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Your Authentic Self, Revealed

The psychological principles that can create the best version of you

PLUS

SCIENCE'S CURE FOR LONELINESS

ARE PEOPLE WITH ADHD MORE CREATIVE?

HOW YOUR INTELLIGENCE CHANGES OVER TIME

WITH COVERAGE FROM nature

FROM THE EDITOR

LIZ TORMES

Our Entirely True Selves

If you ask the average person “Do you know your true self?” you might prompt in him or her a wave of anxiety. And no wonder. From the moment we’re born we are constantly told “to be authentic,” “you do you” and “you are one of a kind.” But studies show that people struggle to define their real selves (even to themselves). We seem to identify with, and want to present to the world, the most admirable versions of ourselves—the kindest, the most generous and compassionate—but where does that leave the less savory (read: human) aspects of our personality? Rather than spiraling into a pit of shame about our nonvirtuous character traits, Scott Barry Kaufman advises in “Authenticity under Fire” that we embrace the whole package: the good, the bad, the ugly. Only then can we take true stock of our true selves.

Elsewhere in this issue, Giovanni Sabato does a straight-faced examination of the history of science on why humans enjoy humor (see “What’s So Funny? The Science of Why We Laugh”). And Caterina Gawrilow and Sara Goudarzi dig into whether those with ADHD have the gift of creative thinking (see “Are People with ADHD More Creative?”). As always, we hope you enjoy!

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TARA MOORE GETTY IMAGES

On the Cover

The psychological principles that can create the best version of you

WHAT'S INSIDE

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NEWS

Our Brain Uses a Not So Instant Replay to Make Decisions

Neural-processing centers repeat recent sequences of events to lay down new memories used for abstract thought

THE HIPPOCAMPUS is a small curl of brain, which nests beneath each temple. It plays a crucial role in memory formation, taking our experiences and interactions and setting them in proverbial stone by creating new connections among neurons.

A report published on June 27 in *Science* reveals how the hippocampus learns and hard-wires certain experiences into memory. The authors show that following a particular behavior, the hippocampus

Computer artwork of the brain highlighting the hippocampus (*red*).

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replays that behavior repeatedly until it is internalized. They also report on how the hippocampus tracks our brain's decision-making centers to remember our past choices.

Previous research has shown that the rodent hippocampus replays or revisits past experiences during sleep or periods of rest. While a rat navigates a maze, for example, so-called place cells are activated and help the animal track its position. Following their journey through the maze, those same cells are reactivated in the exact same pattern. What previously happened is mentally replayed again.

The authors of the new study were curious if this phenomenon only applies to previous encounters with a particular location or if perhaps this hippocampal replay also applies to memory more generally, including mental and nonspatial memories.

It turns out it does.

In the study, 33 participants were presented with a series of images containing both a face and a house. They had to judge the age of either one or the other. If during the second trial, the age of the selected option remained the same, the judged category also did not change in the subsequent trial. If the ages differed, the judged category flipped to the other option in the next round.

While engaged in these tasks, the subjects underwent functional magnetic resonance imaging (fMRI), which allows researchers to monitor brain metabolic activity related to areas of the brain that are active at a given time. In this case, the imaging allowed the authors to view the patterns of activity in different brain regions before, during and after the decision task.

Following 40 minutes of this exercise, participants underwent brain scanning at rest for five minutes. The fMRI patterns recorded in the hippocampus at rest seemed to re-create snippets of activity that occurred during the decision-making task. And they did so again and again. It is as if the brain keeps rewinding a movie scene until it can recite it by heart.

Further, the new research found that people who had more replay in their hippocampus exhibited activity that was more similar to the task in a brain region called the orbitofrontal cortex, an area involved in decision-making. "We found the fact that [activity] in the orbitofrontal cortex relates to replay in the hippocampus really amazing," says Nicolas Schuck, lead author of the paper and a neuroscientist at the Max Planck Institute for Human Development in Berlin. He feels the findings suggest that replay of task and decision sequences in the resting hippocampus helps train the cortex to better solve similar tasks in the future.

"We found the fact that [activity] in the orbitofrontal cortex relates to replay in the hippocampus really amazing."
—Nicolas Schuck

According to the paper's senior author, Princeton University neuroscientist Yael Niv, the new results suggest that replay in the hippocampus is critical not only to forming memories but also to learning which of our behaviors and decisions are most effective at accomplishing a goal and so should be repeated.

Thackery Brown, a professor in the school of psychology at the Georgia Institute of Technology, who was not involved in the study, finds the new work critical in demonstrating that the hippocampus supports replay of not just navigation and spatial experiences but also decision-making. "Although spatial navigation is essential for daily life in both humans and animals," he explains, "we often remember sequences of experiences that take place over time as well as space. The memory of our child's birthday party, for example, may involve many events unfolding over time at one location." Once we are back home on the couch, the hippocampus, it seems, may binge-watch the party on repeat, committing it to memory.

The long-term fate of memories depends on connections between hippocampal neurons and those in the high-level cognitive-processing regions of the cortex, as the new work shows. Brown believes hippocampal activity, in particular the replay described by Schuck and Niv, helps strengthen those bonds so that they provide long-lasting traces we can access, using a variety of memory cues. "This type of 'neural

rehearsal' could encourage stronger connections between neurons that code for the memory," he says.

It is well known that the brain gets busy when we think we're giving it a rest during sleep or meditation. The new findings may be related to the memory consolidation we undergo while snoring away. Schuck explains that the hippocampal replay during sleep probably helps form and store memories. One open question is whether a role for replay exists during dreaming as well: the twisting of recent events into those phantasmagoric nocturnal narratives may serve to process and store—or toss out—our recent experiences.

Schuck and Niv plan to use their brain-analysis technique to explore how planning tasks may be related to replay. They want to investigate whether effective planning entails retrieving and replaying past experiences to better optimize the way we approach the future.

"We think our new methods will be a door opener to look in much more detail at replay in humans," Schuck says. "We hope that our new methods pave the way to look at these things in the future."

—Bret Stetka

"Missing" Wallets with More Cash Are More Likely to Be Returned

A massive global study with 17,000 planted wallets found similar patterns among most of the 40 countries involved

YOU FIND A LOST WALLET. Do you return it? Do you think other people would return it? It is a bit of a hassle. And what if there's a little money in the wallet? A lot of money? Who couldn't use a little extra cash? These are the questions at the heart of the most extensive experiment in civic honesty to date, published on June 20 in *Science*. And the results are remarkable and encouraging.

Most of us would predict that the more money is at stake, the more likely individuals are to keep the wallet. Even economists who study incentives expect people to pocket the cash. But human beings deserve more credit than that. Over three years, a team of economists left more than 17,000 wallets containing varying amounts of money at civic institutions in 40 countries, then measured how many were reported to their owner. Rates of return varied greatly, from 14 percent in China to 76 percent in Switzerland. But strikingly, in 38 out of 40 countries, the more money a wallet contained, the more likely people were to return it. "People are a bit too pessimistic in their view of human behavior," says economist Michel Maréchal of the University of Zurich, one of the lead authors of the study.

Even the researchers believed the opposite would be true. After exploring possible explanations for their finding in follow-up studies, they concluded that people everywhere were motivated by a combination of altruism and an aversion to viewing themselves as a thief.

"This is an amazing study and an important contribution," says economist Marie Claire Villeval of the French National Center for Scientific Research, who was not involved in the work. She found it especially striking that more money generated stronger moral dilemmas. "The psychological cost of not returning

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the wallet increases at the same time as the selfish temptation to keep the money for oneself," she says. "Interestingly, this stronger moral dilemma is resolved by a more honest, or more civic, behavior."

The study is also notable for methodological reasons. "Most research studying human honesty is conducted using experimental tasks in the lab," says behavioral scientist Shaul Shalvi of the University of Amsterdam, who was also not involved in the research and wrote an accompanying commentary on its significance in *Science*. "[This] study provides a measure of civic honesty with an actual behavior that you may encounter in the real world."

The breadth and depth of the study are also impressive. "So many wallets!" Shalvi says. The fact that the result was replicated across such a large number of countries, cities and institutions is convincing. "We can try to understand why one or two countries showed a slightly different pattern than the rest," Shalvi says, "but if you sample 40 countries, and in 38 out of 40, the same pattern emerges, that suggests a very clear, robust finding."

The study began much less ambitiously. In 2013 Maréchal and Alain Cohn of the University of Michigan conducted a pilot study. They asked a student in Finland to pose as a tourist and drop off wallets at civic institutions. He said he had found each wallet and asked the staff to deal with it. When more money led to higher rates of return, Maréchal and Cohn did not believe it and told the student to triple the amount in the wallets. Nothing changed. "We thought, 'Maybe there's something special about Finland,'" Maréchal says. So he and Cohn set out to understand "whether this result is specific to particular cultures or whether it actually represents a more global phenomenon."

In 355 cities, they used clear plastic wallets that revealed their contents. Each contained a key, a grocery list written in the local language, three business cards (using a name common to the country), and either no money or the local equivalent of $13.45 in U.S. dollars. The wallets were always turned in by study collaborators inside similar institutions (banks, hotels, and so on) to control who participated and allow for generalized results. (The study cannot tell us what happens to wallets found by passersby on the street.) The result was nearly always the same: "On average, adding money to the wallet increased the likelihood that it would get reported from 40 to 51 percent," says co-author Christian Zünd of the University of Zurich.

Because the finding was so surprising, Maréchal, Cohn, Zünd and their co-author David Tannenbaum of the University of Utah went to extraordinary lengths to verify it. They controlled for the age of the person receiving the wallet, access to computers, and the presence of witnesses or security cameras. None affected the results. They substantially increased the money to a more tempting $94.14 in three countries. Reporting rates increased to 72 percent.

In surveys, the researchers described the experimental setup to American adults and asked what they thought would happen. Participants overwhelmingly believed that higher amounts of money would inspire more people to keep the cash. A survey of top economists generated more muted predictions, but they still anticipated a slight decrease in return rates as the monetary value went up.

"[People] place too much weight on self-interest and too little weight on psychological factors like self-image concerns," Cohn says. The more money that was in a wallet, he and his colleagues found, the more said it felt like stealing not to report it.

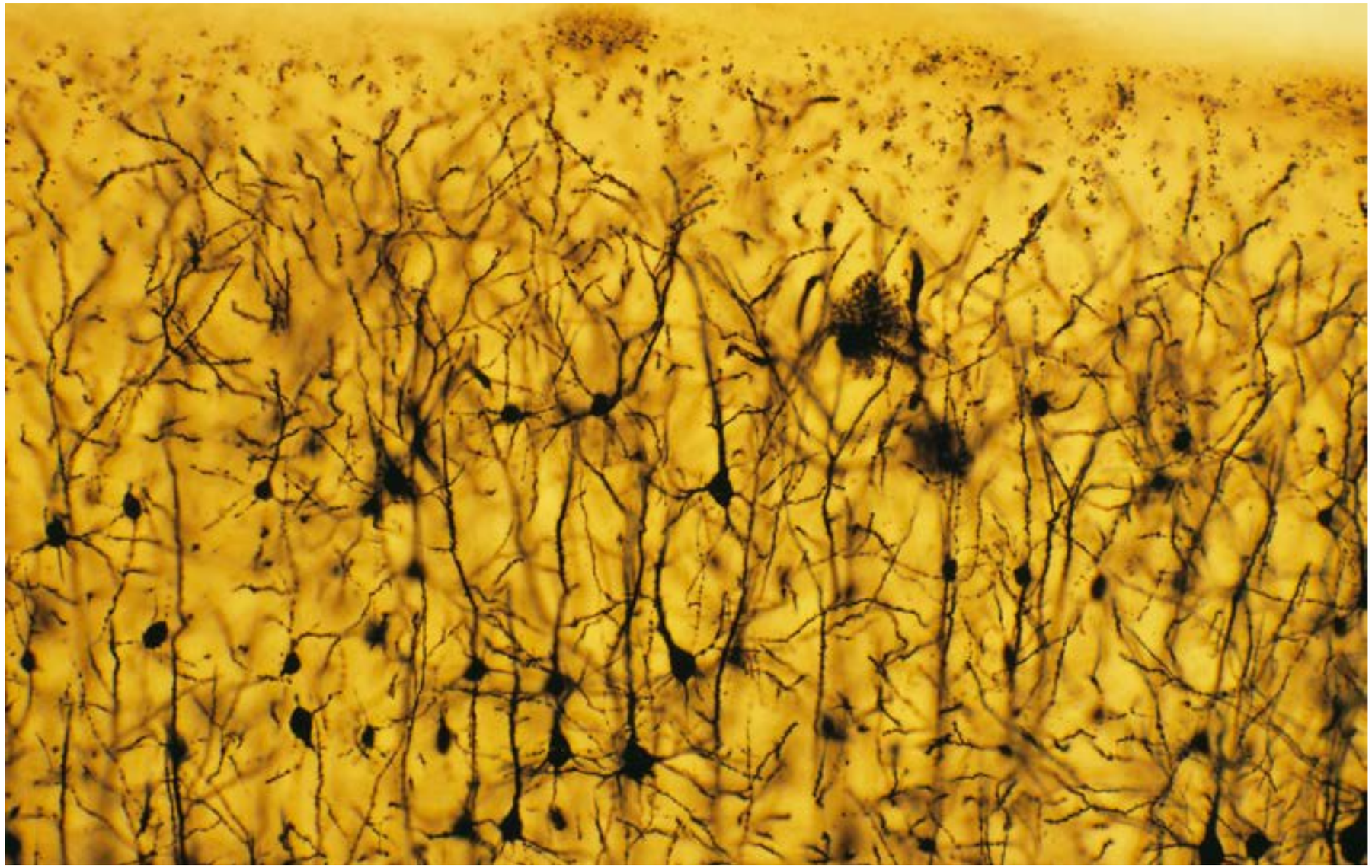
Differences in rates of return in various countries correlated to other proxies of honesty, such as measures of public corruption and tax evasion. Yet the researchers feel strongly that the different rates of return are less interesting than the consistent finding that more money motivated more honesty. Only Mexico and Peru failed to demonstrate that pattern.

