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PLUS

THE EVOLUTIONARY RATIONALE FOR GOING TO THERAPY

WHY SOME PEOPLE CAN'T SHUT UP

OPINION: WE MUST RENAME ADHD

Life Away from the Screen

How to feel less stressed and more empowered and to create a life of meaning … without your phone

WITH COVERAGE FROM nature

FROM THE EDITOR

LIZ TORMES

A Digital Obsession

Before the pandemic grounded most of us, if you'd ever ridden the subway or a bus, flew on a commercial flight or, heck, been anywhere in public with lots of other people, chances are you'd have seen a familiar thing: all heads around you bowed, eyes locked intently on a cell-phone screen. If people had near constant phone fixation in the prepandemic times, it might be safe to call it a flat-out phone addiction in the age of rolling lockdowns and perpetual social distancing; one survey found that average U.S. adult smartphone time surpassed three hours a day for the first time ever in 2020. A lot of this screen time is likely mindless scrolling from one post to another—in one way, it's a distraction from thinking about the strife in one's own life and in the world. As writer Karen K. Ho tells our technology editor Sophie Bushwick in this issue's cover story, this so-called doomscrolling robs "future-you of the energy you need to really focus on important things and also to take better care of yourself" (see "Stop Doomscrolling News and Social Media").

Scrolling further into this issue, senior editor Gary Stix has a fascinating conversation with Vanderbilt University professor of psychology Steven D. Hollon about the role of therapy in treating depression (see "Evolution Could Explain Why Psychotherapy May Work for Depression"). And journalist Christiane Gelitz explores the debate over whether you can read a lie on someone's face (see "Humans Are Pretty Lousy Lie Detectors"). Once you've finished this absorbing collection, I recommend stepping away from your screen and getting some fresh spring air.

Andrea Gawrylewski
Senior Editor, Collections
editors@sciam.com

SCIENTIFIC AMERICAN MIND

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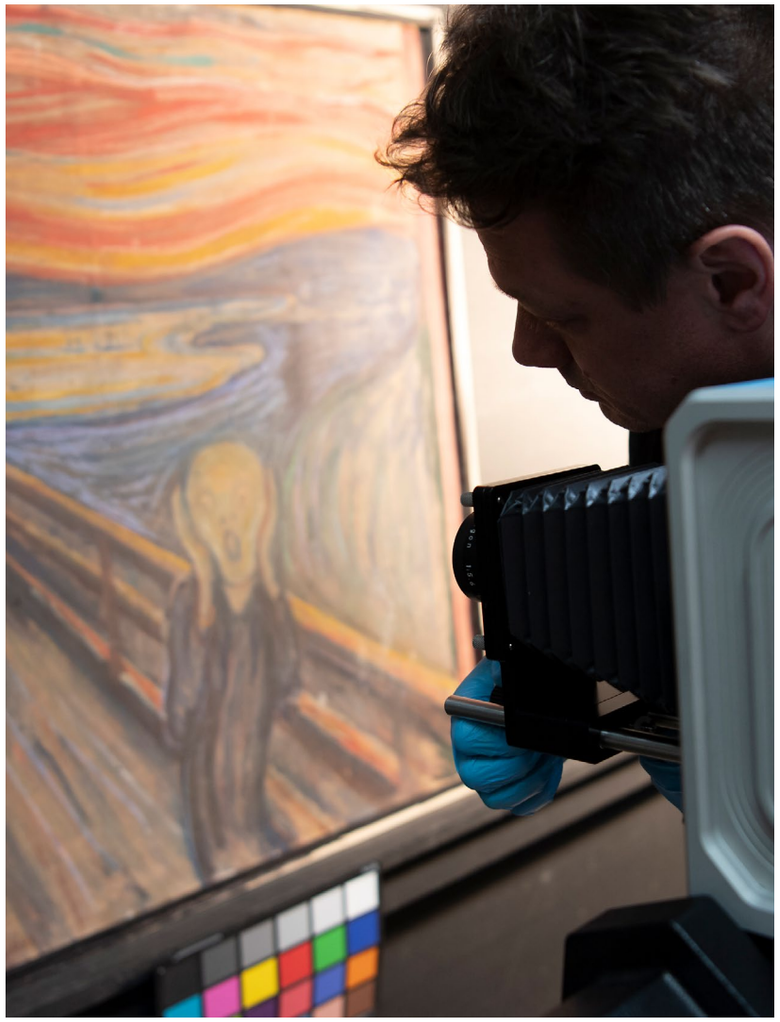
DELMAINE DONSON *GETTY IMAGES*

