in the 30-day group remembered the translations the best. In an analysis of 254

studies involving more than 14,000 participants, students recalled more after spaced study (scoring 47 percent overall) than after massed study (37 percent).

WHEN DOES IT WORK? Children as young as age three benefit, as do undergraduates and older adults. Distributed practice is effective for learning foreign vocabulary, word definitions, and even skills such as mathematics, music and surgery.

IS IT PRACTICAL? Yes. Although textbooks usually group problems together by topic, you can intersperse them on

your own. You will have to plan ahead and overcome the common student tendency to procrastinate.

HOW CAN I DO IT? Longer intervals are generally more effective. In one study, 30-day delays improved performance more than lags of just one day. In an Internet-based study of trivia learning, peak performance came when sessions were spaced at about 10 to 20 percent of the retention interval. To remember something for one week, learning episodes should be 12 to 24 hours apart; to remember something for five years, they

should be spaced six to 12 months apart. Although it may not seem like it, you actually do retain information even during these long intervals, and you quickly relearn what you have forgotten. Long delays between study periods are ideal to retain fundamental concepts that form the basis for advanced knowledge.

RATING: High utility. Distributed practice is effective for learners of different ages studying a wide variety of materials and over long delays. It is easy to do and has been used successfully in a number of real-world classroom studies.

THE RUNNERS-UP

Despite their promise, the following learning techniques fall short, in many cases because not enough evidence has been amassed to support their use. Some techniques, such as elaborative interrogation and self-explanation, have not been evaluated sufficiently in real-world educational contexts. Another emerging method called interleaved practice has just begun to be systematically explored. Nevertheless, these techniques show enough potential for us to recommend their use in the situations described briefly here.

3. ELABORATIVE INTERROGATION Channel Your Inner Four-Year-Old



HOW IT WORKS: Inquisitive by nature, we are always looking for explanations for the world around us. A sizable body of evidence suggests that prompting students to answer “Why?” questions also facilitates learning.

With this technique, called elaborative

interrogation, learners produce explanations for facts, such as “Why does it make sense that...?” or “Why is this true?” In one experiment, for example, students read sentences such as “the hungry man got into the car.” Participants in an elaborative interrogation group were asked to explain why, whereas others were provided with an explanation, such as “the hungry man got into the car to go to the restaurant.” A third group simply read each sentence. When asked to recall which man performed what action (“Who got in the car?”), the elaborative-interrogation group answered about 72 percent correctly, compared with about 37 percent for the others.

WHEN SHOULD I USE IT? When you are learning factual information—particularly if you already know something about

the subject. Its power increases with prior knowledge; German students benefitted from elaborative interrogation more when they were learning about German states than about Canadian provinces, for example. It may be that prior knowledge permits students to generate more appropriate explanations for why a fact is true.

PROMPTING STUDENTS TO ANSWER “WHY?” QUESTIONS, CALLED ELABORATIVE INTERROGATION, ALSO FACILITATES LEARNING.

The effects of this technique appear to be robust across ages, from fourth graders through undergraduates. Elaborative interrogation clearly improves memory for facts, but whether it also might enhance comprehension is less certain, and there is no conclusive information about how long the gains in learning persist.

IS IT PRACTICAL? Yes. It requires minimal training and makes reasonable time demands. In one study, an elaborative-interrogation group required 32 minutes to do a task that took 28 minutes for a reading-only group.

RATING: Moderate utility. The technique

works for a broad range of topics but may not be useful for material more complex than a factual list. Benefits for learners without prior knowledge may be limited. More research will be needed to establish whether elaborative interrogation generalizes to various situations and different types of information.

4. SELF-EXPLANATION How Do I Know?



HOW IT WORKS: Students generate explanations of what they learn, reviewing their mental processing with questions such as “What new information does the

sentence provide for you?” and “How does it relate to what you already know?” Similar to elaborative interrogation, self-explanation may help integrate new information with prior knowledge.

WHEN SHOULD I USE IT? It benefits kindergartners to college students and helps in solving math problems and logical reasoning puzzles, learning from narrative texts and even mastering endgame strategies in chess. In younger children, self-explanation can help with basic ideas such as learning numbers or patterns. The technique improves memory, comprehension and problem solving—an impressive range of outcomes. Most studies, however, have measured effects within only a few minutes, and it is not known

whether the technique is more lasting in people of high or low knowledge.

IS IT PRACTICAL? Unclear. On the one hand, most students need minimal instruction and little to no practice, although one test of ninth graders showed that students without training tended to paraphrase rather than generate explanations. On the other, a few studies report that this technique is time-consuming, increasing time demands by 30 to 100 percent.

RATING: Moderate utility. Self-explanation works across different subjects and an impressive age range. Further research must establish whether these effects are durable and whether the time demands make it worthwhile.

(The Authors)

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5. INTERLEAVED PRACTICE Mixing Apples and Oranges



HOW IT WORKS: Students tend to study in blocks, finishing one topic or type of problem before moving on to the next. But recent research has shown benefits for interleaved practice, in which students alternate a variety of types of information or problems. In one study, for example, college students learned to compute the volumes of four different geometric shapes. In a so-called blocked-practice condition, they finished all the problems for one shape before moving on to the next. In interleaved practice, the problems were intermixed. When tested one week later, the interleaved

What Doesn't Work

These techniques were rated as low utility because they are inefficient, ineffective or beneficial only for certain types of learning and for short periods of retention. Most students report rereading and highlighting, yet these techniques do not consistently boost performance, and they distract students from more productive strategies. Other methods mentioned below are just too time-consuming.

HIGHLIGHTING

Students commonly report underlining, highlighting or otherwise marking material. It is simple and quick—but it does little to improve performance. In controlled studies, highlighting has failed to help U.S. Air Force basic trainees, children and remedial students, as well as typical undergraduates. Underlining was ineffective regardless of text length and topic, whether it was aerodynamics, ancient Greek schools or Tanzania.

In fact, it may actually hurt performance on some higher-level tasks. One study of education majors found that underlining reduced their ability to draw inferences from a history textbook. It may be that underlining draws attention to individual items rather than to connections across items.

WHAT YOU SHOULD DO INSTEAD: Highlighting or underlining can be useful if it is the beginning of a journey—if the marked information is then turned into flash cards or self-tests. Given that students are very likely to continue to use this popular technique, future research should be aimed at teaching students how to highlight more effectively—which likely means doing it more judiciously (most undergraduates overmark texts) and putting that information to work with a more useful learning technique.

REREADING

In one survey of undergraduates at an elite university, 84 percent said they reread textbooks or notes during study. It requires no training, makes modest demands on time, and has shown some benefits on recall and fill-in-the-blank-style tests.

Yet the evidence is muddy that rereading strengthens comprehension, and whether its effects depend on knowledge level or



ability is also woefully underexplored. Most of the benefit of rereading appears to accrue from the second reading, with diminishing returns from additional repetitions. No experimental research has assessed it using materials from actual courses—ironic, given that this strategy is the one most commonly reported by students.

WHAT YOU SHOULD DO INSTEAD: Don't waste your time—in head-to-head comparisons, rereading fares poorly against more active strategies such as elaborative interrogation, self-explanation and practice testing.

Three less commonly used study techniques also fared poorly in our assessment. “Imagery for text learning” needs more evidence before it can be recommended, whereas “summarization” and “keyword mnemonic” appear to be ineffective and time-consuming.

In summarization, students identify a text's main points, excluding unimportant material. Whether it works is difficult to answer, as it has been implemented in many different ways. It is unknown whether summarizing small pieces of a text or large chunks of it works better or whether the length, readability or organization of the material matters.

With keyword mnemonics, imagery is used to enhance memory; for example, a student learning the French word *la dent* (“tooth”) might use the similar-sounding English word “dentist” to form a mental image of a dentist holding a large molar. Mnemonics do seem to help with foreign-language vocabulary, word definitions and medical terminology, but the effects have not been shown to endure, and in the end the effort involved in generating keywords may not be an efficient use of time.

Another technique that uses mental pictures is imagery for text learning, in which students are told to create images for every paragraph they read. Research has revealed a patchwork of inconsistent results that have not been shown to last over the long term. Teachers may consider instructing students to attempt using this technique with image-friendly texts, but further demonstrations of its usefulness are necessary.

➤ See the *Psychological Science in the Public Interest* article “Improving Students’ Learning with Effective Learning Techniques: Promising Directions from Cognitive and Educational Psychology,” on which this story for *Scientific American Mind* is based, at the Association for Psychological Science’s Web site: www.psychologicalscience.org

practice group was 43 percent more accurate. Interleaving allows students to practice selecting the correct method and encourages them to compare different kinds of problems.

WHEN SHOULD I USE IT? When the types of problems are similar, perhaps because juxtaposing them makes it easier to see what is different about them. Blocked practice—doing all the items from one category in a row—may be more effective when the examples are not very much alike because it highlights what they have in common.

It is possible that interleaved practice benefits only those who are already reasonably competent. Outcomes are also mixed for different types of content. It improves performance on algebra problems and was effective in a study that trained medical students to interpret electrical recordings to diag-

STUDENTS ARE NOT BEING TAUGHT THE BEST STRATEGIES, PERHAPS BECAUSE TEACHERS THEMSELVES ARE NOT SCHOOLED IN THEM.

nose cardiac disorders. Yet two studies of foreign-vocabulary learning showed no effect for interleaved practice. Nevertheless, given how much difficulty many students have in mathematics, it may still be a worthwhile strategy for that subject.

IS IT PRACTICAL? It seems to be. A motivated student could easily use interleav-

ing without any instruction. Teachers could also use the technique in the classroom: After one kind of problem (or topic) is introduced, practice first focuses on that problem. Once the next kind of problem is introduced, it is mixed in with examples of earlier subjects. It may take a little more time than blocking practice, but such slowing most likely is worthwhile, reflecting cognitive processes that boost performance.

RATING: Moderate utility. Interleaved practice improves learning and retention of mathematical knowledge and boosts other cognitive skills. The literature on interleaved practice is small, however, and includes enough negative results to raise concern. It may be that the technique does not consistently work well, or perhaps it is not always used appropriately—topics for future research.

What We Have Learned

Why don't students use more effective study techniques? It seems they are not being taught the best strategies, perhaps because teachers themselves are not schooled in them. In our survey of six educational-psychology textbooks, only one technique—"keyword mnemonics"—was covered in every book. None offered much guidance on the use, effectiveness or limitations of different ways of studying.