The importance of the factors at work here may vary from one context to another, Maréchal says, "but we believe that people, policy makers and politicians should be encouraged to adopt a broader view of human behavior." The authors hope increasing awareness of the negative impact people's behavior has on others might increase honesty—so might making it more difficult for people to persuade themselves that they are honest when they do something wrong. "Reduce the moral wiggle room," Maréchal says.

—Lydia Denworth

Decoding the Language of Neurons

A new study reveals surprising variations in the neural code



IN THE DYSTOPIAN WORLD of George Orwell's *Nineteen Eighty-Four*, the government of Oceania aims to achieve thought control through the restriction of language. As explained by the character Syme, a lexicologist who is working to replace the English language with the greatly simplified "Newspeak": "Don't you see that the whole aim of Newspeak is to narrow the range of thought?" While Syme's own reflections were short-lived, the merits of his argument were not: the words and structure of a language can influence the thoughts and decisions of its speakers. This holds for English and Greek, Inuktitut and Newspeak. It also may hold for the neural code, the basic electrical vocabulary of the neurons in the brain.

Neural codes, like spoken languages, are tasked with conveying all manner of information. Some of this information is immediately required for survival; other information has a less acute use. To accommodate these different needs, a balance is struck between the richness of information being transferred and the speed or reliability with which it is transferred. Where the balance is set depends on context. In the example of language, the mention of the movie *Jaws* at a dinner party might result in a ranging and patient—if disconcerting—discussion around the emotional impact of the film. In contrast, the observation of a dorsal fin breaking through the surf at the beach would probably elicit a single word, screamed by many beachgoers at once: "Shark!" In one context, the language used has been opti-

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mized for richness; in the other, for speed and reliability.

In the brain, this same type of balance is usually thought to be an effect of the division of labor. Certain regions—for example, the cingulate cortex—are involved in processing higher-level emotional and motivational information. Other regions, like the amygdala, work to keep you safe from more immediate dangers. In other words, one helps you at the dinner party and the other at the sea. These specialized functions have often been attributed to anatomy: one region might have greater or fewer neurons than the other, and those neurons might wire into different circuits. In either case, it has been assumed, the neurons present are using neural codes with the same basic design.

Neurons can either fire or remain silent, and the combination of the two over time gives rise to a neural code, like dots and dashes in Morse code. As with Morse code, there are theoretical limits on the richness and speed of information transfer. A new Morse code with 1,000 characters could exchange richer information, but the speed and reliability of its SOS signal would suffer. Neural codes accommodate this trade-off in their design, and it has been presumed that from neuron to neuron and region to region the balance between richness and speed is the same.

Neurons can either fire or remain silent, and the combination of the two over time gives rise to a neural code, like dots and dashes in Morse code.

But a closer look at what exactly the neurons in the human cingulate cortex and amygdala are saying has revealed that they employ strikingly different neural codes. One is optimized for richness and one for speed—just such a trade-off as might be expected given the function of these brain regions. Moreover, a comparison of human and monkey brains has revealed that in both of the studied brain regions, the code used by human neurons is more rich. In effect, different regions—and the brains of different animals—use different neural codes.

These discoveries, published earlier this year in *Cell*, have wide-ranging and potentially stunning implications. The function of a neural circuit—whether it underlies echolocation, feeding, or any other behavior—is often understood by its wiring diagrams. As with an electrical diagram, many pieces are considered to be interchangeable—a resistor is a resistor, and a switch is a switch. Thus, a circuit diagram made up of mouse, monkey or human neurons might be expected to perform the same computation. These new findings challenge that idea, showing that even the basic building blocks in two regions of the same brain can behave very differently.

It is as though some regions of the brain employ an English vocabulary; others employ that of Newspeak.

Given the interregion and interspecies nature of this study, its results will require plenty of additional corroboration and support before they can be fully adopted and generalized. But at a minimum, the authors have shown the following: in both humans and rhesus monkeys, neurons in the cingulate cortex employ a richer neural code than neurons in the amygdala. Not only is the code simpler in the amygdala, but multiple amygdala neurons were often observed to use the same code in concert. As in the example of the shark at the beach, this is thought to aid in the robust and rapid transmission of information about immediate threats. Finally, neural codes are more rich in human brains than in macaque brains, regardless of the region. In total, these findings suggest that there is a trade-off between regions and species in the neural code. This trade-off likely helps to shape the cognitive or computational capacities of different brains and different brain regions.

More broadly, this study highlights a number of routes for additional work. For starters, whereas many diseases and disorders of the brain have obvious physical manifestations that can be detected with an x-ray or an MRI, some do not. Changes to

the neural code, even in the absence of another injury or insult, could therefore be an important but undiscovered driver in psychiatric disease. Perhaps even more important are the implications for the pursuit of research at large. Biology is a field that relies heavily on the transferability of its results: one sentence in a biology textbook may have been derived from experiments in different animals and different contexts. Understanding which pieces of the biological puzzle are interchangeable and which are not is indispensable for the construction of knowledge paradigms.

On the horizon is another interesting future direction. The use of neural code–based comparative approaches like those laid out by the authors might allow for a less biased measurement of the cognitive capacities of other animals—work that could ultimately aid in conservation efforts. Why do we need such an approach? Because we cannot understand intelligences that are unlike our own. But that doesn't mean they don't exist. To borrow a word from Orwell, some of them might even be *doubleplusgood*.

—Ryan Dalton

Creative Types Reserve a Special Corner of the Brain for Dreaming Big

Artists, novelists, actors and directors excel at tapping into "imagination" circuits

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FIVE-YEAR-OLDS INVENT imaginary friends, teenagers visualize what an amorous crush would be like, and adults plan for job achievements, buying a house or traveling the world. Imagination is a trait that we all possess and use in our daily lives. But if we try to think of situations that are too far from our reality in time or space—perhaps the world in 2500 or what it would be like to live on the moon or Mars—we often have a hard time visualizing those scenarios.

For decades, neuroscientists and psychologists have tried to understand what exactly goes on in the brain when we turn our imaginations loose and what limits the ability of many of us to envision distant scenarios. In a study published in April in the *Journal of Personality and Social Psychology*, researchers report that creative professionals seem to be better than others at surmounting the mental barriers to accessing distal imagination, and their ability may be explained, in part, by their tapping into a brain network that only they can access.

By using the dorsomedial part of what scientists refer to as the brain's "default network," creative people can stretch their imagination to more distant futures, places, perspectives and hypothetical realities. The default network consists of a group of interconnected brain regions, including the medial prefrontal cortex, the posterior cingulate cortex, the angular gyrus and the hippocampus. These brain areas talk to one another when we daydream, recall memories or think about the intentions of others. Previous literature suggests that they may also play a role in envisioning the future.

Scientists believe that some of these default network circuits may help us draw from our experiences when we imagine situations that are close to us in time and space. For example, we may think of the sights and smells of a coffee shop we've frequented in the past when contem-

plating a new place in town to patronize next week—or next year. Creative professionals, though, engage other default network subsystems when imagining more distant scenarios that can't be reconstructed by mixing and matching different memories that come to mind. Take the example of a fiction writer. "They're imagining somebody else's point of view in a landscape that's not [the writer's] direct reality," says lead author Meghan Meyer, an assistant professor of psychological and brain science at Dartmouth College.

To uncover how creative professionals so vividly picture distant or hypothetical realities, Meyer and her colleagues performed a series of three experiments. First, they asked 300 randomly selected study participants to envision what the planet would be like in 500 years or a world in which the continents had never divided or a life lived as an angry dictator. Participants were also asked to think of as many ways as possible to use a pen or to improve a megaphone. Those who scored high on creativity were rated as better at using distal imagination.

Next, the researchers repeated these tests with 100 participants who had demonstrated some sort of expertise in creativity—writers, actors, directors and visual artists, who had received awards in their fields. They also asked a group of equally successful finance, legal and medical professionals the same questions. The creative professionals outperformed others in written responses and in self-reports of how vividly they could picture the situations in their minds.

Meyer and her team wondered whether the creative professionals simply had stronger "imagination muscles," the way professional baseball players have more robust throwing arms compared with nonathletes. To see these imagination muscles in action, they asked 27 creative types and 26 control participants to go through simulation tasks while lying in a functional magnetic resonance imaging (fMRI) scanner. Brain activity of the creative adepts and controls was similar when imagining the next 24 hours, but to the researchers' surprise, the creative group alone engaged the dorsomedial default network when imagining events further into the future.

The dorsomedial default network was not active at all among the control group. Yet this network was switched on even when creative professionals were at rest. "This is a big step forward in understanding the creative brain," says Roger Beaty, a psychology researcher at Penn State University, who was not involved in the study. "The findings provide insight into how the brain is able to imagine different situations and what makes creative experts exceptional at imagining distant ones," he says.

The results also have implications for the way we consider other people. Because the dorsomedial default network is involved in thinking about perspectives that differ significantly from our own experiences, people who are able to activate this network may be better able to empathize with others or imagine how public policies may impact future gene rations, says Daniel Schacter, a Harvard psychologist, who was not involved in the study.

The next big question is whether activation of the dorsomedial default network can be improved with training, Schacter says. If it is a malleable ability, maybe taking drawing classes or the like will boost our imagination and help us all better connect with others.

—Knvul Sheikh

Better Memory through Electrical Brain Ripples

A study in mice shows improved cognitive performance when these bursting signals move around memory circuits

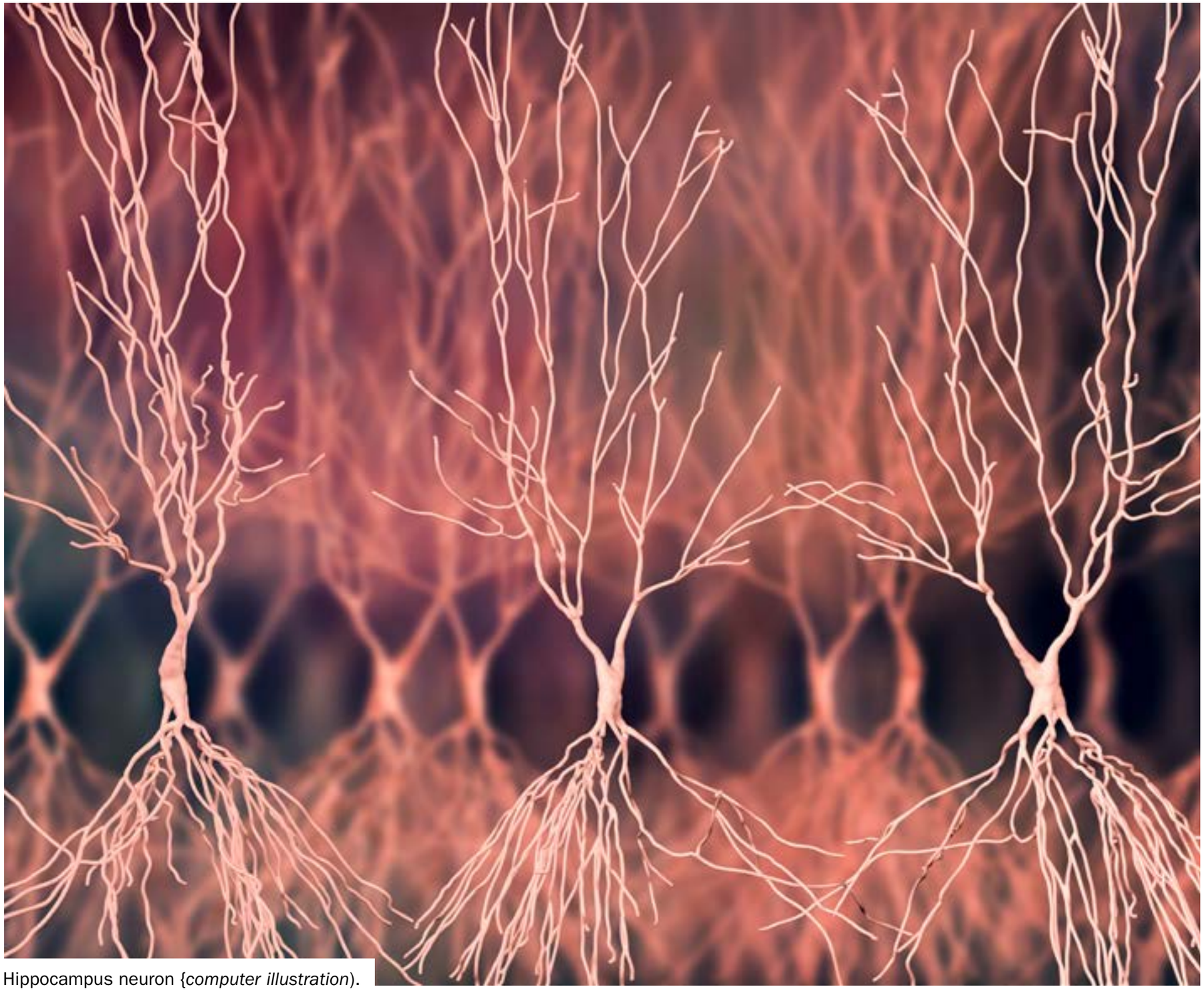
SPECIFIC PATTERNS OF BRAIN activity are thought to underlie specific processes or computations important for various mental faculties, such as memory. One such "brain signal" that has received a lot of attention recently is known as a sharp wave ripple—a short, wave-shaped burst of high-frequency oscillations.