On the Cover

How to feel less stressed and more empowered and to create a life of meaning … without your phone

WHAT'S INSIDE

May–June 2021
Volume 32 • Number 3



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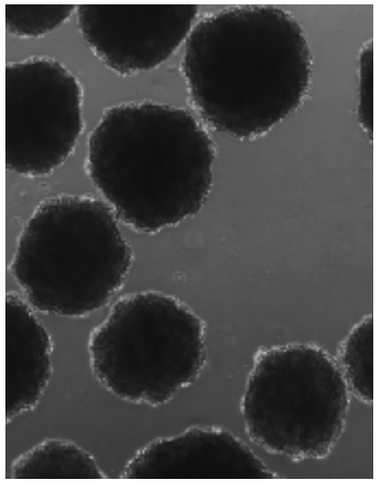

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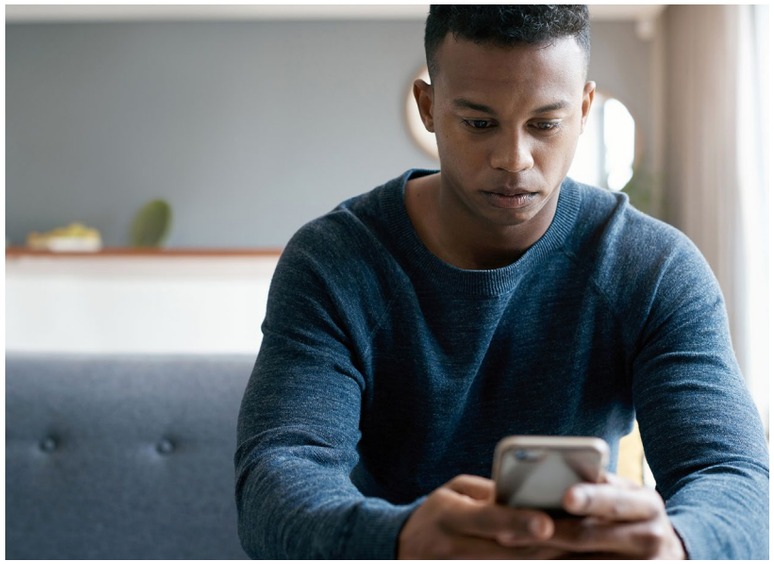


DEAN MITCHELL *GETTY IMAGES*

People Literally Don't Know When to Shut Up—or Keep Talking—Science Confirms

We are really bad at navigating a key transition point during one of the most basic social interactions

One evening Adam Mastroianni was reluctantly putting on his bow tie for yet another black-tie party at the University of Oxford that he had no interest in attending. Inevitably, Mastroianni, then a master's student in psychology at the university, knew that he would wind up stuck in some endless conversation that he did not want with no way to politely extricate himself. Even worse, he suddenly realized, he might unknowingly be

LUIS ALVAREZ *GETTY IMAGES*

the one to perpetuate unwanted conversation traps for others. "What if both people are thinking exactly the same thing, but we're both stuck because we can't move on when we're really done?" he wondered.