A second problem may be that in the educational system, the emphasis is on teaching students critical-thinking skills and content. Less time is spent on teaching them how to learn. The result can be that students who do well in their early years, when learning is closely supervised, may struggle once they are expected to regulate their own learning in high school or college.

Some questions, such as the best age for students to start using a technique and how often they will need to be re-

trained or reminded, still require further research. But even now teachers can incorporate the most successful approaches into lesson plans so that students could adopt them on their own. For instance, when moving to a new section, a teacher can start by asking students to do a practice test that covers important ideas from the previous section and providing immediate feedback. Students can interleave new problems with related ones from preceding units. Teachers can harness distributed practice by reintroducing major concepts during the course of several classes. They can engage students in explanatory questioning by prompting them to consider how the information is new to them or why it might be true.

These learning techniques are no panacea. They benefit only those who are motivated and capable of using them. Nevertheless, we expect that students will make meaningful gains in classroom performance, on achievement tests and during their lifetime. **M**

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- ◆ **Interleaving Helps Students Distinguish among Similar Concepts.** D. Rohrer in *Educational Psychology Review*, Vol. 24, No. 3, pages 355–367; September 2012.
- ◆ **Using Spacing to Enhance Diverse Forms of Learning: Review of Recent Research and Implications for Instruction.** S. K. Carpenter, N. J. Cepeda, D. Rohrer, S.H.K. Kang and H. Pashler, *ibid.*, pages 369–378.
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THE SCIENCE OF *Handwriting*

As we jettison the pen and pencil in a digital world,
we are changing the way our brain thinks about writing

BY BRANDON KEIM ILLUSTRATIONS BY CELIA JOHNSON

I am writing this article in bold, retroexperimental fashion, using a technique found rarely in the modern publishing world: handwriting, using pen and paper, those dead-tree tools seen by technophiles as historical curiosities, like clay tablets or Remington typewriters.

Why do such a thing in a keystroke age? In part I do so because handwriting is becoming a marginal activity, in society and in my life. We type more than ever before, and it's not uncommon to meet people who have ceased writing by hand altogether, their scripts withering like vestigial limbs.

I can't shake the feeling that my thinking is different—more measured, more rich—when mediated by hand rather than machine. People whom I ask often tell similar stories. The bulk of their words are delivered by keyboard, but they still make lists, take notes, outline texts or compose their thoughts by hand. They, too, feel handwriting engages the mind differently.

The feeling alone is certainly unscientific. It could be an illusion or confounded by factors, such as the difficulty of checking e-mail on paper, that have nothing to with hand-

writing's cognitive properties. Skeptics might contend that modern children, weaned on keys and screens, will wield their devices to equal effect. As long as we write, what does it matter how?

So goes the conventional wisdom. Every other major millennial technological shift has occasioned hand-wringing concern: we worry about Internet addiction, friendships trivialized by social media, e-readers supplanting physical books, screens turning kids into stimulation junkies. Yet apart from writer Philip Hensher's lovely *The Missing Ink*, a book that plumbs handwriting's cultural history, the dwindling of this technology, central to civilization's rise, has gone largely unremarked.

As it turns out, only a few researchers have studied handwriting's relation to thought, and their findings are in early-draft

ABCDEFGHIJKLMNOPQRSTUVWXYZ



form—but the draft suggests that us pen-clutching holdouts may be on to something. Pens and pencils do seem to engage our brain in a unique manner, especially as children. Whether these differences translate into nuances of adult thought is still unclear, and if you're looking for advice on whether a number-two pencil will best boost your brain, it doesn't exist. But society ought to be very careful about putting its pencils away for good.

Our Marvelous Hands

Given that writing is one of humanity's foundational achievements—Hammurabi's codes were not committed to memory, and Gutenberg could print only what was first handwritten—one might expect more scientific conclusiveness about its media. From the first modern writing studies in the 1970s until recently, researchers have focused on cognitive and linguistic aspects, such as revision strategies and memory. Brains mattered, not tools, nor the rest of our bodies. The medium was not the message.

“Researchers have been concerned with writing as a linguistic activity. It is, but it must also be accomplished in a material way,” says Christina Haas, a professor in the University of Minnesota's writing studies department and editor of the journal *Written Communication*. In the late 1980s Haas found, to her surprise, that students seemed to do a better job of planning their writing by hand

than by keyboard. It was a data point, not a conclusion; the study was small, and the students likely did not start typing during childhood, which would matter. Still, her result was intriguing.

“I thought, How can it be that the tool you use can influence what's happening in your brain?” Haas says. “I know this sounds simple, but it led me to the insight that people weren't talking about: it's the human body that intervenes between the tool and the brain.” Central to that intervention are our hands, through which so many everyday interactions flow. (If you want to appreciate your hands anew, spend the next 15 minutes being mindful of their movements.) In a vision-centric society, hands tend to be overlooked, but their evolutionary importance is paramount.

Lucy, the australopithecine mother of our lineage, was not merely special because she stood upright but because doing so freed her hands. Over the next several million years these appendages gained exquisite versatility and precision, of use in crafting tools and also possibly in shaping language. Some researchers think gesture allowed language to evolve, imparting the representational richness necessary for syntax to arise. “That linkage between hand and mind is intimate,” says anthropologist David F. Armstrong.

The importance of the hand-mind link is seen in developing children, for

whom the ability to manipulate physical objects tracks uncannily with the acquisition of speech. It is also evident in the clinical literature, which contains many examples of patients with brain lesions that impair their handwriting also struggling to recognize letters by sight. For people who have trouble reading, tracing the outlines of letters with their fingers often helps.

“We use our hands to access our thoughts,” says Virginia Berninger, an educational psychologist at the Univer-

“I THOUGHT, HOW CAN IT BE THAT THE TOOL YOU USE CAN INFLUENCE WHAT'S HAPPENING IN YOUR BRAIN?” HAAS SAYS.

sity of Washington. What our hands do with a keyboard is very different than with pen and paper. For most people, typing becomes automatic after a few months of instruction. Learning the precise geometries that make up handwritten characters, however, takes years. (The dominant hand is not alone, either. As interface expert Yves Guiard of Télécom ParisTech has shown, nondominant hands constantly and subtly adjust paper position just before letters are formed.) The geometries are so rich that forensic analysts take as axiomatic that no two people have the same script.

Visual feedback is also essential. Handwriting is messy in the dark. And that points to what literacy professor Anne Mangen of the University of Stavanger in Norway considers a central property of handwriting: it unifies hand, eye and attention at a single point in space and time. Typing on a keyboard, which Mangen calls “the abstraction of inscription,” breaks the unity. The question is, Does it matter?

FAST FACTS

By the Letter

- 1» Little attention has been paid to the dwindling status of handwriting, both in schools and in life more generally.
- 2» Learning letters in an unfamiliar alphabet by hand rather than typing may lead to longer-term memories. One reason may be that seeing handwriting, but not typed letters, elicits motor activity in the brain.
- 3» This and other findings suggest that handwriting has unique cognitive properties that help to shape how children learn to read and write.

The Scientific Letter

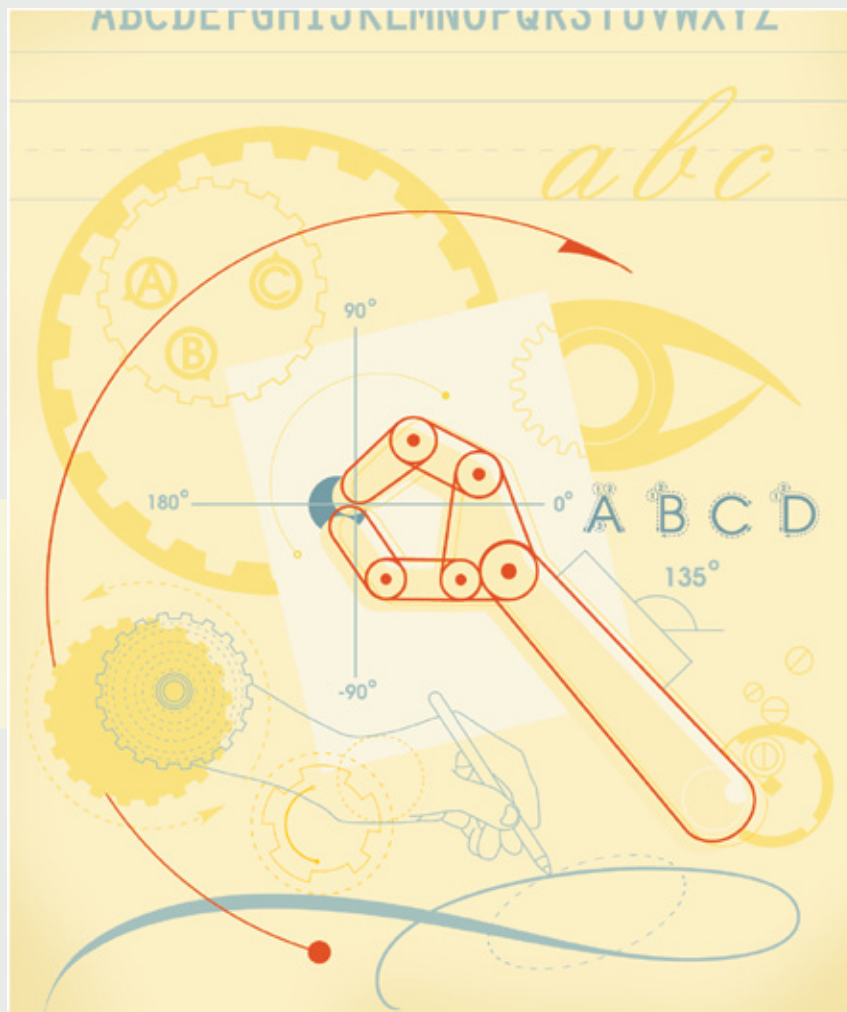
The beginnings of an answer lie, appropriately, with letter perception. Seeing either handwritten or typed letters naturally stimulates visual activity, but the former also produces motor activity, although we remain physically motionless. At the neurological level, a scripted letter is both visual and physical.

Marieke Longcamp, a cognitive scientist at Aix-Marseille University in France, refers to this phenomenon as an embodiment of perception and has investigated its consequences in a series of experiments that test children on their ability to recognize letters, a task of deceptive simplicity to a literate adult. Discerning b and d or understanding that A and a are the same characters is only easy because we have practiced for so long.