Researchers originally identified ripples in the hippocampus, a region crucially involved in memory and navigation, as central to diverting recollections to long-term memory during sleep. Then, a 2012 study by neuroscientists at the University of California, San Francisco, led by Loren Frank and Shantanu Jadhav, the latter now at Brandeis University, showed that the ripples also play a role in memory while awake. The

researchers used electrical pulses to disrupt ripples in rodents' brains and showed that, by doing so, performance in a memory task was reduced. But nobody had manipulated ripples to enhance memory—until now, that is.

Researchers at N.Y.U. School of Medicine led by neuroscientist György Buzsáki have now done exactly that. In a June 14 study in *Science*, the team showed that prolonging sharp wave ripples in the hippocampus of rats significantly improved their performance in a maze task that taxes working memory—the brain's "scratch pad" for combining and manipulating information on the fly. "This is a very novel and impactful study," says Jadhav, who was not involved in the research. "It's very hard to do 'gain-of-function' studies with physiological processes in such a precise way." As well as revealing new details about how ripples contribute to specific memory processes, the work could ultimately have implications for efforts to develop interventions for disorders of memory and learning.

The researchers first examined the properties of ripples recorded in rats performing tasks from a database



Hippocampus neuron {*computer illustration*).

KATERYNA KON GETTY IMAGES

acquired over years of experiments. They found more long-duration ripples occurred when rats had to make their way through mazes than when they were simply exploring or running along tracks. Negotiating mazes required rats to exercise their memories.

“It’s really nice to see another group do something slightly differently and get the same result. It makes you feel confident we’re all on to something.”

—Loren Frank

In one task, the M-maze, rats were trained to first navigate through the right-hand arm of a maze shaped as an “M” to receive a sugary reward, then through the left-hand arm on the next trial. The researchers saw significantly longer ripples in trials the rats performed correctly, compared with those they got wrong. “You can record a very simple electrical pattern in the brain and tell whether the animal's performance will be good or not or whether the animal is learning or not,” Buzsáki says. These findings suggest that the hippocampus generates longer ripples during memory-intensive activities and that these longer-duration signals improve performance.

To verify that longer ripples contribute to better performance, the team artificially prolonged ripples in rats performing the M-maze task. The researchers used optogenetics, involving the use of light piped through a fiber-optic cable to activate genetically engineered light-sensitive neurons in the rats’ hippocampi. They recorded collective neural activity in the hippocampus during the task, to enable them to detect spontaneously occurring ripples. On detection of a ripple, light pulses were triggered to activate engineered neurons. This so-called closed-loop stimulation roughly doubled the duration of ripples and significantly improved the rats’ performance, compared with control conditions with either no light stimulation or stimulation applied after short, random delays.

The rats also learned faster, reaching 80 percent correct performance in remembering which route would lead to a reward earlier than rats in the control conditions. The researchers also switched off any beneficial effects by aborting ripples using high-intensity light pulses, confirming that performance was impaired. “It's really nice to see another group do something slightly differently and get the same result,” Frank says. “It makes you feel confident we're all on to something.”

To investigate how longer ripples might be enhancing performance, the team inspected the properties of the neurons involved. A ripple is not simply repeated activity of the same neurons oscillating over time; instead its activity spreads to more neurons as the signal continues.

The team observed that particular neurons tend to “fire” either in the early or in the later portion of the signal, and they found intriguing differences between these two groups. “Early” neurons were “chatterboxes” with high baseline activity, whereas “late” neurons were more sluggish, with lower average activity. “Neurons that fire fast are like talkative people; they are active in many situations,” Buzsáki explains. “The majority typically don't fire, but once they do, they say something important.”

The hippocampus contains neurons specialized for navigation, called place cells, which fire when an animal is in a specific location. The researchers found that neurons firing in the late part of long ripples (either spontaneously occurring or artificially prolonged) were more highly tuned to location, and the spots tended to be on the arms of the maze. Previous research suggests one function of ripples may be to “replay” memories. The new findings support that idea and suggest that prolonging ripples recruits extra neurons to generate the signal, whose activity is relevant to the task at hand. “When they extend the length of ripples, they’re recruiting cells that are reactivating paths the animals take,” Jadhav explains. “This might be a mechanism for doing a cognitive search of all the available paths that other

brain areas can read out and act on."

The researchers hope this work eventually may help develop ways to treat the type of memory problems that occur in age-related cognitive decline or Alzheimer's disease. Learning difficulties might also be addressed. The techniques in the experiments would be tricky to apply to humans because they are invasive and involve genetic manipulation, but Buzsáki says they are working on noninvasive methods. A recent study, published in April and led by neuroscientist Robert Reinhart of Boston University, used weak electric currents applied to the scalps of elderly participants to obtain an increase in working memory performance, accompanied by greater synchrony between oscillations of certain (theta) frequencies in different cortical regions. "There are intriguing points of connection between the elegant work by [Buzsáki's team] and research conducted in my laboratory," Reinhart says. "Research in systems and cognitive neuroscience is laying critical basic science groundwork, which may open up an entirely new avenue of circuit-based therapeutics for the prevention and treatment of brain disorders."

The problem with existing noninvasive methods, such as transcranial magnetic stimulation, or the transcranial electrical stimulation technique, used in Reinhart's study, is their inability to penetrate into the brain, so manipulating signals in the deeply seated hippocampus is difficult. Recording from deep in the brain noninvasively is even more tricky. One possible solution would be to infer when ripples occur in the hippocampus from activity recorded from the brain's surface. "There might be a very specific pattern of, say, prefrontal activity that precedes these events" and produces ripples in the hippocampus. Frank says. "But we don't understand what that looks like yet."

Also, modifying cortical activity using these techniques may, as a consequence, affect activity in the hippocampus. "We know that these sharp wave ripples can be biased by [specific] neocortical patterns," Buzsáki says. "In fact, many companies are trying to affect memory, by changing neocortical patterns." Finally, invasive methods, similar to implants used to detect and interfere with seizures in epilepsy, could be employed, either for detecting or for manipulating ripples, or both. Invasive and noninvasive methods could even be combined. "As long as you can measure these events and come up with some way to manipulate them, you have the possibility of making the system work better," Frank says. "There's a world of possibilities there."

—Simon Makin

Editors' Note: *György Buzsáki's affiliation was corrected from New York University to N.Y.U. School of Medicine.*

Authenticity under Fire

Researchers are calling into question authenticity as a scientifically viable concept

By Scott Barry Kaufman

TARA MOORE *GETTY IMAGES*

Scott Barry Kaufman is a psychologist at Columbia University, who explores intelligence, creativity, personality and well-being. In addition to writing the column Beautiful Minds for *Scientific American*, he also hosts The Psychology Podcast and is author and/or editor of eight books, including *Wired to Create: Unraveling the Mysteries of the Creative Mind* (with Carolyn Gregoire) and *Ungifted: Intelligence Redefined*.

Authenticity is one of the most valued characteristics in our society. As children we are taught to just "be ourselves," and as adults we can choose from a large number of self-help books that will tell us how important it is to get in touch with our "real self." It's taken as a given by everyone that authenticity is a real thing and that it is worth cultivating.

Even the science of authenticity has surged in recent years, with hundreds of journal articles, conferences and workshops. But the more that researchers have put authenticity under the microscope, the more muddied the waters of authenticity have become. Many common ideas about authenticity are being overturned. Turns out, authenticity is a real mess.

PROBLEMS WITH AUTHENTICITY

One big problem with authenticity is that there is a lack of consensus among both the general public and among psychologists about what it actually means for someone or something to be authentic. Are you being most authentic when you are being congruent with your physiological states, emotions and beliefs, whatever they may be? Or are you being most authentic when you are congruent with your consciously chosen beliefs, attitudes and values? How about when you are being congruent across the various situations and social roles of your life? Which form of "being true to yourself" is the real authenticity: Was it the time you really gave that waiter a piece of your mind or that time you didn't tell the waiter how you really felt about his or her dismal performance because you value kindness and were true to your higher values?

Another thorny issue is measurement. Virtually all measures of authenticity involve self-report measures. Yet people often do not know what they are really like or why they actually do what they do. So a test that asks people to report how authentic they are is unlikely to be a truly accurate measure of their authenticity.

Perhaps the thorniest issue of them all, though, is the entire notion of the real self. Humanistic psychotherapist Carl Rogers noted that many people who seek psychotherapy are plagued by the question: "Who am I, really?" While people spend so much time searching for their real self, the stark reality is that all the aspects of your mind are part of you. It's virtually impossible to think of any intentional behavior that does not reflect some genuine part of your psychological makeup, whether it's your dispositions, attitudes, values or goals.

This creates a real problem for the scientific investigation of a concept such as authenticity. As Katrina Jongman-Sereno and Mark Leary conclude in their recent article "The Enigma of Being Yourself,"

"Given the complexity of people's personalities, two seemingly incompatible actions might both be highly self-congruent. People are simply too complex, multifaceted and often conflicted for the concept of a unitary true self to be a useful standard for assessing authenticity, either in oneself or in others."

So what is this true self that people are always talking about? Once you take a closer scientific examination, it seems that what people refer to as their "true self" really is just the aspects of themselves that make them feel the best about themselves. All around the world, people show an authenticity positivity bias: people include their most positive and moral qualities—such as kind, giving and honest—in their descriptions of their true self. People judge their positive behaviors as more authentic than their negative behaviors even when both behaviors are consistent with their personal characteristics and desires.

Even more perplexing, it turns out that most people's feelings of authenticity have little to do with acting in accord with their actual nature. The reality appears to be quite the opposite. All people tend to feel most authentic when having the same experiences, regardless of their unique personality. In particular, we all tend to feel most authentic when we are feeling content, calm, loving, enthusiastic, free, competent, mindful of the present

moment and open to new experiences. In other words, we tend to feel most authentic when our needs are being met and we feel ownership of our subjective experiences. Not when we are simply being ourselves.

Another counterintuitive finding is that people actually tend to feel most authentic when they are acting in socially desirable ways, not when they are going against the grain of cultural dictates (which is how authenticity is typically portrayed). On the flip side, people tend to feel inauthentic when they are feeling socially isolated or feel as though they have fallen short of the standards of others.

One big problem with authenticity is that there is a lack of consensus among both the general public and among psychologists about what it actually means for someone or something to be authentic.

It makes sense that feelings of authenticity would be so strongly tied to social evaluation considering how important reputation and acquiring a unique role within a group was across the course of human evolution. This also may help explain why people's evaluations of their authenticity is so strongly tied to their morality and most valued goals. Behaving in ways that are consistent with your higher goals (such as announcing your new humanitarian nonprofit) is typically perceived as more authentic by yourself and by others than authentically watching Netflix while eating that stack of glazed doughnuts. Even though, sorry to say it, but both behaviors are really you.

Therefore, what people think of as their true self may actually just be what people want to be seen as. According to social psychologist Roy Baumeister, we will report feeling highly authentic and satisfied when the way others think of us matches up with how we want to be seen and when our actions "are conducive to establishing, maintaining and enjoying our desired reputation." If you think back on your own personal experiences of when you've felt most authentic in your life (and are really honest with yourself), you'll probably agree that this largely rings true.

Conversely, Baumeister argues that when people fail to achieve their desired reputation, they will dismiss their actions as inauthentic, as not reflecting their true self. ("That's not who I am.") As Baumeister notes, "As familiar examples, such repudiation seems central to many of the public appeals by celebrities and politicians caught abusing illegal drugs, having illicit sex, embezzling or bribing, and other reputation-damaging actions."

Saving Authenticity

While there doesn't appear to actually be such a thing as the one true self, the concept of the true self may still serve a useful function. The science of authenticity does show that feeling in touch with your real self (even if there doesn't actually exist such a thing) is a strong predictor of many indicators of well-being. Holding the idea of your true self in mind can play an important meaning-making function and can serve as a useful guide to evaluating whether you are living up to your ideal of the good life.