Mastroianni's hunch may have been on the mark. A study published on March 1 in the *Proceedings of the National Academy of Sciences USA* reports on what researchers discovered when they climbed into the heads of talkers to gauge their feelings about how long a particular conversation should last. The team found that conversations almost never end when both parties want them to—and that people are a very poor judge of when their partner wishes to call it quits. In some cases, however, interlocutors were dissatisfied not because the talk went on for too long but because it was too short.

"Whatever you think the other person wants, you may well be wrong," says Mastroianni, who is now a doctoral candidate in psychology at Harvard University. "So you might as well leave at the first time it seems appropriate because it's better to be left wanting more than less."

Most past research about conversations has been conducted by linguists or sociologists. Psychologists who have studied conversations, on the other hand, have mostly used the research as a means of addressing other things, such as how people use words to persuade. A few studies have explored what phrases individuals say at the ends of conversations, but the focus has not been on when people choose to say them. "Psychology is just now waking up to the fact that this is a really interesting and fundamental social behavior," Mastroianni says.

He and his colleagues undertook two experiments to examine the dynamics of talk. In the first, they quizzed 806 online participants about the duration of their most recent conversation. Most of them had taken place with a significant other, family member or friend. The individuals involved detailed whether there was a point in the conversation at which they wanted it to end and estimated when that was in relation to when the conversation actually ended.

In the second experiment, held in the lab, the researchers split 252 participants into pairs of strangers and instructed them to talk about whatever they liked for anywhere from one to 45 minutes. Afterward the team asked the subjects when they would have liked the conversation to have ended and to guess about their partner's answer to the same question.

Mastroianni and his colleagues found that only 2 percent of conversations ended at the time both parties desired, and only 30 percent of them finished when one of the pair wanted them to. In about half of the conversations, both people wanted to talk less, but their cutoff point was usually different. Participants in both studies reported, on average, that the desired length of their conversation was about half of its actual length. To the researchers' surprise, they also found that it is not always the case that people are held hostage by talks: In 10 percent of conversations, both study participants wished their exchange had lasted longer. And in about 31 percent of the interactions between strangers, at least one of the two wanted to continue.

Most people also failed at intuiting their partner's desires. When participants guessed at when their partner had wanted to stop talking, they were off by about 64 percent of the total conversation length.

That people fail so completely in judging when a conversation partner wishes to wrap things up "is an astounding and important finding," says Thalia Wheatley, a social psychologist at Dartmouth College, who was not involved in the research. Conversations are otherwise "such an elegant expression of mutual coordination," she says. "And yet it all falls apart at the end because we just can't figure out when to stop." This puzzle is probably one reason why people like to have talks over coffee, drinks or a meal, Wheatley adds, because "the empty cup or check gives us an out—a critical conversation-ending crutch."

Nicholas Epley, a behavioral scientist at the University of Chicago, who was not on the research team, wonders what would happen if most conversations ended exactly when we wanted them to. "How many new insights, novel perspectives or interesting facts of life have we missed because we avoided a longer or deeper conversation that we might have had with another person?" he asks.

While this cannot be determined in the countless exchanges of everyday

life, scientists can design an experiment in which talks either end at precisely the point when a participant first wants to stop or continue for some point beyond. "Do those whose conversations end just when they want them to actually end up with better conversations than those that last longer?" Epley asks. "I don't know, but I'd love to see the results of that experiment."

The findings also open up many other questions. Are the rules of conversation clearer in other cultures? Which cues, if any, do expert conversationalists pick up on? What about the dynamics of group chats?

"The burgeoning science of conversation needs rigorous descriptive papers like this one, but we also need causal experiments to test strategies that might help us navigate the important and pervasive challenges of conversation," says Alison Wood Brooks, a professor of business administration at Harvard Business School, who was not involved in the study. "I think it's pretty wild that we can put rovers on Mars, and yet we're just beginning to rigorously understand how people talk to each other."