When Longcamp trained children still learning the alphabet to write letters by hand, they more readily recognized the letters than when she taught them the appropriate keystrokes, as she described in a 2005 study. A year later Longcamp saw a similar pattern in adults, but with an interesting twist. Over several weeks she taught adults to handwrite or type unfamiliar Bengali letterforms. Immediately after training, handwriters and typers were equally adept at recognition tests. After several more weeks, though, dramatic differences in recall emerged. Letterform knowledge accumulated by hand persisted, whereas typed learning dissipated.

Longcamp attributes this difference to the motor activity that seeing handwritten letters triggers. Because reading a scrawled character seems to activate the neurological instructions for penning it, the mere act of reading the letter replays it anew in our mind. “This memory doesn’t exist in the keyboard,” Longcamp says.

Those studies are not definitive; they involved just a few dozen participants, and the inevitable caveats attend. Yet they fit into a continuum of complementary findings, the next of which come from cognitive neuroscientist Karin James of Indiana University Bloomington. James is interested in functional spe-



cialization, which is the way parts of the human brain are fine-tuned to process faces, colors and motion without conscious thought.

Letters also attain specialization, but unlike colors and motion they are almost certainly not evolutionarily hardwired. Instead, James surmises, letter specializations develop during childhood, through exposure to language, raising the question of whether different types of exposure affect specialization.

James observed people’s brains as they looked at letters and letterlike shapes in a pair of experiments in 2008 and 2010. When they have been taught to write those forms by hand, activity in functionally specialized letter areas is greater than when they have learned the

keystrokes. Moreover, as she described in a 2012 paper, seeing handwritten letters not only triggers the expected motor activity but even heightens activity in purely visual areas. Hands help us see.

James attributes this facility not to Longcamp’s mental-letter-replay mechanisms but to the way our hands produce subtly differing letterforms with

(The Author)

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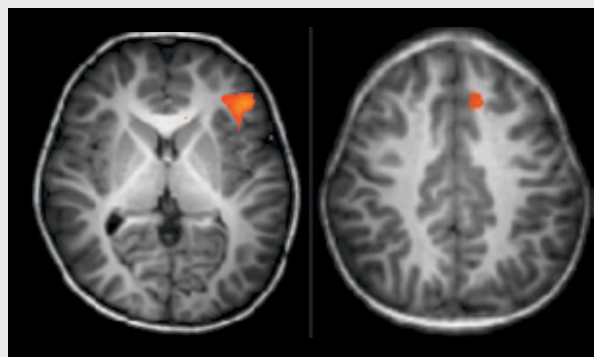
every iteration. Even a practiced writer rarely produces two identical letters, and the effect is more pronounced in children. As James describes it, child letterforms are still “noisy relative to the model” and in aggregate make up a mental library of the many variations a single letter can take.

Letter recognition is a fundament of reading. It is also crucial to spelling, an ability that predicts many high-level language skills, such as translating ideas into text or expressing concepts clearly. “If this process is different according to writing mode, it can affect the whole reading process,” Longcamp says.

Such millisecond-level neurological processing can cross into real-world relevance, as the work of Berninger at the University of Washington reveals. Berninger led an exceptionally thorough, five-year-long study of 128 children as they learned to write. She and her colleagues tracked their subjects on various cognitive and academic measures, from how their fingers tapped in sequence to spelling ability, memory and communication skills.

Key to a 2009 publication emerging from this study were the serially coordi-

Brain activity differs when printing or typing letters. In one study, subjects who saw letters they had earlier printed, but not typed, had more activity in the left inferior frontal gyrus (near right), a speech area, and in the left anterior cingulate cortex (far right), involved in decision making and attention, among other things.



nated finger movements, which renowned psychologist Karl Lashley proposed, in the mid-20th century, as a foundation for basic cognitive functions. In the 1990s they were shown to underlie handwriting as well. While performing them, students showed marked differences in brain activity usually related to language and working memory. The latter—one’s capacity for keeping and organizing information in mind, such as an essay writer simultaneously grasping facts she intends to convey, her overall argument and a just completed sentence—is indispensable to complex reading and writing.

Outside the scanner, these activations in turn tracked with letter-forming ability, handwriting legibility and ultimately the students’ fluency of expression. “It’s legible, automatic handwriting, when you just ask kids to write the alphabet from memory, that was the single best predictor of not only spelling but the quality and amount they composed,” Berninger

says. She considers hands to be “the end organ of the language system.”

The Next Chapter

Berninger emphasizes that her findings need to be replicated, but the studies consistently point to the importance for handwriting in child development. The message comes at an opportune time: the so-called Common Core standards, a set of guidelines issued in 2010 to unify state curricula in the U.S., has set off a national discussion about handwriting’s place in school.

Much of the discussion involves cursive education, which went unmentioned in the standards, leading to its formal abandonment by Indiana and Florida. The ensuing backlash prompted eight states, including California and a chastened Indiana, to affirm cursive’s importance. Cursive aside, the educational trend is nonetheless away from handwriting. It is taught less rigorously than in the past, and typing is ever more common in ever lower grades, a drift reflective of handwriting’s dwindling in society at large. Kathleen S. Wright, handwriting product manager at Ohio-based education company Zaner-Bloser, says teachers often tell her about children who start school without ever having seen an adult write by hand.

“Everybody in the writing community says it’s better to begin writing by hand,” says behavioral scientist Thierry Olive of the University of Poitiers in France. “When you type, you don’t have movement.” Yet once students are old

AN EVOLVING ALPHABET

Hieroglyphic	Proto Sinaitic	Phoenician & Paleo-Hebrew	Early Greek	Greek	Latin	Modern Hebrew

According to one view, the modern alphabet evolved from Egyptian hieroglyphics, and the pictograms’ meaning may have served as a mnemonic tool. For example, the modern Hebrew letter *aleph* is believed to have been derived from a word meaning “ox” (*alp*) and *bet* from a word meaning “house.”

FROM “THE EFFECTS OF HANDWRITING EXPERIENCE ON FUNCTIONAL BRAIN DEVELOPMENT IN PRE-LITERATE CHILDREN,” BY KARIN H. JAMES AND LAURA ENGELHARDT, IN *TRENDS IN NEUROSCIENCE AND EDUCATION*, VOL. 1, NO. 1, DECEMBER 2012. REPRINTED WITH PERMISSION FROM ELSEVIER (BRAIN SCANS); SCIENTIFIC AMERICAN MIND; SOURCE: “HOW THE ALPHABET WAS BORN FROM HIEROGLYPHS,” BY ORLY GOLDWASSER, IN *BIBLICAL ARCHAEOLOGY REVIEW*, VOL. 36, NO. 2, MARCH/APRIL 2010 (letter chart)

enough, can pens and pencils be dropped, like training wheels on the way to typing's 10-speed bicycle? On this question, research goes fuzzy. Writing in the adult sense is more than letterform and character recognition. It is a mentally recursive process, an ever shifting, feedback-looping interplay between thoughts and knowledge.

In some circumstances, the text-manipulating powers of word-processing programs seem to aid complex thought. The programs also offer a sheer speed that, for some people, ultimately feels more true to mind than handwriting. David Slomp, a literacy education instructor at the University of Lethbridge in Alberta, thinks this automaticity is what matters: as long as the letters flow, keyboarding is just fine. And just as Stephen Peverly, an educational psychologist at Columbia University's Teachers College, can offer anecdotes about students swapping laptops for notebooks because they better remember handwritten notes, some studies suggest the opposite.

There is, however, one aspect of writing that hints at a unique role for hands. Writing also seems to have spatial properties, a dimension revealed in experiments on writing with distractions. Texts composed while writers trace shapes with one hand, for example, engaging their brain's spatial processes, are uniquely disorganized compared with texts composed with background noise flashing on a screen and contain fewer new ideas. Minds encode the relative locations of words and paragraphs, a blueprint of thought without which text may be less differentiated, a pile of beams rather than a scaffold.

Here, it seems, is a possible intersection for handwriting's physical aspects and higher-level properties. Perhaps hand-formed letters, inscribed more deeply in our mind, are building blocks for sturdier mental architectures. However speculative and untested a hypothesis, it resonates with many people's experiences. Often, Haas says, students reported that "somehow with the com-

puter, I can't get a sense of my text. They used that term, over and over. Maybe they were not understanding the structure of their text." The benefits of pen and paper may then be traced, at least in part, to what they offer as interfaces: the ability to easily make squiggles and arrows, to write between lines, to integrate

PERHAPS HAND-FORMED LETTERS, INSCRIBED MORE DEEPLY IN OUR MIND, ARE BUILDING BLOCKS FOR STURDIER MENTAL ARCHITECTURES.

text with diagram. For all the effort expended on programs for brainstorming and mind-mapping and outlining, those functions remain clumsy on computers.

One's writing experiences and preferences are ultimately personal, varying by situation and mental habits. Such is the case with people I interviewed for this article: Marieke Longcamp types for work but takes notes by hand. Christina Haas types documents that can be composed quickly but switches to handwriting for deep thinking. Thierry Olive types his articles but writes in his journal. Both David Armstrong and anthropologist Sherman Wilcox, his collaborator, type almost exclusively, although

Wilcox edits by hand. So does John Hayes, a founder of modern cognitive studies of writing.

As for myself, coming to the end of an article that, by the time you read it, will have been written and edited by hand, typed in editor-friendly digital format, then edited again, it is difficult to say what precisely would differ if I had typed from the beginning or composed every last iteration by hand.