After all, I do believe there is within each of us best selves—aspects of who you are that are healthy, creative and growth-oriented and make you feel most connected to yourself and to others. I would argue that getting in touch with your best selves and intentionally actualizing your most creative, growth-oriented potentialities is a much more worthy goal than spending your entire life trying to find your one true self. In my view, there is such a thing as healthy authenticity.

Healthy authenticity is not about going around saying whatever is on your mind or actualizing all of your potentialities, including your darkest impulses. Instead healthy authenticity, of the sort that helps you become a whole person, involves accepting and taking responsibility for your whole self as a route to personal growth and meaningful relationships. Healthy authenticity is an ongoing process of discovery, involving self-awareness, self-honesty, integrity with your most consciously chosen values and highest goals, and a commitment to cultivating authentic relationships.

As long as you are working toward growth in the direction of who you truly want to be, that counts as authentic in my book regardless of whether it is who you are at this very moment. The first step to healthy authenticity is shedding your positivity biases and seeing yourself for who you are, in all of your contradictory and complex splendor. Full acceptance doesn't mean you like everything you see, but it does mean that you've taken the most important first step toward actually becoming the whole person you most wish to become. As Carl Rogers noted, "the curious paradox is that when I accept myself just as I am, then I can change."

What's So Funny? The Science of Why We Laugh


Comedian Hannah Gadsby

SCOTT CAMPBELL *GETTY IMAGES*

Psychologists, neuroscientists and philosophers are trying to understand humor

By Giovanni Sabato

“How Many Psychologists Does It Take ... to Explain a Joke?”

Many, it turns out. As psychologist Christian Jarrett noted in a 2013 article featuring that riddle as its title, scientists still struggle to explain exactly what makes people laugh. Indeed, the concept of humor is itself elusive. Although everyone understands intuitively what humor is, and dictionaries may define it simply as “the quality of being amusing,” it is difficult to define in a way that encompasses all its aspects. It may evoke the merest smile or explosive laughter; it can be conveyed by words, images or actions and through photos, films, skits or plays; and it can take a wide range of forms, from innocent jokes to biting sarcasm and from physical gags and slapstick to a cerebral double entendre.

Even so, progress has been made. And some of the research has come out of the lab to investigate humor in its natural habitat: everyday life.

Giovanni Sabato trained as a biologist and is now a freelance science writer based in Rome. Beyond psychology, biology and medicine, he is interested in the links between science and human rights.

SUPERIORITY AND RELIEF

For more than 2,000 years pundits have assumed that all forms of humor share a common ingredient. The search for this essence occupied first philosophers and then psychologists, who formalized the philosophical ideas and translated them into concepts that could be tested.

Perhaps the oldest theory of humor, which dates back to Plato and other ancient Greek philosophers, posits that people find humor in, and laugh at, earlier versions of themselves and the misfortunes of others because of feeling superior.

The 18th century gave rise to the theory of release. The best-known version, formulated later by Sigmund Freud, held that laughter allows people to let off steam or release pent-up “nervous energy.” According to Freud, this process explains why tabooed scatological and sexual themes and jokes that broach thorny social and ethnic topics can amuse us. When the punch line comes, the energy being expended to suppress inappropriate emotions, such as desire or hostility, is no longer needed and is released as laughter.

A third long-standing explanation of humor is the theory of incongruity. People laugh at the juxtaposition of incompatible concepts and at defiance of their expectations—that is, at the incongruity between expectations and reality. According to a variant of the theory known as resolution of incongruity, laughter results when a person discovers an unexpected solution to an apparent incongruity, such as when an individual grasps a double meaning in a statement and thus sees the statement in a completely new light.

BENIGN VIOLATION

These and other explanations all capture something, and yet they are insufficient. They do not provide a complete theoretical framework with a hypothesis that can be measured using well-defined parameters. They also do not explain all types of humor. None, for example, seems to fully clarify the appeal of slapstick. In 2010 in the journal *Psychological Science*, A. Peter McGraw and Caleb Warren, both then at the University of Colorado Boulder, proposed a theory they call “benign violation” to unify the previous theories and to address their limits. “It’s a very interesting idea,” says Delia Chiaro, a linguist at the University of Bologna in Italy.

McGraw and Warren’s hypothesis derives from the theory of incongruity, but it goes deeper. Humor results, they propose, when a person simultaneously recognizes both that an ethical, social or physical norm has been violated and that this violation is not very offensive, reprehensible or upsetting. Hence, someone who judges a violation as no big deal will be amused, whereas someone who finds it scandalous, disgusting or simply uninteresting will not.

Experimental findings from studies conducted by McGraw and Warren corroborate the hypothesis. Consider, for example, the story of a church that recruits the faithful by entering into a raffle for an SUV anyone who joins in the next six months. Study participants all judged

The greatest of them all: Charlie Chaplin was among the fathers of slapstick comedy, which relies on physical gags. Chaplin refined his comedy by tinging it with melancholy and social commitment.

the situation to be incongruous, but only nonbelievers readily laughed at it.

Levity can also partly be a product of distance from a situation—for example, in time. It has been said that humor is tragedy plus time, and McGraw, Warren and their colleagues lent support to that notion in 2012, once again in *Psychological Science*. The recollection of serious misfortunes (a car accident, for example, that had no lasting effects to keep its memory fresh) can seem more amusing the more time passes.

Geographical or emotional remoteness lends a bit of distance as well, as does viewing a situation as imaginary. In another test, volunteers were amused by macabre photos (such as a man with a finger stuck up his nose and out his eye) if the images were presented as effects created with Photoshop, but participants were less amused if told the images were authentic. Conversely, people laughed more at banal anomalies (a man with a frozen beard) if they believed them to be true. McGraw argues that there seems to be an optimal comic point where the balance is just right between how bad a thing is and how distant it is.

EVOLUTIONARY THEORY

The idea of benign violation has limitations, however: it describes triggers of laughter but does not explain, for instance, the role humor has played in humanity's evolutionary success. Several other theories, all of which contain elements of older concepts, try to explain humor from an evolutionary vantage. Gil Greengross, an anthropologist then at the University of New Mexico, noted that humor and laughter occur in every society, as well as in apes and even rats. This universality suggests an evolutionary role, although humor and laughter could conceivably be a by-product of some other process important to survival.

In a 2005 issue of the *Quarterly Review of Biology*, evolutionary biologist David Sloan Wilson and his colleague Matthew Gervais, both then at Binghamton University, S.U.N.Y., offered an explanation of the evolutionary benefits of humor. Wilson is a major proponent of group selection, an evolutionary theory based on the idea that in social species like ours, natural selection favors characteristics that foster the survival of the group, not just of individuals

Wilson and Gervais applied the concept of group selection to two different types of human laughter. Spontaneous, emotional, impulsive and involuntary laughter is a genuine expression of amusement and joy and is a reaction to playing and joking around; it shows up in the smiles of a child or during roughhousing or tickling. This display of amusement is called Duchenne laughter, after scholar Guillaume-Benjamin-Amand Duchenne de Boulogne, who first described it in the mid-19th century. Conversely, non-Duchenne laughter is a studied and not very emotional imitation of spontaneous laughter. People employ it as a

MAX MUNN AUTREY *GETTY IMAGES*

Laurel and Hardy's characteristic gags are examples of a subgenre of slapstick called the slow burn, a term that refers to a situation where an apparently minor incident builds inexorably to a devastating finish.

voluntary social strategy—for example, when their smiles and laughter punctuate ordinary conversations, even when those chats are not particularly funny.

Facial expressions and the neural pathways that control them differ between the two kinds of laughter, the authors say. Duchenne laughter arises in the brain stem and the limbic system (responsible for emotions), whereas non-Duchenne laughter is controlled by the voluntary premotor areas (thought to participate in planning movements) of the frontal cortex. The neural mechanisms are so distinct that just one pathway or the other is affected in some forms of facial paralysis. According to Wilson and Gervais, the two forms of laughter, and the neural mechanisms behind them, evolved at different times. Spontaneous laughter has its roots in the games of early primates and in fact has features in common with animal vocalizations. Controlled laughter may have evolved later, with the development of casual conversation, denigration and derision in social interactions.

Ultimately, the authors suggest, primate laughter was gradually co-opted and elaborated through human biological and cultural evolution in several stages. Between four million and two million years ago Duchenne laughter became a medium of emotional contagion, a social glue, in long-extinct human ancestors; it promoted interactions among members of a group in periods of safety and satiation. Laughter by group members in response to what Wilson and Gervais call protohumor—nonserious violations of social norms—was a reliable indicator of such relaxed, safe times and paved the way to playful emotions.

When later ancestors acquired more sophisticated cognitive and social skills, Duchenne laughter and protohumor became the basis for humor in all its most complex facets and for new functions. Now non-Duchenne laughter, along with its dark side, appeared: strategic, calculated, and even derisory and aggressive.

Over the years additional theories have proposed different explanations for humor's role in evolution, suggesting that humor and laughter could play a part in the selection of sexual partners and the damping of aggression and conflict.

SPOT THE MISTAKE

One of the more recent proposals appears in a book dedicated to an evolutionary explanation of humor, *Inside Jokes: Using Humor to Reverse-Engineer the Mind* (MIT Press, 2011), by Matthew M. Hurley of Indiana University Bloomington, Daniel C. Dennett (a prominent philosopher at Tufts University) and Reginal Adams, Jr., of Pennsylvania State University. The book grew out of ideas proposed by Hurley.

Hurley was interested, he wrote on his Web site, in a contradiction. "Humor is related to some kind of mistake. Every pun, joke and comic incident seemed to contain a fool of some sort—the 'butt' of the joke," he

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explained. And the typical response is enjoyment of the idiocy—which "makes sense when it is your enemy or your competition that is somehow failing but not when it is yourself or your loved ones." This observation led him to ask, "Why do we enjoy mistakes?" and to propose that it is not the mistakes per se that people enjoy. It is the "emotional reward for discovering and thus undoing mistakes in thought. We don't enjoy making the mistakes, we enjoy weeding them out."

Hurley's thesis is that our mind continuously makes rule-of-thumb conjectures about what will be experienced next and about the intentions of others. The idea is that humor evolved from this constant process of confirmation: people derive amusement from finding discrepancies between expectations and reality when the discrepancies are harmless, and this pleasure keeps us looking for such discrepancies. (To wit: "I was wondering why the Frisbee was getting bigger, and then it hit me.") Moreover, laughter is a public sign of our ability to recognize discrepancies. It is a sign that elevates our social status and allows us to attract reproductive partners.

In other words, a joke is to the sense of humor what a cannoli (loaded with fat and sugar) is to the sense of taste. It is a "supernormal" stimulus that triggers a burst of sensual pleasure—in this case, as a result of spotting mistakes. And because grasping the incongruities requires a store of knowledge and beliefs, shared laughter signals a commonality of worldviews, preferences and convictions, which reinforces social ties and the sense of belonging to the same group. As Hurley told psychologist Jarrett in 2013, the theory goes beyond predicting what makes people laugh. It also explains humor's cognitive value and role in survival.

And yet, as Greengross noted in a review of *Inside Jokes*, even this theory is incomplete. It answers some questions, but it leaves others unresolved—for example, "Why does our appreciation of humor and enjoyment change depending on our mood or other situational conditions?"

Giovannantonio Forabosco, a psychologist and an editor at an Italian journal devoted to studies of humor (*Rivista Italiana di Studi sull'Umorismo*, or *RISU*), agrees: "We certainly haven't heard the last word," he says.

UNANSWERED QUESTIONS

Other questions remain. For instance, how can the sometimes opposite functions of humor, such as promoting social bonding and excluding others with derision, be reconciled? And when laughter enhances feelings of social connectedness, is that effect a fundamental function of the laughter or a mere by-product of some other primary role (much as eating with people has undeniable social value even though eating is primarily motivated by the need for nourishment)?

There is much evidence for a fundamental function. Robert Provine of the University of Maryland, Baltimore County, showed in *Current Directions in Psychological Science*, for example, that individuals laugh 30 times more in the company of others than they do alone. In his research, he and his students surreptitiously observed spontaneous laughter as people went about their business in settings ranging from the student union to shopping malls.

Forabosco notes that there is also some confusion about the relation between humor and laughter: "Laughter is a more social phenomenon, and it occurs for reasons other than humor, including unpleasant ones. Moreover, humor does not always make us laugh." He notes the cases where a person is denigrated or where an observation seems amusing but does not lead to laughter.

A further lingering area of debate concerns humor's role in sexual attraction and thus reproductive success. In one view, knowing how to be funny is a sign of a healthy brain and of good genes, and consequently it attracts partners. Researchers have found that men are more likely to be funny and women are more likely to appreciate a good sense of humor, which is to say that men compete for attention and women do the choosing. But views, of course, differ on this point.

Even the validity of seeking a unified theory of humor is debated. "It is presumptuous to think about cracking the secret of humor with a unified theory," Forabosco says. "We understand many aspects of it, and now the neurosciences are helping to clarify important issues. But as for its essence, it's like saying, 'Let's define the essence of love.' We can study it from many different angles; we can measure the effect of the sight of the beloved on a lover's heart rate. But that doesn't explain love. It's the same with humor. In fact, I always refer to it by describing it, never by defining it."