—Rachel Nuwer

The Famed Painting *The Scream* Holds a Hidden Message

Open speculation about his mental health plagued artist Edvard Munch. In his most famous work, he left a biting commentary

"Kan kun være malet af en gal Mand!" ("Can only have been painted by a madman!") appears on Norwegian artist Edvard Munch's most famous painting *The Scream.* Infrared images at Norway's National Museum in Oslo recently confirmed that Munch himself wrote this note.

The inscription has always been visible to the naked eye, but the infrared images helped to more clearly distinguish the writing from its background. Comparing it with the artist's handwriting then clearly proved Munch's authorship.

"The finding closes the question about who the author of the inscription was," says Mai Britt Guleng, a curator at the National Museum. "The [infrared] photo gave a clear image of the sentence, and this made it possible to systematically compare the handwriting, which is identical to Munch's. The size of the letters are also too small for anyone to have written them as an act of vandalism."

The inscription was first noticed in 1904, 11 years after its creation. At that time, the artwork was exhibited in Copenhagen. Critics assumed that an outraged viewer had defaced the painting. The Expressionist work provoked discussion from the outset, with Munch's state of mind being openly broached even in his presence. Art critic and museum director Henrik Grosch wrote at the beginning of the 20th century that this painting indicated that Munch "could no longer be considered "a serious man with a normal brain"—an opinion that was shared by others besides Grosch.

Diary entries and letters by Munch demonstrate that the artist suffered from this perception. They show "a man who is both ready to provoke but who is also vulnerable," Guleng says. Munch was concerned about hereditary illnesses. His grandfather and father suffered from melancholia, as depression was then called.

Inscription visible on Edvard Munch's *The Scream* was determined to have been written by the artist himself.

BØRRE HØSTLAND NATIONAL MUSEUM

Munch's sister Laura was also treated in a psychiatric ward at times. "There was hereditary diseases in Munch's family—mental, nervous illness and tuberculosis," Guleng says. "Munch and his siblings were worried about this."

The Scream was first exhibited in October 1895 at a private art gallery in Christiania, now Oslo. (There are four versions of the the painting, only one of which contains the note.) It was possibly written after a student club event, where participants debated *The Scream* and Munch's mental state. Guleng says what Munch wrote was ironic. "The inscription says that the painting could only have been painted [by] a madman," Guleng says. "Coming from the artist himself, who clearly did not believe himself to be mad, [it] is ironic. The inscription can also be seen as a way to take control of his own life and his own feelings. It is an unorthodox thing to do—to write on your own painting. However, in this way, he shows that he is in charge of the situation."

—Jan Dönges

This article originally appeared in Spektrum der Wissenschaft *and was reproduced with permission.*

Infrared image of the inscription (*right*).

Infrared technology discovered that the writing on the painting belonged to Munch (*bottom*).

BØRRE HØSTLAND NATIONAL MUSEUM (*TOP*), ANNAR BJORGLI NATIONAL MUSEUM

Entitled People Are More Likely to Be Angry at Bad Luck

Even when nobody is to blame, some feel they were victimized

Defeat is never fun, but losing a game of poker is less painful when it's due to the luck of the draw rather than an opponent who's cheating. Unfairness fires people up, whereas bad luck just disappoints.

But interestingly, this isn't true for everyone. In a series of studies, we found that people who have higher levels of psychological entitlement—who believe they deserve good things—actually felt victimized and angered when they experienced, remembered or imagined bad luck befalling them.

For most of us, anger arises when someone else causes us to suffer. It's an uncomfortable state, often associated with lost sleep as well as impaired social and cognitive functioning. And when anger is accompanied by aggression, there can be interpersonal, medical and even legal consequences, not to mention shame and regret. When expressed in the right way, however, anger can help someone get what they want. Anger signals to other people that they are treating you unfairly and can prompt others to reconsider their actions. For example, when your colleague has been slacking off on a shared project, your ire might lead them to pitch in more.

While anger can help when directed at the offender, it's hard to see any upside to seething in response to bad luck. But what people expect, and think they are owed by the world, varies widely. We hypothesized that for more psychologically entitled individuals, mere bad luck—not getting what they want—may feel like an injustice and cause righteous anger, as if the cosmos were set against them.