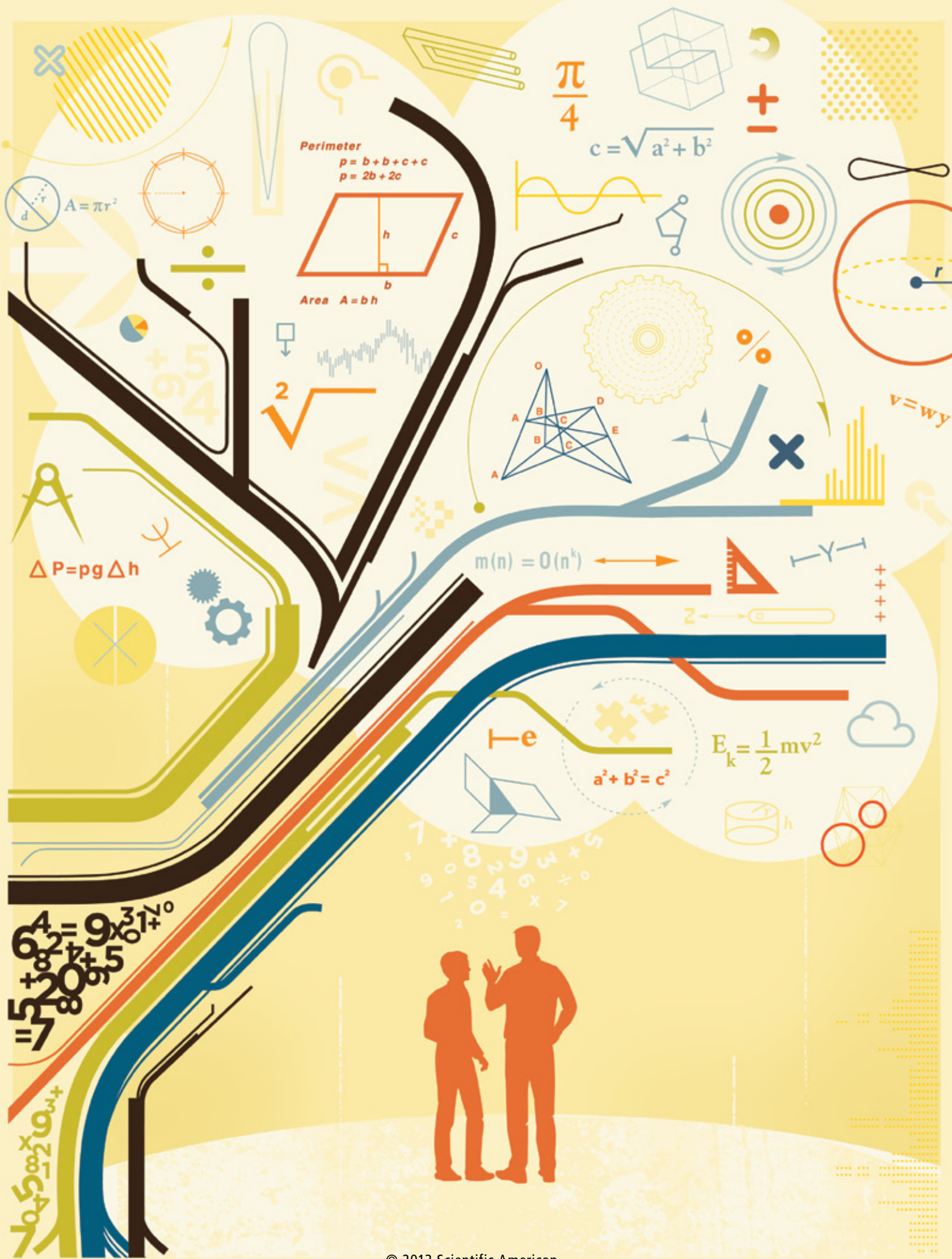
Frequently I outline longer articles by hand, so the essential structure would likely be similar. I do think, though, that there is something special in how a pen rests in the hand and moves across paper, to Mangen's sense of meditative flow arising from motor and sensory unity. I don't have that sense, as I do on-screen, of manipulating text blocks but rather words and sentences.

The text itself also feels somehow more complete, especially those parts derived from handwritten notes and hand-annotated reference material. I feel that I know the text more than usual. Years from now I will likely remember this story more fully than those I have typed, which sometimes I encounter online with no memory at all of writing.

Is that sentiment scientific? Not in the least. Would you have the same experience? Not necessarily. Could it be ascribed in part to the extra days that handwriting required or the subject's closeness to my heart? Quite possibly. But I can report, in this nonconclusive, N of 1 study, with no controls or standardized metrics or objective behavioral outcomes, that writing by hand felt good, even right. **M**

(Further Reading)

- ◆ **The Hand: How Its Use Shapes the Brain, Language, and Human Culture.** Frank R. Wilson. Vintage, 1999.
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- ◆ **The Missing Ink: The Lost Art of Handwriting.** Philip Hensher. Faber and Faber, 2012.



$A = \pi r^2$

Perimeter
 $p = b + b + c + c$
 $p = 2b + 2c$

Area $A = bh$

$\frac{\pi}{4}$
 $c = \sqrt{a^2 + b^2}$

$\Delta P = \rho g \Delta h$

$m(n) = O(n^4)$

$E_k = \frac{1}{2}mv^2$

$a^2 + b^2 = c^2$



FOR THE LOVE OF MATH

With the right lesson plan, teachers can turn struggling students into budding mathematicians. The secret is carefully guiding their adventure in numbers

BY JOHN MIGHTON

ILLUSTRATIONS BY CELIA JOHNSON

I still vividly remember the day, 14 years ago, when a tall and painfully shy sixth grade student named Lisa sat down at my kitchen table for her first math lesson with me. Lisa's principal had recommended her for a free after-school tutoring program I had started in my apartment with several friends. Although I had asked the principal for students struggling in math, I was not prepared for Lisa.

SAMPLE PROBLEM

“IF THE RATIO OF GIRLS TO BOYS IN A TOWN IS 4 TO 5, WHAT FRACTION ARE GIRLS?” MANY WILL ANSWER FOUR FIFTHS. THE CORRECT ANSWER IS FOUR NINTHS, WHICH REQUIRES UNDERSTANDING THAT THE DENOMINATOR OF THE FRACTION HAS TO REPRESENT ALL OF THE CHILDREN, NOT JUST THE BOYS.

and kept saying, when I mentioned the simplest concepts, “I don’t understand.”

I had no idea what to do with Lisa, so I decided to see if she could learn to count by twos so she could eventually multiply by two. To ease her fears, I told her I was certain that she was smart enough to learn to multiply. I was afraid I might be giving her false praise, but my encouragement seemed to help her focus, and she made more progress than I expected.

I tutored Lisa once a week for three years. In grade nine, she transferred out of the remedial stream in math, and in her second term she skipped a year and enrolled in grade 10 math. She was able to solve word problems and carry out complex operations on tests independently, and several times I watched her teach herself material out of a textbook. Her final mark in grade 10 math was a

I had planned to boost Lisa’s confidence by teaching her to add fractions. I knew from previous experience as a tutor that children often develop anxieties about math when they first encounter fractions. Because my lesson involved multiplication, I asked Lisa if she had trouble remembering any times tables, but she stared at me blankly. She had no idea what multiplication meant. Even the concept of counting by a number other than one was foreign to her. She was terrified by my questions

C+, but she was a year ahead. She had progressed from grade one to grade nine in only 100 hours of lessons, fewer than she would have received in a year of school. If I had had more time to prepare her, she could have done better.

In working with Lisa and the other students I tutored, I became convinced that children have far more potential to learn math than they typically exhibit at school. I registered my tutoring program as a charity, called JUMP (Junior Undiscovered Math Prodigies) Math, and embarked on a decade-long odyssey to determine the true math capabilities of children and why so many find the subject hard to learn. JUMP Math is now a classroom program used by more than 100,000 elementary and intermediate students in Canada. In the U.S., a number of school districts are testing a version of JUMP aligned with the Common Core State Standards.

From my experience as a tutor and then a volunteer in hundreds of classrooms, I developed a number of principles that form the basis of JUMP and are supported by research in educational psychology and cognitive science. They include providing lots of practice, giving students immediate feedback, teaching general math problem-solving strategies, and helping students discover new concepts by breaking down problems into small, manageable steps.

FAST FACTS

Formula for Success

1» Pure discovery-based math lessons can cause cognitive overload and therefore do not work as well as those in which a teacher helps a student to navigate a problem’s complexities.

2» Studies show that JUMP Math, a guided-discovery program the author developed, lifts students to much higher levels in math than most standard methods while shrinking the gap between weaker and stronger students.

3» The confidence that students gain by succeeding in math can bring broader benefits.

Surprisingly, these principles work not only in one-on-one lessons but also in whole classes. In a randomized controlled study presented at the Society for Research in Child Development in 2011, for example, cognitive scientists Tracy Solomon and Rosemary Tannock of the Hospital for Sick Children and the University of Toronto found that students from 18 classrooms using JUMP showed twice the rate of progress on a number of standardized math tests as those receiving standard instruction in 11 other classrooms. A large, multiyear pilot in inner-city schools in England, among many other anecdotal reports, have also shown that JUMP Math lifts students to much higher levels in math than most standard methods while dramatically shrinking the gap between weaker and stronger students.

Little Discovery

I believe that a root cause of many children's troubles in math, as well as in other subjects, is the belief in natural academic hierarchies. As early as kindergarten, children start to compare themselves with their peers and to identify some as talented or "smart" in various subjects. A child who decides that she is not talented will often stop paying attention or making an effort to do well. This problem will likely compound itself more quickly in math than in other subjects because when you miss a step in math it is usually impossible to understand what comes next. The more a child fails, the more her negative view of her abilities is reinforced and the less efficiently the child learns.

This belief in hierarchies causes greater differences between children in their success in math than do actual ability gaps. The fact that good instruction can dismantle hierarchies in math means that a child's current level of achievement need not dictate her long-term success in math.

In the past 15 years most schools in North America have adopted some kind of discovery- or inquiry-based math program, in which students are supposed to figure out concepts by themselves rather than being taught them explicitly. Discovery-based lessons tend to focus less on problems that can be solved by following a general rule, procedure or formula (such as "find the perimeter of a rectangle five meters long and four meters wide") and more on complex problems based on real-world examples that can be tackled in more than one way and have more than one solution ("using six square tiles, make a model of a patio that has the least pos-



sible perimeter"). Instead of memorizing facts and learning standard algorithms such as long division, students learn math primarily by exploring concepts and developing their own methods of calculation, mostly through hands-on activities with concrete materials.

Although I agree with many of the aims and methods of the discovery approach, a growing body of research suggests that some of its elements have significant drawbacks. To make math more relevant or appealing, for example, teachers will often select textbooks that are dense with illustrations or involve the use of concrete materials with engaging features, but these details can actually impede learning. For example, in 2013 psychologists Constance Kaminski and Vladimir Sloutsky of Ohio State University taught two groups of primary students to read bar graphs using two different types of graph: one had pictures of stacked shoes or flowers, and the other, more abstract graph had solid bars. Students who learned with the bars were better at reading graphs when the scale of the graph changed to reflect some multiple of the number of objects. Students taught with pictures tended to be distracted by counting the ob-



jects and so did not look at the scale on the graph.