Still, certain commonalities are now accepted by almost all scholars who study humor. One, Forabosco notes, is a cognitive element: perception of incongruity. "That's necessary but not sufficient," he says, "because there are incongruities that aren't funny. So we have to see what other elements are involved. To my mind, for example, the incongruity needs to be relieved without being totally resolved; it must remain ambiguous, something strange that is never fully explained."

Other cognitive and psychological elements can also provide some punch. These, Forabosco says, include features such as aggression, sexuality, sadism and cynicism. They don't have to be there, but the funniest jokes are those in which they are. Similarly, people tend to see the most humor in jokes that are "very intelligent and very wicked."

"What is humor? Maybe in 40 years we'll know," Forabosco says. And perhaps in 40 years we'll be able to explain why he laughs as he says it.

Are People with ADHD More Creative?

A look at whether people whose minds drift away easily, such as those with the disorder, are more likely to come up with original ideas

By Caterina Gawrilow and Sara Goudarzi

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Caterina Gawrilow, a psychology professor at Eberhard Karls University Tübingen, investigates learning difficulties in children and adolescents.
Sara Goudarzi is a Brooklyn-based writer.

Those affected by attention deficit hyperactivity disorder (ADHD) are clinically thought of as inattentive, hyperactive and impulsive. But people with ADHD are also perceived as being very spontaneous, curious, inquisitive, enthusiastic, lively and witty, a perception that creates an impression they are more creative than those without ADHD. But is there truth to this idea?

Creativity is generally the ability to generate something original and unprecedented. The ideas must be not only new and surprising but also useful and relevant. Among other things, creativity comes through intensive knowledge and great motivation in a particular field, be it painting, music or mathematics.

For years, both laypersons and scientists have been fascinated by the proverbial proximity of genius and madness. According to psychologist Dean Keith Simonton of the University of California, Davis, unusual and unexpected experiences, such as psychological difficulties and psychiatric stays, are an important characteristic of people who create masterpieces.

Two core symptoms, inattention and impulsiveness, suggest a connection between creativity and ADHD. Inattention, which occurs more frequently in those affected with the disorder, likely leads to mind wandering, or the drifting of thoughts from an activity or environment. Such drifting can lead to new, innovative and creative ideas.

In a study, detailed in the *Journal of Creative Behavior,* researchers asked 26 college students with ADHD and 26 without ADHD to perform two creativity tests. The first involved inventing and drawing alien fruit without copying those on Earth. Students with ADHD were able to create more unique fruit. Similarly, when asked to invent product labels, those with ADHD were able to come up with less conventional names.

People with ADHD are also more impulsive and therefore more willing to take risks: they dare to approach new things and situations without fear of contact. In a 2011 study, 203 five- to 10-year-old children participated in a Balloon Analogue Risk Task (BART) experiment. BART is a computerized test where participants can blow up balloons one click at a time. Each time a balloon is inflated, participants earn money. If, however, the balloon pops, participants lose their earnings. Researchers found that those with ADHD pumped more than the control group—meaning they took greater risks than those without ADHD. Those with both ADHD and oppositional defiant disorder (ODD), children with defiance toward authority figures, pumped the most of all groups. Even at primary school age, teachers perceive more impulsive children as more curious. This is likely to create more learning opportunities for these students, which, in turn, could enhance their creativity.

ADHD is, however, a highly heterogeneous disorder. Not only are there large differences between affected individuals, but the symptoms are also not always the same in patients. In addition, cognitive performance fluctuates from person to person. For example, for some with ADHD, the disease has a flip side in that they possess the ability to focus intensely on one single thing, when interested. A 2018 study showed that adults with ADHD had higher, and more frequent episodes of, hyperfocus when it came to hobbies, school and screen time. Similar to mind wandering, this ability is also extremely beneficial for creative or artistic tasks.

Nonetheless, research into the relation between ADHD and creativity to date has painted an inconsistent picture, partly because it is more difficult to understand creativity using psychological tests than it is to comprehend, say, intelligence. So far, though, studies that are of higher quality and involve sufficient test subjects do not provide clear evidence that people with ADHD are actually the better lateral thinkers.

Does Psychology Have a Conflict-of-Interest Problem?

Some star psychologists don't disclose in research papers the large sums they earn for talking about their work. Is that a concern?

By Tom Chivers

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Tom Chivers is a science journalist based in London.

GENERATION Z HAS MADE JEAN TWENGE A LOT OF MONEY. As a psychologist at San Diego State University, she studies people born after the mid-1990s, the YouTube-obsessed group that spends much of its time on Instagram, Snapchat and other social-media platforms. Thanks to smartphones and sharing apps, Generation Z has grown up to be more narcissistic, anxious and depressed than older cohorts, she argues. Twenge calls them the "iGen" generation, a name she says she coined. And in 2010 she started a business, iGen Consulting, "to advise companies and organizations on generational differences based on her expertise and research on the topic."

Twenge has "spoken at several large corporations, including PepsiCo, McGraw-Hill, nGenera, Nielsen Media, and Bain Consulting," one of her Web sites notes. She delivers anything from 20-minute briefings to half-day workshops and is also available to speak to parents' groups, nonprofit organizations and educational establishments. In e-mail exchanges, she declined to say how much she earns from her advisory work, but fees for star psychologists can reach tens of thousands of dollars for a single speech— possibly much more, several experts told *Nature*.

Twenge's academic papers don't mention her paid speeches and consulting. Yet that stands in stark contrast to the conflict-of-interest (COI) guidelines issued by the International Committee of Medical Journal Editors (ICMJE), an influential organization whose standards have been widely adopted by many medical and some psychology journals. Those guidelines say that such "personal fees" should be declared as potential COIs in research papers because readers should be made aware of any financial interests that they might perceive as potentially influencing the findings.

Twenge is not a lone outlier; an analysis for this article found that several well-known academic psychologists do paid speeches and consultancy work and don't declare them in their research papers. Many editors and psychologists say that this is fine and is standard behavior. They argue that this kind of income should not count as a COI and that psychology should not be held to the norms of medical science. "Speaking fees and consultancies would not be obvious conflicts of interest, unlike, say, evaluating a drug produced by a company in which one holds stock, since there would not seem to be incentives aligned with making one claim versus another," says Steven Pinker, a well-known author and psychologist at Harvard University, who can also be booked for speaking engagements.

But other psychologists say they think personal speaking fees ought to be declared. There is no suggestion that any scientists are deliberately skewing their results to maintain their speaking income. But critics say that lax COI disclosure norms could create problems by encouraging some scientists to play down—perhaps unconsciously—findings that contradict their arguments and could lead them to avoid declaring other conflicts. "A lot of researchers don't know where to draw the line [on COIs]," says Chris Chambers, a psychologist at the University of Cardiff, who is an editor for five journals, including one on psychology. "And because there are no norms, they gravitate to saying nothing."

Researchers who spoke to *Nature* about their concerns say they see the issue as connected to psychology's greater need for self-scrutiny because of some high-profile cases of misconduct, as well as to broader concerns about the reproducibility of results. "Even the appearance of an undisclosed conflict of interest can be damaging to the credibility of psychological science," says Scott Lilienfeld, the editor in chief of *Clinical Psychological Science* (*CPS*), which published papers of Twenge's in 2017 and 2018. "The heuristic should be 'when in doubt, declare,'" he says (although he added that he did not have enough information to judge Twenge's nondisclosures in *CPS*). Psychology, he adds, needs to engage in a "thoroughgoing

discussion of what constitutes a conflict of interest and when and how such conflicts should be disclosed."

SPEAKING INCOME

Supplementing one's income with speeches isn't uncommon among academic psychologists and other researchers. Take Adam Grant, whose Web site declares him to be the "top-rated professor" at Wharton Business School. He is best known for his work on the psychology of business and offers speaking engagements on his Web site, which notes that he has spoken to more than 100 organizations, including Credit Suisse, Goldman Sachs, Merck and Facebook.

Angela Duckworth, a psychologist at the University of Pennsylvania and author of the bestselling book *Grit: The Power of Passion and Perseverance* (2016), told *Nature* that she does about 12 speaking engagements a year. Other well-known researchers who can be booked for speaking appearances include Carol Dweck, famous for her work on "growth mindset," and her long-time collaborator David Yeager; Amy Cuddy, the researcher behind "power posing"; Barbara Fredrickson, a pioneer of "positive psychology"; Jonathan Haidt, the author of *The Righteous Mind* (2012) and *The Coddling of the American Mind* (2018); and Philip Tetlock, who wrote *Superforecasting* (2015).

None of them would comment on their fees for speeches and consultancy work, although one U.S.-based psychologist—who didn't want their identity revealed by *Nature* to protect their privacy—said that they get between U.S.$10,000 and $20,000 for speaking at universities and up to $40,000 for speaking to trade groups.

Some psychologists appear on "speakers' bureau" Web sites, which put potential clients in touch with speakers. One site claimed Twenge can be booked for $20,000 to $30,000; when *Nature* asked her about this, she said the page was "out of date," and it was deleted shortly afterward. Another site lists Grant as available for $100,000 to $1 million. A literary agent—who has negotiated speaking fees for well-known scientists but didn't want to be identified—says that someone of Twenge's fame could expect between $5,000 and $15,000 per appearance. And an American motivational speaker, Dave Sheffield, says that speaking fees for "celebrity" psychologists "begin at $10,000 and can go as high as $100,000."

"If the norm were to change in psychology with respect to reporting COIs for consultancies and speakers' fees, I would follow that new norm."
—Barbara Fredrickson

Nature examined 60 papers from the psychologists named above that were relevant to their most well-known theses and dated back no further than 2013. In almost all, researchers either declared they had no COIs or did not include such declarations. One of Grant's papers noted that he engaged in "unrelated" consultancy for a firm that funded the research. In two of Twenge's papers about the impacts of smartphone use on adolescents' sleep, published in *Sleep Medicine,* there are no declarations of COIs, but the journal uploads declaration of interest forms on its Web site. In these forms, Twenge says that she has received money from consultancies and speakers' bureaus "unrelated" to her research, although her Web site says that her speaking engagements are about her research findings.

Asked to comment, some researchers said that it was simply the case that they had not received speaking or consulting fees related to the specific papers that *Nature* looked at. "I've always declared potential conflicts of interest according to the guidelines of the journals in which I publish—and of our institutional review board—and I believe strongly that scientists should do so," Grant said. A press spokesperson at the University of Texas at Austin responded on behalf of Yeager to note that he discloses his financial interests (including speaking appearances) internally to his university, as required, and that the university had not identified any financial COIs.

But others noted that although they wouldn't mind disclosing speeches and consulting fees if required, they understood that this was not currently the case. "If my COI disclosures are in error, I would be happy to correct them," said Twenge (who added that she doesn't use the name iGen Consulting much any more). "Generally, I do not consider the speaking and consulting I do to be conflicts of interest because both compensate for presenting the research, not for a particular research result or analysis.… If the norms do indeed move toward agreement that it is important to disclose these types of activities, I will certainly do so."

Fredrickson said: "If the norm were to change in psychology with respect to reporting COIs for consultancies and speakers' fees, I would follow that new norm." And Duckworth noted: "I would have no issue with disclosing in scientific publications that I engage in paid speaking engagements," adding, "I have no complaint about changing editorial rules and norms."

That chimes with what other researchers say: that psychology's norms do not include declaring speaking fees and consultancy income. Marcus Crede, a psychologist at Iowa State University, who has followed the issue, says he doesn't think he has ever seen such a thing declared as a COI in a paper. He adds that this is particularly a problem

when researchers have been severely criticized for their results but continue to earn money for talks on them, pointing to statistical concerns that have come to light in Cuddy's power-posing research since her papers were published. "To ask Cuddy to be an objective reporter, and say she has no COIs, seems ludicrous," he says. (Cuddy, who is at Harvard Business School, did not reply to *Nature*'s requests for comment.)

NOT THE NORM

Other disciplines are stricter than psychology when it comes to declaring speaking and consulting gigs. Richard Hurley, an editor at the *British Medical Journal*, says that speaking engagements would unambiguously be considered COIs at his journal, because speeches are often about a researcher's findings; if results come back negative, that could affect future earnings from speeches.

"Anything you get money for, beyond about £200 [$255] or £300, you are expected to declare: certainly fees for speaking," says Alan Carson, a neuropsychiatrist at the University of Edinburgh, who is associate editor at the *Journal of Neurology, Neurosurgery and Psychiatry* and an editorial board member for the journal *Brain Injury*. And at the general-interest journal *PLOS ONE,* editor in chief Joerg Heber says: "Anything that may be perceived as a COI should be declared," and that includes speaking fees. He says that the journal will ask Twenge about a paper she published with them without declaring a conflict.

It is only in the past two decades that many disciplines, led by the medical journals, have codified rules requiring full transparency about payments to researchers. The ICMJE issued its guidelines in 2009, and in 2013 a U.S. law called the Sunshine Act came into force that requires pharmaceutical companies to declare their payments to doctors and hospitals. These rules were introduced as researchers became aware that COIs can color scientific objectivity. Meta-analyses looking at the work of scientists with COIs have found that their work is consistently more likely to return positive results and that research funded by for-profit organizations is more likely to find benefits from interventions than is nonprofit-funded research.