Math teaching methods should not only avoid derailing students with extraneous material, they should also not saddle them with too much information at once. Discovery approaches can place a huge burden on working memory, the temporary mental scratchpad we use so heavily in solving math problems. Human working memory is extremely limited. On average, it holds the equivalent of about seven numbers at a time, a limit that the demands of a complex problem can easily exceed if the problem requires a lot of new knowledge.

Because of this hefty cognitive load, lessons based on pure discovery do not work as well as those in which a teacher helps a student navigate the complexities of a problem by providing feedback, working through examples and offering other guid-

(The Author)

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ance, according to a 2006 article by psychologist Paul Kirschner of the Open University of the Netherlands and his colleagues. The key is for a student to have mental capacity remaining to make inferences, integrate knowledge and reorganize information. “Empirical evidence collected over the past half-century consistently indicates that minimally guided instruction is less effective and less efficient than instructional approaches that place a strong emphasis on guidance of the learning process,” Kirschner and his co-authors wrote. In a 2011 meta-analysis (quantitative review) of 164 studies of discovery-based learning, psychologist Louis Alfieri of the City University of New York and his colleagues concluded: “Unassisted discovery does not benefit learners, whereas feedback, worked examples, scaffolding and elicited explanations do.”

Micro Inquiry

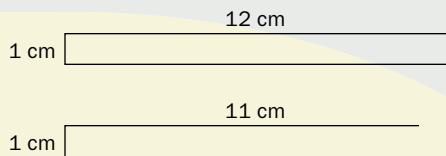
With these data in mind, we designed JUMP with supports such as additional examples, activities and practice. Based on a method called guided discovery or micro inquiry, JUMP lessons ask students to derive concepts and solve problems with a teacher’s guidance so that virtually all of the students succeed. What is more, the teacher’s direction closely aligns with certain principles that greatly assist the learning of mathematics.

One of these is scaffolding, which means breaking learning into chunks and providing relevant examples and practice to help students tackle each chunk. In a scaffolded lesson, concepts are introduced in a logical progression, with one idea leading naturally to the next. For instance, if you ask sixth graders this question, “If the ratio of girls to boys in a town is 4 to 5, what fraction are girls?” many will answer four fifths, or 80 percent. The correct answer is four ninths, which requires understanding that the denominator of the fraction has to represent all of the children, not just the boys.

In a scaffolded JUMP lesson on ratios and percentages, the first question asks students to write down the number of girls, boys and children in a class after statements such as “there are three girls and 10 children” and “there are six boys and five girls.” The next question asks the same thing, but students must also write down the fraction of girls and boys. Later, when students find the fraction of girls or boys in various problems, they must say if they are given the part and the whole, the two parts, or the “wrong” part and the whole. This sequence

of tasks stops students from forming a fraction by just putting one number over another without considering what the numbers mean. With this approach, it is possible to teach even the biggest ideas through a series of small steps.

Such lessons are designed to anticipate potential confusions or gaps in knowledge. To take a different example, if fifth grade students are asked to draw on graph paper all possible rectangles with whole-number sides that have a perimeter of 12 centimeters, many will start by drawing the figures shown below.



In the first instance, the student has confused perimeter with area; in the second, the child used up the allotted perimeter before completing the rectangle. To prepare students for the drawing exercise, the teacher might draw one side of a rectangle and allow students time to practice completing the drawing until they understand how the perimeter wraps around the figure. The teacher might also discuss a system for generating all the answers—say, by starting with a rectangle with width 1, then width 2, and so on.

Despite trying to prevent such confusions, students will still make plenty of mistakes, and those who repeat their errors will begin to doubt their abilities and lose hope that math can make sense to them. For this reason, JUMP Math lesson plans instruct teachers to provide immediate feedback and continuous assessment. During each JUMP lesson, which consists of a series of questions, exercises and challenges, the teacher selectively marks and discusses the student work as it is completed, so as to spot and correct errors and misconceptions before students move on, instead of testing the class a week later when it may be too late to help the ones who have fallen behind.

Another essential element of JUMP is to give kids general tools for solving math problems. Many adults struggle with the following elementary problem: “A person is standing 5,152nd in line, and a second person is 2,238th in line. How many people are between them?” Most people will subtract to find the answer, but if you ask them how they know

their answer is correct, they often will not be able to say. I know this approach will give the wrong answer, but not because I was born with an ability to see it. As a mathematician, I have learned basic strategies for solving problems, including this one: create an easier version of the problem and solve it instead. In this case, I would imagine five people in line and ask how many people are between the person who is fourth and the person who is second in

SAMPLE PROBLEM

“ONE PERSON IS STANDING 5,152ND IN LINE. ANOTHER IS 2,238TH. HOW MANY PEOPLE ARE BETWEEN THEM?” MOST PEOPLE SUBTRACT TO FIND THE ANSWER. BUT NOW IMAGINE A LINE OF FIVE PEOPLE AND ASK HOW MANY ARE BETWEEN THE SECOND AND THE FOURTH PERSON IN LINE. IS THE CORRECT ANSWER $4 - 2 = 2$?

line. Clearly, one person. From that simpler scenario, I immediately discover that subtracting the positions gives an answer that is one too high.

Practice Makes ...

I once tutored a student who had a severe attention deficit disorder and who had not managed to learn any multiplication facts by grade four. I told him I was going to give him a challenge: I would show him how to double large numbers mentally. I wrote:



I covered all but the millions part of the number with my hand and asked him to read what he could see. He said, “Two hundred thirty-four” and then “million.” I drew back my hand to reveal the thousand part, and he said, “One hundred twenty-two thousand.” When I exposed the rest of the number, he said, “One hundred forty-one.” As I had hoped, the boy was excited about reading this enormous number and asked to read more. My true goal,

holding them back. Ordinarily, teachers try to challenge faster students by giving them questions that introduce new concepts, skills and vocabulary. So the students need the teacher’s help, depriving the rest of the class of the teacher’s attention. In a JUMP lesson, an instructor assigns a set of incrementally harder bonus questions that kids can do on their own because they do not introduce new skills or concepts. Yet they feel as if they are surmounting a series of interesting challenges, similar to what happens in a video game. For example, if a teacher asks a fourth grader to state a rule for the sequence “63, 67, 71, 75 ...” students for whom this answer is obvious could be given bonus questions such as “This sequence has a mistake in it; can you correct the mistake?” (Students love this.) Or “Find the missing numbers in the sequence 3, $_$, $_$, 18 ...” Or “Say how many odd numbers in the sequence 1, 4, 7, 10... are less than 100.”

Such questions help the more advanced students gain a deeper understanding of the curriculum. In addition, when youngsters who are initially slower see that they can handle the work, they speed up so they can get bonus questions, too. Indeed, teachers who follow the JUMP lesson plans with fidelity can

dramatically close the gap between weaker and stronger students.

For example, in the fall of 2007 fifth grade teacher Mary Jane Moreau of the Mabin School in Toronto gave her students a standardized assessment called the Test of Mathematical Abilities. The class average was in the 54th percentile, with a wide range of scores, including one student who ranked at just the ninth percentile. A fifth of the pupils were identified as learning disabled. Moreau then abandoned her usual approach, which meant pulling together lessons with the best materials she could find, and followed the JUMP lesson plans. After a year of JUMP, the class average rose to the 98th percentile, with the lowest mark in the 95th percentile. After two years of JUMP, 17 of her 18 students signed up for the Pythagoras Math competition, a prestigious contest for sixth graders, and 14 of them received awards of distinction (with the other three close behind).

This case is not isolated. In 2006 Nikki Aduba, a math consultant for Lambeth, one of the neediest

SAMPLE PROBLEM

STUDENTS WHO CAN EASILY SEE THE RULE FOR THE SEQUENCE AT LEFT COULD BE GIVEN A BONUS QUESTION SUCH AS “SAY HOW MANY ODD NUMBERS IN THE SEQUENCE 1, 4, 7, 10 ...ARE LESS THAN 100.”

63
67
71
75

however, was to motivate him to multiply. So I then made a list of the first four entries of the two times table and showed him how to double a large number by doubling each digit and writing the result under the digit. While he was happily doubling numbers, the boy memorized the list and soon no longer needed it. He had practiced and learned part of the two times table in several minutes without being aware of it.

Although some educational theorists have made practice seem unnecessary or detrimental by calling it “drill and kill,” children need practice to become experts. The true challenge in education is thus to make practice interesting. If teachers make learning into a game with different levels and twists and turns as I did in my lesson with the big numbers, students will happily practice for a long time.

JUMP Math lesson plans also include extra “extension” questions that allow elementary and middle school teachers to give all students roughly the same lesson, without boring the stronger students or

boroughs in England, enlisted teachers to use JUMP with 159 students who were a year below grade level at the beginning of grade six. Almost all the students had learning disabilities or behavior problems, and few were expected to pass the national exams in math. A year later 69 percent of them had advanced about two years in math, and 60 percent passed the exams. Aduba reported similar results with hundreds of students in various grades four years in a row. In another case, Muheim Elementary School in northern British Columbia for years ranked in the bottom 10 percent in its school district on provincial math tests. Since the principal introduced JUMP Math five years ago, the school has held its position among the top 10 percent.

Confidence Boost

None of the basic learning strategies used in JUMP are radical or even new in education. But JUMP has applied them with rigor, paying close attention to the order and size of steps, the amount of review provided and the methods of questioning, among other details. If there is anything new about JUMP, it lies in the assumptions that guided its development, including the idea that almost all students can achieve more in math than schools require. JUMP assumes that children who believe in their abilities can enjoy doing math as much as they enjoy making art or playing sports. It is fun to overcome challenges and exercise the mind, and it can be thrilling to discover or understand something that is beautiful, useful or new.

The confidence that students gain by succeeding in math can have effects in other parts of their lives. Because math is supposed to be hard, when children think they are capable of learning math they tend to think that they can learn anything. In Lambeth, one teacher reported that students with behavior problems would reprimand others who misbehaved in math class because they were so engaged in their lessons. Another teacher wrote that her students had become “ballsy, independent problem solvers.” I once taught 11-year-olds in Lambeth how to read binary codes, the strings of 0s and 1s that represent numbers for computers. The students seemed to think they were little code breakers and demanded longer and longer codes. On my third day at the school, when the teacher and I entered the classroom the children cheered.