Reimbursement for speaking engagements or consultancy "fits quite clearly with what [the ICMJE guidelines] call personal fees."
—Adam Dunn

The COIs in these kinds of studies generally relate to companies directly funding relevant research or paying scientists, rather than to fees for speaking engagements or consulting. But the ICMJE guidelines say that researchers should declare "all monies from sources with relevance to the submitted work," including personal fees, defined as "monies paid to you for services rendered, generally honoraria, royalties, or fees for consulting, lectures, speakers bureaus, expert testimony, employment, or other affiliations." Reimbursement for speaking engagements or consultancy "fits quite clearly with what [the ICMJE guidelines] call personal fees," says Adam Dunn, who studies COIs in pharmaceutical research at Macquarie University in Sydney, Australia.

Most COI declarations in research papers run on an honor system: scientists are expected to declare, but there is little actual checking. Last year, for instance, a well-known cancer researcher, José Baselga of the Memorial Sloan Kettering Cancer Center in New York City, resigned after failing to declare millions of dollars he had received from various pharmaceutical companies. Journalists found the payments in a federal database related to the Sunshine Act. COI problems have affected psychology, too: this year a *PLOS ONE* paper about mindfulness was retracted over methodological concerns, but its editors also noted that the authors had failed to disclose their employment at an institute that sold related mindfulness products.

Many psychology journals follow the ICMJE's line in the declaration-of-interest forms that they ask authors to complete. "Do you have any potential or perceived conflicts of interest?" asks the journal *Psychological Science* in its form. Its examples include "Having received fees for consulting" and "Having received funds reimbursing you for attending a related symposia [sic] or talk." Similar formulations are adopted by other psychological journals, such as *Perspectives on Psychological Science*, *Archives of Sexual Behaviour* and *Child Development*, which want to know about "relevant financial interests (for example … consultancies, or speaker's fees)." All of these journals have published at least one study by a high-profile psychologist who receives money for consultancy and speaking fees but didn't declare any COIs in the final paper. (*Archives of Sexual Behaviour* is published by Springer Nature, the publisher of this journal; *Nature*'s news team is editorially independent of its publisher.)

Still, there is much ambiguity, making it hard to pin down whether psychologists actually went against journal guidelines. *CPS* instructs authors to follow ICMJE-style disclosures, but its editor in chief Lilienfeld, speaking on his own behalf and not that of the journal's publisher, the U.S. Association for Psychological Science (APS), said that he understood that such ethical considerations were a strong recommendation but not a formal require-

ment. An APS spokesperson said that the society "has had no formal role in defining conflicts of interest for its members" and pointed to the individual instructions given by APS journals.

DIVIDED OPINION

Not all psychologists think that their field's norms need to change. Some take Pinker's line, saying that although it is important to draw bright, unambiguous lines separating what is and what isn't a COI, speeches and consultancy work probably don't qualify. "My idea of a conflict of interest is something like someone hires a fox to look after the chickens' welfare, and I don't see that that's a problem in this case," said Alex Michalos, an emeritus political scientist at the University of Northern British Columbia and the founding (though not current) editor of *Social Indicators Research*. Following a rubric common to many journals published by Springer Nature, this journal states that it requires disclosure of all potential competing interests, includ-ing honoraria for speaking at symposia, and employment or consultation.

Stephen Lindsay, a psychologist at the University of Victoria in British Columbia and the editor in chief of *Psychological Science*, said that he was "not sure how to draw the line." But what worried him most was secretive outside payments for presenting a perspective—such as when a cognitive scientist publishes evidence on the beneficial effects of video gaming while secretly being remunerated by a game company. That's different, he says, from research psychologists giving speeches or consultancy work that promotes their own work's claims. He said it was "public knowledge" that researchers such as Cuddy and Twenge receive fees for lectures promoting their research findings, and readers would be aware of this. "When in doubt, it is better to err on the side of caution and declare potential conflicts of which readers might otherwise be ignorant. But when someone is known for taking a specific stand, it does not seem necessary to include a COI acknowledging that. If we all detailed the various ways in which our self-interest intertwines with our science, COI statements would be very long," he said.

Although the psychologists are not being paid by a firm to promote a product, by running a consultancy business based on their own research "they are the firm. Their message is the product."

—Eduardo Franco

Psychologist Jonathan Haidt of New York University said he agreed that income from speeches and consultancy work could in theory affect an academic's research findings. "When professors take on the telos [purpose] of businesses, of maximizing their revenue, it could corrupt their search for truth. The more a professor becomes a consulting service, the more that becomes a conflict of interest," he said. But in the vast majority of cases, he felt, speeches and consulting work do not present an issue—unlike in medical research, where companies do often pay speakers fees to influence doctors' decisions.

And there are other reasons for academics not to declare such income, he added. "In today's polarized climate, people write hit pieces about academics using little more than Google and guilt by association. If everyone could scrutinize the list of every group that has paid every academic, then many of us would be reluctant to speak to groups that depart from the favored political orientations."

Others were more worried about the lack of disclosure. Although the psychologists are not being paid by a firm to promote a product, by running a consultancy business based on their own research "they are the firm. Their message is the product," says Eduardo Franco, the editor in chief of *Preventive Medicine Reports,* a medical journal that published a paper by Twenge. Franco says that Twenge should have disclosed her consulting business.

CHANGING NORMS

Alongside the push for more transparent disclosures there is also a reaction against psychologists who, some consider, promote work that isn't strongly supported by data. For instance, Moin Syed, editor in chief of *Emerging Adulthood,* told *Nature* that the most damaging cases were when people speak about the results of their work without making it clear that there is "lots of research that runs counter to their ideas." Unprompted, he brought up Cuddy, Duckworth and Twenge as "three key figures whose names come up most often. It's not limited to them, but they're particularly salient because they have held steadfast to their views, discounting the disconfirming evidence, and continue to do speaking tours and books." Twenge, however, replies that she closely follows the scientific debate in her field.

Syed was not the editor in 2013, when *Emerging Adulthood* published two articles by Twenge about a narcissistic "Generation Me" but says his initial reaction is that, if they were to be published now, he would want the articles to have COI declarations. (The editor of the journal at the time, Manfred van Dulmen, a psychologist at Kent State University, did not reply to *Nature*'s request for

comment.) “Just because you’re being paid doesn’t mean that there’s really a conflict, just potential for one. The cornerstone of the open-science movement is transparency in all regards. Any potential conflicts are part of that,” Syed says.

Even proponents of declaring COIs in publications say that it won’t prevent some potential problems, especially as much consultancy work might be done after a paper is published. Carson, the neuropsychiatry journal editor, points out that it is not just the existence of income but also the level of it that is important. “Whether it’s £100,000 or £10,000 or £1,000 makes a difference,” he says. He thinks that the reader needs to know in order to make a decision on whether to trust the research. And no journal requires that level of transparency.

One possibility, he notes, would be for researchers to simply publish a regularly updated page of all their potential COIs, perhaps with approximate income levels. This could be attached to their unique Open Researcher and Contributor ID (ORCID), which could be linked to from research papers. Syed says this could also help in mitigating false accusations of COIs. Having a publicly available list of funding sources could also help researchers to debunk false accusations.

Whether or not that is the right route, it is important for psychology that some sort of solution is found, Lilienfeld says: “I don’t know whether the norms differ in psychology as opposed to other scientific domains. It may be that psychological scientists more often write popular books, give public workshops, TED talks, etcetera, on topics of interest to the average person than do chemists.”

“My hunch, and it’s only a hunch, is that the issue of authors not declaring COIs is much more the exception than the rule,” he says. “But even if it is relatively rare, it’s a problem that needs to be fixed.”

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Toward a New Frontier in Human Intelligence: The Person-Centered Approach

New research is shedding light on how intelligence changes and develops over time

By Scott Barry Kaufman

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Scott Barry Kaufman is a psychologist at Columbia University, who explores intelligence, creativity, personality and well-being. In addition to writing the column Beautiful Minds for *Scientific American*, he also hosts The Psychology Podcast and is author and/or editor of eight books, including *Wired to Create: Unravelling the Mysteries of the Creative Mind* (with Carolyn Gregoire) and *Ungifted: Intelligence Redefined*.

When it comes to intelligence, we all have bad days. Heck, we even have many bad moments, such as when we forget our car keys, forget a friend's name or bomb an important test that we've taken a day after staying up all night worrying about it. Truth is, none of us—including the world's smartest human—is perfectly consistent in our cognitive functioning. Sometimes we are at our very best and feel like our brain is on fire, and at other times, we don't even recognize ourselves.

All of this sounds so obvious, but surprisingly, the field of human intelligence has not had much to say on the topic. For the past 120 years, the field has shed far more light on how we differ from one another in our patterns of cognitive functioning than how we each differ within ourselves over time.

This is curious considering that a person-centered approach has proved fruitful in other fields, such as medicine and neuroscience. Even within the study of human behavior there has been progress, from looking at how individual emotions fluctuate over time to how individual personality traits such as introversion and openness to new experiences and even our morality fluctuate throughout the course of the day. It has become increasingly clear that the results from the traditional individual differences paradigm—where we compare people with each other—often does not apply at the person-specific level.

In only the past few years, intelligence researchers have been able to demonstrate that this is also true in the domain of human intelligence. For the past 120 years, the field just hasn't had the tools to view intelligence at such a level of granularity. With the adoption of newer technologies, however, researchers have begun to view an individual's intelligence at a more microscopic level, able to capture all sorts of fascinating variations—across days, within days, and even moment to moment. It turns out that intelligence is changing all over the place all the time. Who knew?

Of course, this was true well before these recent papers emerged, but we literally didn't have a way to think about how to measure intelligence at such a level until we got things like computer tablets that make it feasible to test people at a wide range of different timescales. As the University of Cambridge neuroscientist Rogier Kievit, one of the leaders of this new paradigm, told me:

"I think about it as a cognitive microscope. It's like we put a bit of rain water under the microscope and looked at it, and suddenly there are animals or tiny creatures moving around. It was there all along, but we just didn't have the tools to look at it. This is a whole new avenue into studying how people differ and how they change and which types of variability are bad and which ones are uniformly good."

Let's take a deep dive into this exciting new view of intelligence.

FLUCTUATIONS IN INTELLIGENCE

In the past few years, Florian Schmiedek, Martin Lövdén and Ulman Lindenberger of the Max Planck Institute for Human Development in Germany have been leading the charge in understanding fluctuations in cognitive ability over time. They have demonstrated not only that the cognitive functioning of most people fluctuates quite a bit throughout the day and across days but that some people fluctuate quite a bit more than others. This applies to children in elementary school as well as adults in everyday life. Remember these findings the next time you panic that you might be getting dementia because you forgot your house keys. Just think about how many times you actually remembered your house key in the past month!

In my view, this research is revolutionary for a number of reasons. For one, this research shows that these cognitive fluctuations aren't simply the result of random noise or "error variance." They are systematic. Researchers have started to reveal some of the most important factors that have a systematic impact on fluctuations in intelligence, including sleep quality and sleep duration, emotions, noise disturbance in the school classroom, cognitive fatigue and poverty.*

The person-centered approach to intelligence is also groundbreaking because it allows us to tease out different profiles of variability that may have important implications on real-world functioning. For instance, one study by Schmiedek and Judith Dirk of the Leibniz Institute for Research and Information in Education in Germany had 110 schoolchildren in grades 3 and 4 complete

working-memory tasks on smartphones three times a day in school and at home for four weeks. Those who have strong working-memory performance are able to hold multiple bits of information in memory while simultaneously processing other information (such as comprehending the last sentence I wrote, which required a lot of working memory). Working memory is essential for learning and reasoning, and this is especially the case when it comes to complex, on-the-spot problem-solving under timed conditions. In other words, school.

While the researchers found overall significant fluctuations day to day and moment to moment, some children showed a lot more variability than other children. In fact, some children showed no systematic day-to-day variability whatsoever in their working-memory performance. This had real-world implications, as more variable working-memory performance was related to lower school achievement and lower scores on a fluid intelligence test that measured on-the-spot abstract reasoning.

In the same study, the children also rated their momentary emotional states. Overall, working-memory performance was lower on occasions when the child reported higher negative emotions, and there was no link between working-memory performance and positive emotions. Yet—and this is critical—children differed in the degree to which they were affected by their environment.

Using the person-centered approach, the researchers were able to identify different groups of children. In line with the distinction between "the orchid and the dandelion," some children were sensitive to all emotional stimuli, showing a strong effective of both positive and negative emotions on their working-memory performance (orchids), whereas others showed low sensitivity to their current affective state overall (dandelions). This new paradigm allows us to see more clearly than ever before that when it comes to the complex relation between emotions and cognition, there is no one-size-fits-all approach.

Finally, this research is important because it suggests that the much researched "general factor of intelligence" (*g*)—the largest source of cognitive variation ever discovered in humans—is much less prominent within people than between people. To be sure, over the past 120 years intelligence researchers have done a truly remarkable job cataloguing the structure of cognitive abilities that exists when you assess intelligence between people, and general intelligence does predict many important things in life.