Children love solving puzzles, seeing patterns and making connections. They have a sense of won-



der that is diminished only by failure. In the past decade cognitive scientists and educators have begun to uncover the mechanisms by which our brains learn best, and they have gathered evidence that the significant majority of students can excel at and love learning subjects such as math. One of the most important questions of our time is whether we will act on that evidence by educating children according to their extraordinary potential. **M**

(Further Reading)

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- ◆ **The End of Ignorance: Multiplying Our Human Potential.** John Mighton. Vintage Canada, 2008.
- ◆ **Does Discovery-Based Instruction Enhance Learning?** Louis Alfieri et al. in *Journal of Educational Psychology*, Vol. 103, No. 1, pages 1–18; February 2011.
- ◆ To download JUMP Math lesson plans for grades one to eight, teachers and parents can go to jumpmath.org



Clutter, Clutter Everywhere

If parting with possessions is a serious problem, you can now be officially diagnosed with hoarding disorder

BY SCOTT O. LILIENFELD AND HAL ARKOWITZ

STUFF, STUFF and more stuff. Many of us love to buy and keep things, even when the items are not useful. About 70 percent of children amass collections of favored objects, such as coins, dolls or baseball cards; many adults do the same. People often regard possessions as extensions of themselves and become attached to them accordingly.

Yet in rare cases, the habit of gathering and retaining things reaches unhealthy extremes, culminating in hoarding disorder, a condition that is poorly understood. Many laypeople believe that clinical hoarders are too lazy to discard their junk or that they enjoy living with it. Neither of those assumptions appears to be true. Moreover, most experts have long assumed that extreme hoarding is a variant of obsessive-compulsive disorder (OCD), even though most recent research suggests otherwise. Instead the ailment may stem from an exaggerated version of a basically adaptive tendency to accumulate materials that are important to us.

Distinct Pathology

Nikolai Gogol's 1842 novel, *Dead Souls*, featured a character named Plyushkin, a landowner who saved almost everything he found. Sigmund Freud regarded hoarding as a symptom of what he termed the "anal character," purportedly stemming from overly harsh toilet training. (Few psychologists today share this view.) In the early and mid-1990s, however, hoarding increasingly came to be recognized as a serious clinical problem. Systematic research criteria for pathological hoarding, introduced in 1993 by psychologist Randy O. Frost of Smith College, spread awareness of the malady, as did a parade of television documentaries and reality shows, such as *Hoarders*, *Clean House* and *Hoarding: Buried Alive*.



Until recently, most mental health professionals regarded pathological hoarding as a subtype of OCD. Hoarding was considered a compulsion—a repeated, ritualized action intended to ward off anxiety, such as checking the stove repeatedly to make sure that it is turned off. According to a 2010 review by psychologist David Mataix-Cols of King's College London, however, 80 percent or more of people who engage in ex-

treme hoarding do not meet criteria for OCD. For example, many do not experience the obsessions—recurrent or intrusive thoughts, images or impulses—that are widespread in OCD. Moreover, hoarders tend to be poorer, older, and more prone to mood and anxiety disorders than those with OCD; they are also less likely than OCD sufferers to be aware that they are disordered.

In recognition of these differences,

COURTESY OF SCOTT O. LILIENFELD (Lilienfeld); COURTESY OF HAL ARKOWITZ (Arkowitz); KATY LEMAY (Illustration)

the fifth edition of the American Psychiatric Association's diagnostic manual (*DSM-5*), published this past May, for the first time included pathological hoarding as a distinct condition. According to this volume, "hoarding disorder" is char-

acterized by extreme and enduring difficulties parting with possessions, even if they have no tangible value. The afflicted have powerful urges to retain items or become very upset about tossing them out. Their home or workplace is filled with so much clutter that the space is unusable—and their problems seriously impair their everyday functioning or cause distress. Before diagnosing hoarding disorder, clinicians must rule out medical conditions that can lead to hoarding. For instance, in a 1998 study psychiatrist Jen-Ping Hwang of the Veterans Administration of Taipei and his colleagues found that 23 percent of patients with dementia displayed clinically significant hoarding behavior.

paths" to get from one location to another. In a 2008 study psychologist David Tolin of the Institute of Living in Hartford, Conn., and his co-workers reported that 2 percent of hoarders had been evicted because of their mess. In a 2009 investiga-

tion, psychology student Gregory Lucini and his colleagues at the Worcester Polytechnic Institute Project Center in Melbourne, Australia, revealed that hoarding contributed to 24 percent of preventable deaths in house fires. In other cases, hoarders have been smothered to death by their clutter; this past April a 68-year-old New Jersey woman was found dead underneath piles of rotting garbage, clothing, tote bags and other possessions.

gins. The behavior is present in a host of species, including honeybees, crows, rodents and monkeys, as psychologist Jennifer G. Andrews-McClymont, now at Morehouse College, and her colleagues pointed out in a 2013 review. This obser-

vation raises the possibility that the condition reflects a naturally selected urge to stockpile resources for times of scarcity.

Help for Hoarders

Help for Hoarders

Hoarding disorder is challenging to treat, but some types of cognitive-behavior therapy can reduce its severity, according to a 2007 literature review by Tolin and his colleagues. The treatment focuses on altering irrational beliefs about the value of objects and providing supervised practice with organizing and discarding things. This intervention is not a panacea, however, given that many people with hoarding disorder do not complete their "homework," which typically involves rearranging and tossing out clutter.

Hoarding disorder appears to be present in between 2 and 5 percent of the population, making it more prevalent than schizophrenia. It afflicts men and women in about equal numbers. People most often hoard books, magazines, newspapers and clothes; in some cases, they accrue scores of shirts, pants and dresses that have never been removed from their packaging. More rarely, individuals stockpile animals. In one case in 2010 authorities found more than 150 cats living in a home in Powell, Wyo. Animal hoarders tend to be more psychologically impaired than other hoarders and live in more squalid conditions, according to a 2011 article by Frost and his colleagues.

No one knows for sure why hoarders hoard. One clue to the condition, however, is that they often report a powerful emotional attachment to objects; some may imbue them with humanlike qualities, such as feelings, while recognizing that doing so is irrational. In other cases, hoarders insist on maintaining old items, such as clothing, "just in case." Hoarding runs in families; in a 1993 study by Frost and psychology student Rachel C. Gross, now a professor at American University, 85 percent of pathological hoarders described one or more first-degree relatives (parents, children, siblings) as "pack rats"; this percentage significantly exceeded that of nonhoarders. In a 2009 study of more than 5,000 twin pairs, psychologist Alessandra C. Iervolino of King's College London and her collaborators found that this family pattern is genetically influenced; they estimated the heritability of severe hoarding at 50 percent.

Hoarding may have evolutionary ori-

The limited treatment options for hoarders partly reflect our relatively poor understanding of this serious ailment. With the formal recognition of hoarding disorder in *DSM-5*, however, research into the causes of pathological hoarding will likely increase and, along with it, the promise of more effective therapies. **M**

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

Send suggestions for column topics to editors@SciAmMind.com

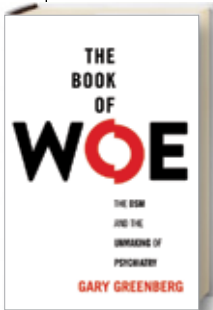
Deadly Business

Hoarding can be a serious, even deadly, business. The clutter may reach such proportions that living spaces become essentially uninhabitable, and patients may need to construct narrow tunnels or "goat

(Further Reading)

- ◆ **Hoarding Disorder: A New Diagnosis for DSM-V?** David Mataix-Cols et al. in *Depression and Anxiety*, Vol. 27, No. 6, pages 556–572; June 2010.
- ◆ **Stuff: Compulsive Hoarding and the Meaning of Things.** Randy O. Frost and Gail Steketee. Houghton Mifflin Harcourt, 2010.

books



► WOE IS US

The Book of Woe: The DSM and the Unmaking of Psychiatry

by Gary Greenberg. Blue Rider Press, 2013 (\$27.95)

This is a landmark book about a landmark book. Psychotherapist and author Greenberg first took on the *Diagnostic and Statistical Manual (DSM)* in a blistering article in *Wired* in 2010. *The Book of Woe* is the nearly 400-page update, whose re-

lease coincided with the May 2013 release of the *DSM-5*, the fifth edition of the bible of mental health, which first appeared in 1952.

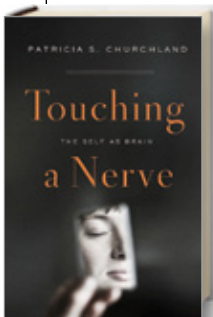
Relying heavily on interviews with distinguished insiders in the psychiatric establishment, Greenberg paints a picture so compelling and bleak that it could easily send the vulnerable reader into therapy. The basic message is this: everyone in the mental health profession knows full well that the *DSM* is a work of fiction—that the hundreds of “disorders” described therein are just labels for fuzzy, overlapping clusters of symptoms and that we have never found a definitive biological marker for even one of those disor-

ders. Mental health professionals pretend that the disorders are real, but they’re not, period.

And then there’s the money. The American Psychological Association, a shrinking and financially strapped organization of 36,000 psychiatrists, has made \$100 million off sales of the fourth edition of the *DSM*, Greenberg says. More than 400,000 licensed mental health professionals in the U.S. alone depend on the diagnostic codes in the *DSM* for insurance income. Prominent research psychiatrists who misused *DSM* diagnostic categories to open up the prescription drug market for children received more than \$1 million each in kickbacks from pharmaceutical companies for their efforts.

Greenberg takes the reader deep inside the secretive world of the panels and personalities that have spent years arguing about which disorders and symptoms they would keep and which they would discard in the new *DSM*, focusing on one especially rancorous debate over the bereavement exclusion. Previous *DSM* editions advised therapists that people grieving over the loss of a loved one should not be labeled as clinically depressed; the *DSM-5* eliminates the exclusion, potentially bringing therapists and drug companies eight million new customers a year.

Psychiatrists are in the business of pathologizing and throwing drugs at everyday problems, and given the money at stake, perhaps nothing can stop this trend. —Robert Epstein



► MIND CONTROL

Touching a Nerve: The Self as Brain

by Patricia S. Churchland. W. W. Norton, 2013 (\$26.95)

When Galileo announced his observation of Jupiter’s moons, his discovery challenged a deeply entrenched way of thinking about our place in the universe.

Modern neuroscience has kindled a similar revolution in the way we think about the brain. In *Touching a Nerve*, neurophilosopher Churchland argues that all things that we have traditionally ascribed to a higher power—morality, free will, the soul—are in fact products of the brain. The mysterious lump of matter inside our head is responsible not only for everything that makes us human but also for what makes us unique.