But Schmiedek and his colleagues found that within-person structures of daily cognitive performance cannot be inferred from between-person structures. To demonstrate this, the researchers administered a wide range of cognitive tests to 101 young adults on 100 occasions over the course of six months. They found that each person had their own cognitive signature, with differing fluctuations across the different tasks over the span of six months. The research team then attempted to predict how well an individual would perform on one particular task on a certain day by their performance on the other eight tasks that were also done on each day. They found that this prediction worked much better if the prediction took into account the individual's highly idiosyncratic structure of daily fluctuations, rather than using the structure that describes average between-person differences in cognitive ability.

All of this is a fancy way of saying that if you really want to understand the complexities of a person's intelligence, we can do much better than simply looking at a person's overall IQ score based on their one-time intellectual deviation from other people who all took the test at different times in a sterile testing environment. This doesn't offer nearly as much information about the rich tapestry of individuals' intellectual landscape as actually following them over time at different times of the day as they engage in a variety of different cognitive tasks in their everyday lives.

PRACTICAL IMPLICATIONS AND FUTURE DIRECTIONS

This new frontier in intelligence research opens up a lot of avenues. One avenue is the investigation of the long-run consequences and causes of variability. The longest timescale Schmiedek and his team has looked at is six months, which involved 100 different measurements for each person. What happens when we look at years, even decades, with thousands and thousands of different data points per person? What does the long arc of a person's intellectual life look like? What are the major life events that cause the biggest fluctuations in a person's life, and what impact do those fluctuations have on a life well lived?

Rogier Kievit—who is currently applying for a grant to look at the impact of long-term fluctuations—told me that he finds this line of research "absolutely fascinating." Kievit isn't only interested in the antecedents and causes of cognitive fluctuations over long timescales, but he is also curious as to which fluctuations can be beneficial and which ones may be detrimental to performance. Kievit points out that some fluctuations can be a positive sign that a person is trying different strategies to solve a problem, whereas for others fluctuations can be an indication of floundering.

The implications may also be different for adults than young children. Low variability may be a positive sign for adults, whereas high variability among children can be more mixed, depending on the causes of the variability (is it the result of exploration and smart strategies or blind trial and error?). Kievit is particularly excited by the increased attention to topics such as the "microgenetics" approach pioneered by Robert Siegler, which examines change as it occurs at a very high temporal resolution. Such moment-to-moment fluctuations in abilities such as spatial working memory have already been captured in schoolchildren using smartphones. It'll be exciting to see how this plays out in the long run for the child.

I can envision a smartphone app someday that will allow you to do repeated assessments of your cognitive performance across a wide range of tasks over the course of months to determine what times of the day you are at peak cognitive performance and for which cognitive abilities. This would be useful not only for adults to plan their workday but also for children scheduling when to take which classes. What appears to be a "dull" child may have more to do with the time of day that assessment is being made, or a particular time in that child's life, than a reflection of his or her true intelligence.

Which leads me to another important implication of this research, which is high-stakes testing. Let's be clear: this research doesn't suggest that there is no such thing as intelligence—of course, differences in intelligence exist! Instead it highlights that if we want to more fully and accurately understand intellectual potential we must look at individual intelligence over time. This is critical because many gifted and talented programs base their admissions on the result of a single-shot testing session. Likewise, many important college decisions are based on the result of a one-shot standardized test. Ideally, we would allow students take a test many times over a year and submit their aggregate result, and college admissions officers would also be on the lookout for conditions that may have depressed a child's true score.

I asked Schmiedek what avenue of research excites him the most using the person-centered approach, and he told me he is excited to conduct more research that takes into account social and emotional factors and uses that information to design interventions that can help people improve cognitive functioning. This avenue of research is also very exciting to me, as I believe it highlights the importance of viewing individuals as whole people, with not just cognitive potentials but also motivations and passions, personality traits, rich life experiences and daily fluctuations in the lived stream of life.

Yes, it is possible to take a single trait—say, IQ—and compare people with one another, treating all else equally. But within individuals, all else is assuredly not equal. Our levels of engagement affect our intellectual potential, as do our personal long-term dreams and goals. This is why in my 2013 book *Ungifted: Intelligence Redefined*, I presented a theory of Personal Intelligence, which I defined as "the dynamic interplay of abilities and engagement in pursuit of personal goals." At the end of the day, what individuals care the most about is not how their overall intellectual functioning compares with others but how they can maximize their own unique capacities in the service of realizing a desired future image of themselves.

I'm truly excited by this new frontier in intelligence research because it will allow us the opportunity to capture the complexities of an individual's potential to a much greater degree than we ever have before. And maybe one day we can use that information—not to limit possibility—but to make sure we are bringing out the best in everyone.

*Take cognitive fatigue. Hans Sievertsen and his colleagues looked at standardized test data for literally *every single child* who attended Danish public schools between 2009 and 2013. This comprised two million tests taken! They found that the time of day of the testing significantly affected test scores, with the impact being particularly strong for low-performing students. Additionally, a 20- to 30-minute break every hour substantially improved average test scores. They calculated that the breaks are worth about $1,900 higher household income, almost two months of parental education, or 19 school days. The authors conclude that "cognitive fatigue should be taken into consideration when deciding on the length of the school days and the frequency and duration of breaks."

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BEHAVIOR & SOCIETY

A Solution for Loneliness

Get out and volunteer, research suggests

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I was riding a bus recently and noticed an older man sitting outside a coffee shop on a busy sidewalk. He had set up a chessboard on the table in front of him, and he watched as people passed by, mostly engrossed in their phones. His eyes kept jumping from person to person, searching for someone to notice and join him for a game of chess. Right before the traffic cleared and my bus moved on, he reached over to make the first move and then resumed his searching.

Loneliness is rampant, and it's killing us—literally. Anywhere from one quarter to one half of Americans feel lonely a lot of the time, which puts them at risk for developing a range of physical and mental illnesses, including heart disease, cancer, diabetes and depression. This is a public health problem that needs to be addressed on a wide scale.

But at the individual level, there is much we can do to ward off loneliness. One strategy is to bring a chessboard to a busy street and wait for someone to play with you. For the older man's sake, I sincerely hope that this is effective, but I can't be sure.

Another strategy is to volunteer. In a recent survey of more than 10,000 people in the U.K., two thirds reported that volunteering helped them feel less isolated. Similarly, a 2018 study of nearly 6,000 people across the U.S. examined widows who, unsurprisingly, felt lonelier than married adults. After starting to volunteer for two or more hours per week, their average level of loneliness subsided to match that of married adults, even

after controlling for demographics, baseline health, personality traits and other social involvement. These benefits may be especially strong the older you are and the more often you volunteer.

Participating in volunteer opportunities may help alleviate loneliness and its related health impact for several reasons. The first and most obvious is that it's a meaningful way to connect with others and make new friends. I experienced this firsthand when I moved to San Francisco and knew almost no one. After joining a young professionals volunteer group, getting involved with a local nonprofit serving seniors and adults with disabilities, and both organizing and assisting with neighborhood events, I felt my own sense of community and social support increase dramatically.

Second, volunteering can make up for the loss of meaning that commonly occurs with loneliness. Research using the U.C.L.A. Loneliness Scale and Meaning in Life Questionnaire has shown that more loneliness is associated with less meaning. This makes sense, given our deeply rooted need for belonging. By volunteering for social causes that are important to us, we can gain a sense of purpose, which in turn may shield us from negative health outcomes. For example, purpose in life has been linked to a reduced likelihood of stroke and greater psychological well-being.

Third, loneliness and isolation can lead to cognitive decline, such as memory loss. But according to neuroscientist Lisa Genova, people who regularly engage in mentally stimulating activities build up more neural connections and are subsequently more resilient to symptoms of Alzheimer's. Thus, volunteering is one way to stay engaged and stimulated, rather than isolated and lonely, and thereby protect against cognitive decline.

These insights may be especially relevant for the growing senior population. By 2030 one in five residents in the U.S. will be of retirement age, may no longer have work to provide purpose and connection, and will be prone to isolation as the result of increased physical limitations and loved ones passing away. Given that loneliness seems to be most prevalent among those older than 65 and younger than 25, mentoring across ages could be a powerful way to volunteer and connect. Indeed, I recently experimented with hosting an intergenerational friendship gathering and found that it left baby boomers and millennials—not to mention me—feeling gratified.

I wish I could have stopped my bus and skipped my plans that day to play chess with the older man. He struck me as a symbol of our times: people wanting desperately to connect—not through a screen but face-to-face, with others from their community. Now more than ever, we have a real need and opportunity to build a culture of social health, one interaction at a time. Volunteering is a great way to start.

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OBSERVATIONS

Socrates' Critique of 21st-Century Neuroscience

The ancient thinker saw limits to what natural science can tell us about ourselves

GETTY IMAGES

If chocolate releases the same chemicals in the brain as sexual excitement, why not forgo the trials and tribulations of a romantic relationship for a bowl of Hershey's kisses? Twenty-first century neuroscience provides such a sophisticated understanding of brain functions that it is tempting to mistake the psychic mechanism with the ultimate goal.

This is precisely what goes on in the field of psychobiology, which eschews discussion of meaning beyond the biological process. Ironically, the scientific study of psychology was initiated by Socrates' disillusionment with the natural sciences in light of their complete inability to account for human behavior. Alongside advances in brain science, we need to rediscover the ancient approach to behavioral science as a means of restoring meaning to function, if for no other reason than that our lives depend on it.

Socrates (469–399 B.C.) recounts, in his final recorded conversation before his fateful execution, his interest and subsequent disenchantment with the works of the natural scientists. "When I was young, Cebes, I was tremendously eager for the kind of wisdom which they call investigation of nature," Socrates tells those gathered in his prison

cell. "I thought it was a glorious thing to know the causes of everything, why each thing comes into being and why it perishes and why it exists."

Rather than appealing to a supernatural world of gods, the Ionian physicists had, for the first time in history, attempted to apply reason to understand the natural world. Thales of Miletus (circa 624–548 B.C.) initiated this approach with the provocative claim that everything is water—not a bad first attempt given water's plasticity and primacy.

Later thinkers presented rival claims culminating in the work of the atomists, who posited that all reality, including human behavior, could be understood by an indivisible substance along with empty space to give the atoms room to move. As one atomist puts it, mental states are nothing other than sensations that result from the imposition of atoms on the organism: "We know nothing about anything really," declares Democritus (circa 460–370 B.C.), "but opinion is for all individuals an inflowing of the atoms."

Socrates was initially excited by the explanatory power afforded by the physicists, who were able to explain the multiplicity of existing things by appealing to a few simple principles. His youthful exuberance soon turned to dismay as he realized that the natural sciences could explain everything except the most important thing he could hope to understand. "Since I had given up investigating realities," Socrates goes on to detail the mental turmoil he experienced: "I decided that I must be careful not to suffer the misfortune which happens to people who look at the sun and watch it during an eclipse."

For Socrates, the misapplication of the natural sciences to human affairs renders the investigator incapable of seeing such fundamental notions as justice, beauty and goodness since they lack a material explanation. He poignantly illustrates the fallacy of scientific reasoning by considering how a biologist would explain why Socrates is sitting in his prison cell: "The bones are hung loose in their ligaments, the sinews, by relaxing and contracting, make me able to bend my limbs now," declares Socrates just before drinking the poison, "and that is the cause of my sitting here with my legs bent." Of course, one cannot argue with the truth of the biologist's explanation; nonetheless, bones and sinews have nothing to do with why Socrates is sitting on death row.

"We know nothing about anything really, but opinion is for all individuals an inflowing of the atoms."

—Democritus

Socrates' disenchantment with the natural sciences led him to initiate a second scientific revolution in which he establishes the rational basis of ethics and politics. Despite disavowing the natural sciences, he remained committed to the scientific approach, which attempts to explain a multiplicity of phenomena by appealing to a single cause. The Socratic scientific revolution was thus not so much in the method he pursued but in his application of it. Rather than positing primal matter as his first principle, Socrates initiates a whole new line of investigation premised on the absolute existence of immaterial ethical principles such as justice and goodness. Socrates' unique research method began with a ruthless examination of people's belief systems.

He further clarifies how he used these discussions as a therapeutic means of helping to purge his discussion partners of their misguided opinions. "But the greatest thing about my art is this," says Socrates about his unique gift for helping others, "that it can test in every way whether the mind of the young man is bringing forth a mere image, an imposture, or a real and genuine offspring." In contrast to Freudian psychotherapy, Socrates employs the talking cure to get people to join in the inquiry as co-investigators and in so doing to get them to think more rationally about their lives.

Although Socrates wrote nothing, we have preserved (with more or less fidelity) several thousand pages of these unique therapy sessions. In one of these discussions, a young man approaches Socrates for help in treating a recurring problem with headaches on waking in the morning—no doubt caused by the teenager's overindulgent behavior the prior night. Socrates informs the young man that most physicians fail to treat the real cause of many physical maladies because they neglect the patient's mental health.

In contrast, Socrates claims to have learned a technique that will effectively treat the boy's condition: "A certain leaf, but there was a charm to go

with the remedy," Socrates explains, "and if one uttered the charm at the moment of its application, the remedy made one perfectly well, but without the charm there was no efficacy in the leaf." Socrates then went on to engage the young boy in a long discussion about the meaning of moderation. Sobriety will obviously afford the boy a more permanent solution than the immediate relief provided by any drug.

By the end of the discussion, one realizes that Socrates was not completely forthright when describing the treatment plan since he never actually administered the leaf. Evidently, the medicinal leaf needs the charm, but the charm of philosophical inquiry does not need the addition of a drug to produce the desired effect.

Socrates demanded that human behavior be treated as a legitimate field of scientific inquiry. Just like other sciences, he insisted that ethical claims must be validated in order to be regarded as knowledge. It was this rigorous commitment to knowledge that compelled him to admit his ignorance in spite of his sustained efforts investigating human behavior: "The one thing I know is that I know nothing." Just as cancer research continues despite the inability to find a cure, Socrates demands that inquiry must continue in the human sciences even if many fundamental questions remain unanswered. "The duty of inquiring after what we do not know," charges Socrates to one of his skeptical conversation partners, "will make us better and braver and less helpless than the notion that there is not even a possibility of discovering what we do not know."

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OBSERVATIONS

You've Heard of Postpartum Depression but Probably Not Postpartum Anxiety

More accurately known as perinatal anxiety, and like most people, I had no idea it existed until it struck me

GETTY IMAGES

Four days after the birth of our daughter, my husband and I brought her home from the hospital. We were exhausted but giddy, ready to start our new lives. For nine months I had imagined what those first weeks at home would be like: sleepless nights, bleary-eyed arguments, a few late-night tears, all bundled up in the soft happy glow of new motherhood. In short, an adventure. But none of that materialized. What I came up against instead was a sheer wall of blinding panic.

We had left the hospital with instructions to wake our newborn up every three hours to feed, but by the time we got home and settled in, five hours had elapsed, and nothing would rouse her long enough to nurse. She lay limp in my arms, drifting in and out of sleep, howling uncontrollably just long enough to tire herself out. We took our cues from the Internet and tickled her feet with ice cubes, placed wet towels on her head and blew onto her face but only managed to upset her more.

And somewhere between trying to persuade her to latch for what felt like the hundredth time and willing my body to stay awake, it struck me that I had made a terrible mistake, one that I could never unmake. My stomach lurched, my hands and feet went numb, and my heart began to pound.

These feelings weren't new. Panic and I have a long and storied history together. But they were surprising. Even though my team of obstetricians had known I was on antidepressants throughout my pregnancy for an anxiety disorder, no one had thought to tell me I was at high risk for postpartum anxiety. And so when it hit me, I had never even heard of it.

And I'm not alone. According to some estimates, postpartum anxiety (PPA) affects up to 15 percent of pregnant and postpartum women, making the condition at least as prevalent as postpartum depression (PPD). (Postpartum is actually a misnomer, since the symptoms can hit anytime during pregnancy or after birth. A more accurate descriptor is perinatal, encompassing the months on either side of childbirth.) In some it's experienced as negative intrusive thoughts, including thoughts of harming themselves or their babies. In others, PPA manifests as obsessive worrying, watching the baby's chest rise and fall all night to make sure she's breathing. And in a smaller group, including me, the anxiety is diffuse and nebulous but all-consuming. What's common in all cases is a paralyzing worry, often accompanied by an inability to eat, sleep, function in any meaningful way, and, most critically, to connect with an infant.

"Everything in a woman's life is changing," says Sheryl Green, a psychologist at McMaster University, who specializes in women's health. "It makes sense to have a little bit of anxiety. When it comes to the point that it's debilitating ... that is when people need to get formal treatment, just as they would with depression."

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Green began her career working at a women's clinic and "kept getting referrals for pregnant and postpartum women who had primary anxiety," she recalls. "So I went to turn to resources and protocols to start treating these women effectively, and there was nothing there."

The condition is not listed in the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-5*), which is supposed to be the gold standard of reference for mental health professionals. Whether or not a disorder is included can also impact insurance companies' willingness to cover treatment for it. "It's just not on people's radars," Green says.

It certainly wasn't on my radar. And in my case, the anxiety was annoyingly meta: I became terrified that the fever-pitched panic would never abate. Unlike a lot of new moms, I wasn't obsessing over my daughter's breathing, her heart rate, whether she would wake from her next nap. But I was convinced that panic had become my new normal, that something had snapped in me and would never unsnap.

In the weeks that followed, I fantasized for the first time in my life about getting hit by a bus or not waking up in the morning. Every time my baby cried I became physically ill, an ironic reminder of the morning sickness I had just left behind. I felt nothing for her, just a tightening in my chest and a hopelessness that's hard to explain. It seemed absurd that I should be her mother, very much a nightmare I couldn't wake up from. She and I couldn't possibly exist harmoniously in the world, I decided, and the only way out was for one of us to disappear.

And it didn't help that my mother asked me if I'd ever felt such love before or that distant relatives were making long-distance phone calls to find out whether I was nursing—an uncle I had only met a handful of times in my life was suddenly interested in the nutritional value of my breasts. By this point I hadn't eaten a proper meal in weeks, and my milk had all but dried up, but the pressure to nurse didn't let up, and I pumped every two hours round the clock. But since tears were more forthcoming than milk, I eventually stopped trying altogether.

Green eventually decided to develop her own treatment protocol based around cognitive-behavioral therapy, which is currently being piloted with a group of pregnant and postpartum women. The preliminary results are promising,

and the research is now under review by the *Journal of Clinical Psychiatry*.

Like Green, psychiatrist Nichole Fairbrother of the University of British Columbia arrived at research into perinatal mood disorders after uncovering a gaping hole in the literature. Her career path was defined by a thought that would have petrified many new moms. After her son was born, she remembers looking at his little hands, and thinking how easy it would be to cut his fingers off. "What would it be like to have a thought like that if I didn't know anything about [negative intrusive thoughts]?" she wondered. "It would be terrifying. In that moment I really needed to find out: Is anybody studying this? Is this a thing?" The answer was a resounding no.

Her lab published a landmark paper that found the incidence of PPA to be at least as high as PPD. "We weren't surprised," she says. "But it was validating." Now they're focused on finding treatments that don't involve pharmacological interventions, because drugs have been shown to have adverse effects on the developing fetus. "If there's any population that deserves nonmedication-based treatments, it's new mothers," she says. "These women deserve an alternative."

Unlike postpartum anxiety, postpartum depression has made its way into the common vernacular around early motherhood. In its mildest form, it's called the "baby blues" and is experienced by up to 80 percent of new moms, according to the National Institute of Mental Health. Although scientists don't know for certain what causes it, it's probably brought on in part by the sudden hormonal changes experienced after childbirth. A woman's brain is bathed in a cocktail of hormones, including estrogen and progesterone, throughout her pregnancy, but after she gives birth the levels plummet almost instantly.

"There's a lot of misinformation and miseducation around what is common and or normal in the postpartum period."
—Paige Bellenbaum

This withdrawal, coupled with the ordeal of pushing a baby out (or having it cut out of you), makes new moms very vulnerable to mood swings, weepiness and irritability. And it's no longer the taboo it once was: the discharging nurse at our hospital told a group of new dads, my husband included, that if their partners weren't having at least one public breakdown a day, it was only because they were sobbing alone in the bathroom.

But postpartum depression is not the same as the baby blues, and what tips some women over the edge from mild weepiness to major depressive disorder remains, in part, a mystery. Over the past decade, there has been a steady rise in academic and clinical research around PPD, but the same cannot be said for PPA. A search of academic articles that included the terms perinatal or postpartum depression yields 6,488 results, with just 191 for perinatal or postpartum anxiety.

Why the discrepancy? Maybe we just don't know how to talk about debilitating anxiety in motherhood. While the baby blues gave us a common language for discussing sadness and depression, anxiety is so often dismissed as normal. New mothers are expected to feel overwhelmed and anxious—it's par for the course.

"There's a lot of misinformation and miseducation around what is common and or normal in the postpartum period," says Paige Bellenbaum, social worker and co-founder of the Motherhood Center, a space in New York City offering a range of treatment options for women suffering from perinatal mood and anxiety disorders. Women experiencing anxiety or intrusive thoughts might "think they're crazy and they're not fit to be a mother," she says. "It's probably easier to talk about feeling sad or weepy than it is to say I feel completely anxious. I can't sleep, I can't eat. I'm hypervigilant. I keep having these very intrusive thoughts."

I eventually found my way to the Motherhood Center and to Bellenbaum, where a combination of cognitive-behavioral therapy, dialectical behavioral therapy and psychiatric treatments over the course of six weeks helped me find a semblance of normalcy once again. I was admitted into their day program, a partial hospitalization requiring my daughter and I to be at the center five hours a day, five days a week.

Bellenbaum suffered from PPD herself and co-founded the center when she realized how little help there was for women out there. "When I finally

did get the treatment I needed," she recalls, "I got really angry that nobody was talking about it [PPD], and nobody asked me how I was doing. Even when I had described my symptoms, nobody was able to tell me what it was that was happening."

As wonderful as day programs are, they can be prohibitively expensive, and most insurance carriers will not reimburse for it. Nor will they pay for drugs to treat postpartum depression: just last week, the first FDA-approved treatment for PPD was announced, with a price tag of $30,000. "Health insurance companies sadly don't value women's mental health. It's been a real uphill battle," Bellenbaum says. "There's a lot of work that needs to be done around bringing costs down."

Thanks to people like Bellenbaum, who spearheaded legislation around PPD screening in New York State, awareness of maternal mental health is on the rise, and treatment clinics are slowly beginning to appear around the country. But the screening procedures remain woefully inadequate. Most prenatal clinics administer a questionnaire designed to identify at-risk women sometime during the first trimester and then again at the six-week postpartum visit.

But for many women, these check-ins come either too early or too late. And even the best-intentioned providers can make women feel inadequate: At my six-week visit, the doctor took one look at my daughter and cooed, "Aren't you just so in love with this little bundle?" I looked her in the eye and pronounced an emphatic no. Needless to say, she looked terribly uncomfortable. She had me fill out the questionnaire, perused my responses and eyed me with concern: "Oh, you're going to score pretty high on the depression scale." No shit, I thought to myself.

The most commonly used screen is the Edinburgh Postnatal Depression Scale. Although it does include questions about anxiety, it's mostly focused on depression.

"There's a desperate need for measures to screen for perinatal anxiety disorders," Fairbrother says. "It's going to be really tricky to treat if we don't have screens."

What's more, screening without an increase in awareness and education is just not going to cut it. More and more women are getting screened, but they may lie because of a reluctance to admit they're having thoughts of self-harm or of harming their baby. Providers can also be part of the problem: "I've heard stories of nurses taking screens before a women is discharged from the hospital and saying: 'I really think you should fill this out again,'" says Bellenbaum. "If I give this to the doctor, they're not going to let you go home with the baby."

I eventually found my stride with my daughter and am beginning to imagine a world where the two of us can live happily side by side. I can't state with any certainty whether it was the medication, therapy or just time that began the healing process—most likely it was some combination of the three (and it doesn't hurt that my daughter started to smile and coo right around the time I was all but ready to give up). What I do know with certainty is that motherhood is hard, and no one should be made to feel isolated and inadequate for having feelings that are so devastatingly commonplace.

Susana Martinez-Conde and **Stephen Macknik** are professors of ophthalmology at the State University of New York and the organizers of the Best Illusion of the Year Contest. They have co-authored *Sleights of Mind: What the Neuroscience of Magic Reveals about Our Everyday Deceptions* and *Champions of Illusion: The Science behind Mind-Boggling Images and Mystifying Brain Puzzles*.

Help, I'm Stuck in a Painting!

When the real world looks like Flatland

Pigment on canvas can be so vivid, with brushstrokes so precise, that viewers may need to remind themselves that they are looking at depictions of life, rather than life itself. *Trompe l'oeils* (from the French "deceives the eye") are spectacular examples of the sort of artistic deception in which a photorealistic portrayal of a bowl of fresh berries can be nearly as mouth-watering as the real fruit.

Installation artist Alexa Meade does not paint *trompe l'oeils*. She does just the opposite. Whereas *trompe l'oeil* art consists of making flat paintings look like three-dimensional objects and people, Meade's reverse *trompe l'oeils* make 3-D objects and people look like flat paintings.

Meade uses the human body as her canvas—including Ariana Grande's body for her music video God Is a Woman. The artist spends two to five

ALEXA MEADE

days painting the props, walls and floors that will be part of a portrait, with one to five hours focused on the clothes the model will wear. Then the model puts on the prepainted clothes, and Meade paints the face and any exposed skin.

Meade's unique work illustrates that depth perception is always a brain construct, not only in art but also in life. Because our retinas are fundamentally flat surfaces, our neurons must infer the third dimension from cues such as shadows, perspective lines or the relative sizes of objects—both in paintings and in everyday perception. Meade's artful application of paint disrupts this brain process.

In daily vision, our brains also use the small discrepancy between the left and right eye images to produce stereopsis, the binocular mechanism that allows you to see depth in 3-D movies or in the *Magic Eye* books. Stereopsis cues are absent in paintings, which helps explain why even masterpieces often seem flatter than actual landscapes. Meade's artworks look even flatter in photographs than in real life, because photography removes stereo cues.

The artist offers some advice for enhancing the artifice when you visit her installations: watch the artwork with one eye closed (to prevent stereopsis) and "frame it off as if through a window" to remove any leftover depth cues, rendering life into art.

ALEXA MEADE

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