This view that the brain is responsible for every aspect of our physical and mental lives has gained traction among neuroscientists, but the idea of the self as brain has also encountered resistance. It’s not hard to understand why, Churchland notes. Some research, for example, shows that patterns of brain activity can predict our choices or actions before we become consciously aware of having made a decision, and it may be hard to reconcile this evidence with the notion of free will.

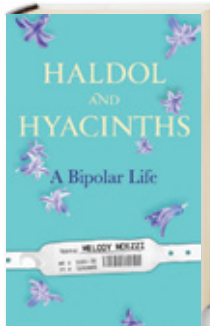
Churchland illustrates how our under-

standing of the brain is beginning to reveal the biological basis of traits such as aggression and morality. For instance, zapping the temporal lobe using deep-brain stimulation can improve spatial memory, and using a powerful magnet to alter activity in the right temporoparietal junction can make our moral compass go haywire, causing behaviors we think of as immoral to become permissible.

Brain-damaged patients provide some of the strongest evidence for how our brain makes us who we are. Injuries to various parts of the frontal lobe can leave some people unable to talk or can alter personality, yielding impulsive or antisocial behaviors, and lesions to the medial temporal lobe can erase our memories or prevent new ones from forming.

Churchland also seamlessly weaves this research with experiences from her own life. She describes, for instance, how as a child growing up on a farm in British Columbia, a friend lost awareness of her legs after injuring them in a bicycle accident and how her grandmother lost her sense of self to Alzheimer’s disease.

By drawing on personal stories and modern brain research, Churchland creates a compelling narrative to further the idea of the self as brain. Her well-supported, cautious analysis provides insights into how we evolved traits such as empathy and altruism and explores the genetic and biological factors that determine an individual’s unique sense of self. Through her examples, we can all come to understand our actions and intentions more clearly.—Moheb Costandi



► MENTAL DIVIDE

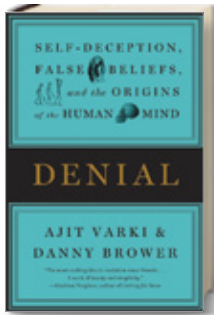
Haldol and Hyacinths: A Bipolar Life

by Melody Moezzi. Avery, 2013 (\$26)

A fine line separates creativity and madness. Bipolar disorder teeters along that line, with patients experiencing moments of impulsive thought, which can yield bold insights or quickly descend into confusion or rage.

In her new book, *Haldol and Hyacinths*, Iranian-American author and activist Moezzi presents a captivating autobiographical account of her struggle with bipolar disorder. Using a series of vignettes, she reconstructs her downward spiral

into psychosis, which eventually led to a suicide attempt and multiple stays in mental health facilities. From seemingly innocuous bouts of insomnia to full-blown hallu-



► **EVOLUTION SOLUTION**

Denial: Self-Deception, False Beliefs, and the Origins of the Human Mind

by Ajit Varki and Danny Brower. Twelve, 2013 (\$27.00)

About 100,000 years ago something in our ancestors changed. Humans began to show new behaviors that set them apart from all other animals on the planet. Most notably, they began creating symbolic art and ornaments. For the first time, people wanted to

adorn themselves and their dead, activities that suggested a newfound interest in the perceptions of others.

These artifacts may be the earliest evidence of a human theory of mind, the recognition that every individual has unique intentions, beliefs and desires. In *Denial*, biologists Varki and Brower (Brower died in 2007) propose a novel explanation for why humans surpassed all other species in mental prowess. The authors argue that as humans contemplated the intentions of those around them, they began reflecting more deeply on the meaning of life itself, and this examination led to the frightening awareness of their mortality. To assuage such fears, humans evolved the unique ability to deny reality. The authors reason that religion and philosophy represent some of our best efforts to do so.

A wealth of evidence documents the human talent for disregarding reality. Sometimes this ability benefits us, as when optimistic cancer patients outlive their pessimistic peers or when an athlete tricks himself into believing he has plenty of reserve energy to push his body past its limits. At other times, our self-deceptions are detrimental. According to Varki and Brower, humans are the world's ultimate risk takers, ignoring scientific facts such as the dangers of smoking and climate change.

The authors believe that this denial mechanism became essential once our brain evolved a more comprehensive understanding of ourselves and others. Before this point, they suggest, we were more like birds and elephants, possessing some—but not much—self-awareness.

Although pivotal to their thesis, Varki and Brower's claim that our fear of mortality predicated our capacity for denial remains somewhat unconvincing, in part because it is impossible to gather evidence of how we developed the relevant abilities. As they observe, there is no specific neural circuitry to explain how we evolved a theory of mind or a propensity for self-deception. It seems equally probable that these qualities

co-evolved or that they are unrelated to each other.

The authors acknowledge that much of their proposal is untestable, and readers seeking conclusive answers will be disappointed. Yet *Denial* raises a key point regarding our contemporary concerns. Although a gift for self-deception may have saved our ancestors from despair, it might also be our downfall. But recognizing this tendency in ourselves may push us to stop ignoring unpleasant truths, such as global warming and poverty, and start addressing them.

—Daisy Yuhas



ROUNDUP

►► **All Fired Up**

Three books provide insights on creativity

“No matter what kind of creativity I studied, the process was the same. Creativity did not descend like a bolt of lightning that lit up the world in a single brilliant flash. It came in tiny steps, bits of insight, and incremental changes,” psychologist Keith Sawyer writes in **Zig Zag: The Surprising Path to Greater Creativity** (Jossey-Bass, 2013). In his book, Sawyer draws on research and personal experience to provide simple strategies to enhance innovative thinking. He suggests, for instance, expanding your knowledge base by learning a new skill or talking to someone outside your immediate network.

Creativity is not limited to artists and inventors; anyone can harness their creative potential, says artist and entrepreneur Erik Wahl. In **Unthink: Rediscover Your Creative Genius** (Crown Business, 2013), Wahl reveals that success in business does not come from being a cog in the wheel but rather from the ability to think creatively. To that end, Wahl encourages goofing off at work, explaining that this unstructured time can fuel curiosity and spontaneous thought.

Ben & Jerry's has stayed relevant for 35 years by creating playful ice cream flavors and rolling with the times by introducing environmentally friendly packaging. In **Creative Intelligence: Harnessing the Power to Create, Connect, and Inspire** (HarperBusiness, 2013), Bruce Nussbaum, professor of innovation and design at Parsons the New School for Design, describes the demand for this type of creative intelligence to fuel problem solving and drive innovation. Nussbaum also provides ways to help individuals and businesses become more in tune with their creative intelligence by pivoting—adapting an idea and making it profitable—and playing—being silly and imaginative.

—Victoria Stern

inations, Moezzi describes how she descended into madness.

Moezzi's medical issues first emerged in her sophomore year of college, when she began to experience severe abdominal pain, later diagnosed as pancreatitis. Doctors decided to remove her pancreas to save her life and prevent a cyst from festering. Everyone she knew rallied alongside her during this time.

Things were much different when Moezzi's bipolar disorder took hold in the years following her physical illness. She soon discovered that mental illness has no heroes, no celebrity spokesperson, no champions. Relying solely on the support of her immediate family and a devoted husband, Moezzi saw that the disorder carries a stigma, exacerbated by inaccurate media portrayals. Even worse is the plight of patients in places such as Moezzi's homeland of Pakistan, where mental illness is simply ignored. Despite bipolar disorder being the sixth leading cause of disabil-

ity in the world, there is not even a word for the disease in Farsi.

Moezzi's doctors placed her on a medication regimen to balance her moods, but simply controlling the disorder did not satisfy her. She decided to channel her energy into writing and speaking in public forums, providing people with an inside look at the personal and medical dimensions of mental illness. Moezzi's activism has put a much needed human face behind the illness.

Moezzi uses a powerful narrative to illustrate that battling bipolar disorder means relying on others to overcome the struggle. Yet she also succeeds in offering hope to people suffering from any mental illness and their caretakers: we can thrive despite our brain's quirks and weaknesses. Much like the hyacinth flower, which rarely grows perfectly straight, Moezzi believes we need to embrace the disorder in our lives and understand that support from loved ones will keep us afloat.

—Brian Mossop

ISTOCKPHOTO (book structures and hands)

asktheBrains

What physiological changes can explain the honeymoon phase of a relationship?

—Emily Lenneville, Baltimore



Gary W. Lewandowski, Jr., associate professor of psychology at Monmouth University and co-editor of www.ScienceOfRelationships.com, replies:

AH, THE HONEYMOON stage—that magical time when your partner is still perfect and you are very much in love. This period features high levels of passionate love, characterized by intense feelings of attraction and ecstasy, as well as an idealization of one's partner. The strong emotions associated with passionate love have physical manifestations, such as butterflies in the stomach or heart palpitations. Recent research has begun to explore how these feelings manifest in the brain and in one's physiology.

Using functional MRI, investigators have identified several brain regions associated with feeling love. Individuals who

experience passionate love (typically brought on by pictures or thoughts of the beloved) show greater activation in the caudate nucleus, important in learning and memory, and the ventral tegmental area, central to emotional processing. Both brain areas tend to be rich in dopamine, a neurotransmitter associated with reward and motivation.

Another study found that when women who were madly in love thought about their partner, instead of a friend, they exhibited elevated levels of the stress-buffering hormone cortisol.

Researchers have also examined how experiencing passionate love can influence an individual's brain chemistry. One study revealed that recent lovebirds had higher levels of nerve growth factor (NGF), a protein that aids in the development and functioning of neurons, than

Ah, the honeymoon stage—that magical time when your partner is still perfect and you are very much in love.

people who were single or in long-term relationships. The authors speculated that elevated NGF levels might increase a person's feelings of euphoria or connection. When measuring cortisol and NGF levels 12 to 24 months later, they found that differences between the passionate love group and the others had disappeared.

These findings suggest that romantic love is an arousing but stressful experience. These physiological changes are short-lived, perhaps because we become acclimated to our partner with time. Although the ardor may diminish, do not lose faith—research shows that some couples can sustain these honeymoon period feelings throughout their relationship by challenging each other with new activities, such as biking or dance.

People say they don't like negative political ads, but do they work?

—Matthew Robison, Contoocook, N.H.



Donald Green, professor of political science at Columbia University, answers:

FOR 20 YEARS political scientists have investigated whether negative campaign ads, those that criticize the opponent, are more effective than positive ads, which extol the sponsoring candidate. Yet the jury is out on whether “going negative” pays off.

A comprehensive literature analysis published in 2007 in the *Journal of Politics* examined the effects of political ads. The authors reported that negative ads tended to be more memorable than positive ones but that they did not affect voter choice. People were no less likely to turn out to the polls or to decide against voting for a candidate who was attacked in an ad.

Though noteworthy, this study did not settle the debate. The research analyzed was limited to surveys and laboratory experiments, both of which have drawbacks. The typical survey looks at the correlation between television ad exposure and public opinion, yet that TV advertising is neither targeted nor received randomly, so the apparent correlation between perceptions of a candidate and exposure to negative campaigns may be misleading.

In the lab, although exposure to TV advertising can be randomly assigned, participants are exposed to ads in a contrived setting, and their candidate preferences are usually measured shortly after. Thus it's unclear whether the effects of ads persist after participants leave the lab. After all, in an actual campaign, people seldom vote immediately after viewing TV ads.

To overcome these limitations, it is important to study the effectiveness of TV ads on voter preferences during a campaign. In a study that my colleagues and I conducted in collaboration with the 2006 election campaign of Governor Rick Perry of Texas, 18 media markets in the state were randomly assigned to receive different levels of pro-Perry TV ads, and daily tracking polls gauged whether Perry's numbers improved as a function of increased advertising. The results suggested that advertising effects are short-lived. Perhaps the effects would have lasted longer than a week had the ads revealed memorable damning information about the opponent. But no field experiment has done a head-to-head comparison of TV advertising tone.

Although evidence on the effectiveness of negative political ads is inconclusive, campaign consultants clearly believe in their power, which explains why negative ads are so often used. **M**

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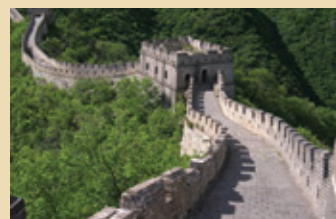


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Head Games

Match wits with the Mensa puzzlers

1 EFFICIENT RECYCLING

The local recycling plant can make one new bottle from every seven bottles returned. One week the plant received 343 bottles. Assuming all the new bottles eventually returned to the plant, how many bottles were eventually remade from those 343?

2 ANTI-MAGIC SQUARE

In a magic square, all the numbers from 1 to 9, placed in a grid as shown below, add up to 15 in each direction—across, down and long diagonals. Make an anti-magic square, in which each line total is different.

4	9	2
3	5	7
8	1	6

Magic Square **Anti-Magic Square**

3 WORD MORPH

Go from POOR to RICH in seven steps by changing one letter at a time and making a valid English word at each step.

P O O R

R I C H

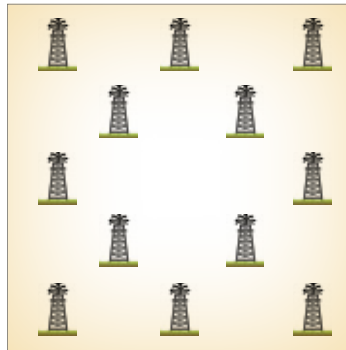
4 POETIC DEFINITION

Find the word described by the clues for each of its letters below.

- My first is in water but not in tears.**
- My second in listen but not in hears.**
- My third in three but not in she.**
- My fourth in clear but not in tea.**
- My last in hang but not in grand.**
- My whole assembles in a band.**

5 HEIRS APPARENT

A rancher had 12 oil wells on his field, as shown below. When he died, he divided his property equally among his four daughters, so that each inherited an identically shaped piece of land with three wells on it. How did he do it?



6 WORD SQUARE

Stack the words that match these definitions in an order that creates a word square, which reads the same across and down.

1. Lack or want
2. Geometric shape
3. Not shut
4. Brings to a conclusion

7 DECODING SYMBOLS

Each of the signs in the grid below has a numerical value. The sum of each row and column except one is shown. Figure out the missing number.

				110
				110
				110
				110
90	105	125	?	

8 AGE GAME

A math enthusiast had two sons exactly a year apart. The day after their birthday, she noticed that if she squared their ages and then added the squares the total would be 1,105. How old were her sons?

9 SALES STRATEGY

The manager of a clothing store had a Labor Day coat sale. He marked the coats down twice, but he still had one coat left to sell after the markdowns. The coat was originally \$300. At the first markdown, the price was reduced to \$210. At the second markdown, the price was reduced to \$147. If he follows the same system for marking down the coat, what will the new price be?

Answers

1. 57.
 2. Here's one solution:

9	8	7
2	1	6
3	4	5

 3. One common solution: POOR, POOL, POLL, POLE, PILE, RILE, RICE, RICH, WITCH.
 4. WITCH.
 5.

 6.

C	O	N	E
O	P	E	N
D	E	E	D
S	D	N	E

 7. 120. (Railroad crossing = 20, pedestrians = 25, traffic light = 30, no left turns = 35, by 30 percent reduced the price merchant 9. \$102.90. (The 8. 23 and 24.

TURKEY, APRIL 1 – 12, 2014

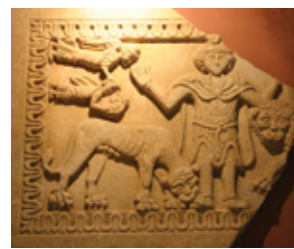
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YOUR GUIDE: HAKAN EDIRNE

Hakan Edirne was born in Izmir, Turkey, and studied archaeology at Ege University, where he graduated in 1994. After working on archaeological excavations in the Aegean region of Turkey, Edirne earned his professional tour guide license, and has led numerous archaeological, historical, and biblical study tours.

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Watch the National Geographic short (February 2013) on the meaning of Gobekli Tepe.



FEAR ITSELF

by DWAYNE GODWIN & JORGE CHAM

We have an innate capacity...



for **FEAR!**

But what we respond to with fear is conditioned by our experiences.



In 1919 psychologist John B. Watson did a controversial experiment to see whether fear could be learned.



A young boy he called "Little Albert" was shown different creatures, including a rat.



At first, Albert showed no fear of the rat.

Then, Watson paired the exposure with an aversive sound that scared the little boy.



Soon, Little Albert would react with fear at just the sight of the rat alone.



His fear even generalized to other furry creatures.

Fear is complex but appears to be processed by a brain region called the amygdala.



Patients whose amygdalae are damaged don't feel fear like the rest of us.

You can reduce your fear by associating positive experiences with the things you fear.



It's a process called *fear extinction*.

So don't be afraid to face your fears.



They might just be guilty by association.

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

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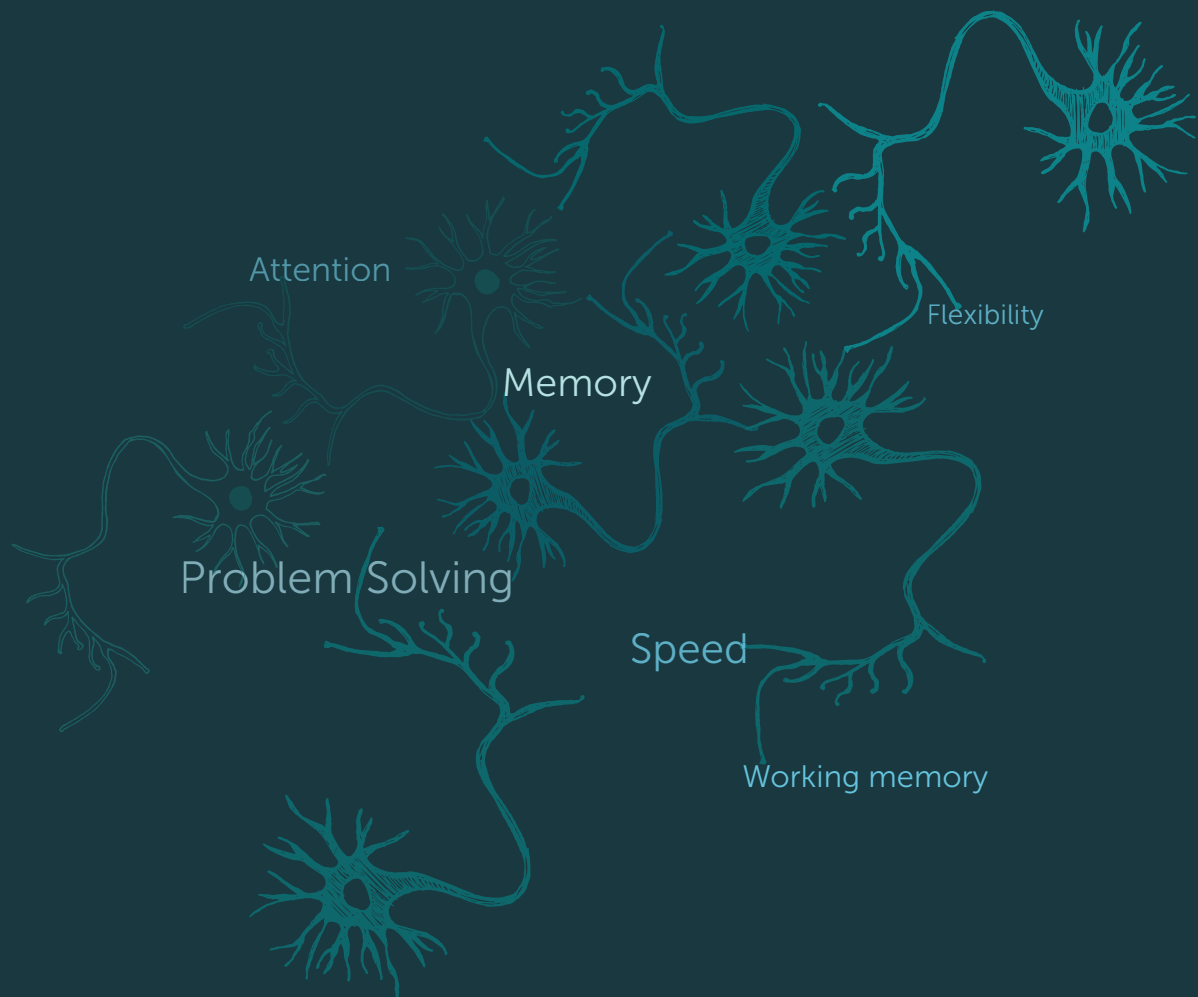


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