To test this idea, we examined whether highly entitled people were more likely to get angry when they experienced minor bad luck. As part of our study, about 200 participants were asked to agree or disagree with statements such as "Things should go my way," as a commonly used measure of their psychological entitlement. We also asked them to report their expectations regarding

GETTY IMAGES

their personal luck. The participants then were told they had been "randomly" assigned to complete a dull task (counting letters in a paragraph) rather than a fun one (rating a comic strip). Before starting the boring task, participants indicated the degree to which it felt unfair they had to complete this task, rather than rating the comic strip, and the amount of anger they felt in response. As predicted, we found that more entitled people expected better luck, and felt cheated, and in some cases angry, they had been given the dull task.

We then conducted a larger experiment—with about twice as many people—in which participants were randomly assigned to reflect on a time they had bad luck, with no one to blame, or a time when they were treated unfairly by someone else. (This time the random assignment was genuine!) Participants again completed a measure of psychological entitlement prior to the experimental task.

After recording their memories, participants reported their emotions using a standardized scale. In this

second study, consistent with our predictions, there was a significantly stronger relation between entitlement and anger in the bad luck condition compared with the unfair treatment condition. Although all the participants felt angry after remembering unfair treatment (not getting credit for their work, being punished for something someone else did, experiencing prejudice), the more highly entitled participants were more likely to report anger after remembering an experience of (impersonal) bad luck (accidents, illnesses, equipment failures).

In a third study, we investigated whether more entitled people also felt angry in response to other people's bouts of misfortune or, as we hypothesized, only when they were personally victimized by bad luck. One hundred participants imagined that they or someone else had a flight canceled because of weather, preventing them from flying until the next day. As expected, the greater the entitlement, the greater the self-reported anger, but only when the participant himself was impacted. When it was another person's hardship, highly entitled people were no angrier than those who were less entitled.

Across our studies, we found that people with an inflated sense of entitlement were more likely to get angry about bad luck, as if it were a personal injustice and the cards were purposely stacked against them. We've all encountered people like this, who exhibit very high levels of psychological entitlement. And when they're your co-workers, family members and even elected leaders, entanglement is unavoidable. In these situations, it's best to remember that that the entitled person's anger doesn't necessarily mean that you or anyone else has wronged them. Although we can sympathize, their sense of victimization and outrage may simply be the result of getting dealt a bad hand rather than the great one they feel they deserve.

—Alex Jordan and Emily Zitek

Alex Jordan is an instructor at Harvard Medical School, a clinical psychologist at McLean Hospital and in private practice, and an adjunct professor at the Tuck School of Business at Dartmouth. He is currently writing a book on test anxiety.

Emily Zitek is an associate professor in the School of Industrial and Labor Relations at Cornell University. She studies personality, hierarchy, diversity, and perceptions of fairness.

Neandertalized "Mini Brains" Yield Clues to Modern Human Uniqueness

Experiments on clusters of cultured cells hint that a gene variant found only in *Homo sapiens* profoundly changed brain development in our species, compared with our extinct relatives

We take it for granted that *Homo sapiens* is the only human species in existence, but it didn't use to be this way. From the origin of our species a few hundred thousand years ago until a few tens of thousands of years ago, multiple human species shared the planet with our own. What distinguished *H. sapiens* from other members of the human family, and why did our lineage alone survive to the present day? Scientists have long sought answers to these questions in the fossil and archaeological records. More recently, they have started mining the genomes of living and extinct humans—including the Neandertals—for clues.

The Neandertals and the lesser-known Denisovans are our closest evolutionary relatives, so we share a lot of DNA in common with them. But we also have alleles, or genetic variants, that are unique to *H. sapiens*. Research published online in February in *Science* has identified these *sapiens*-specific variants and homed in on one in particular that may have brought about a pivotal change in the way our brain develops.

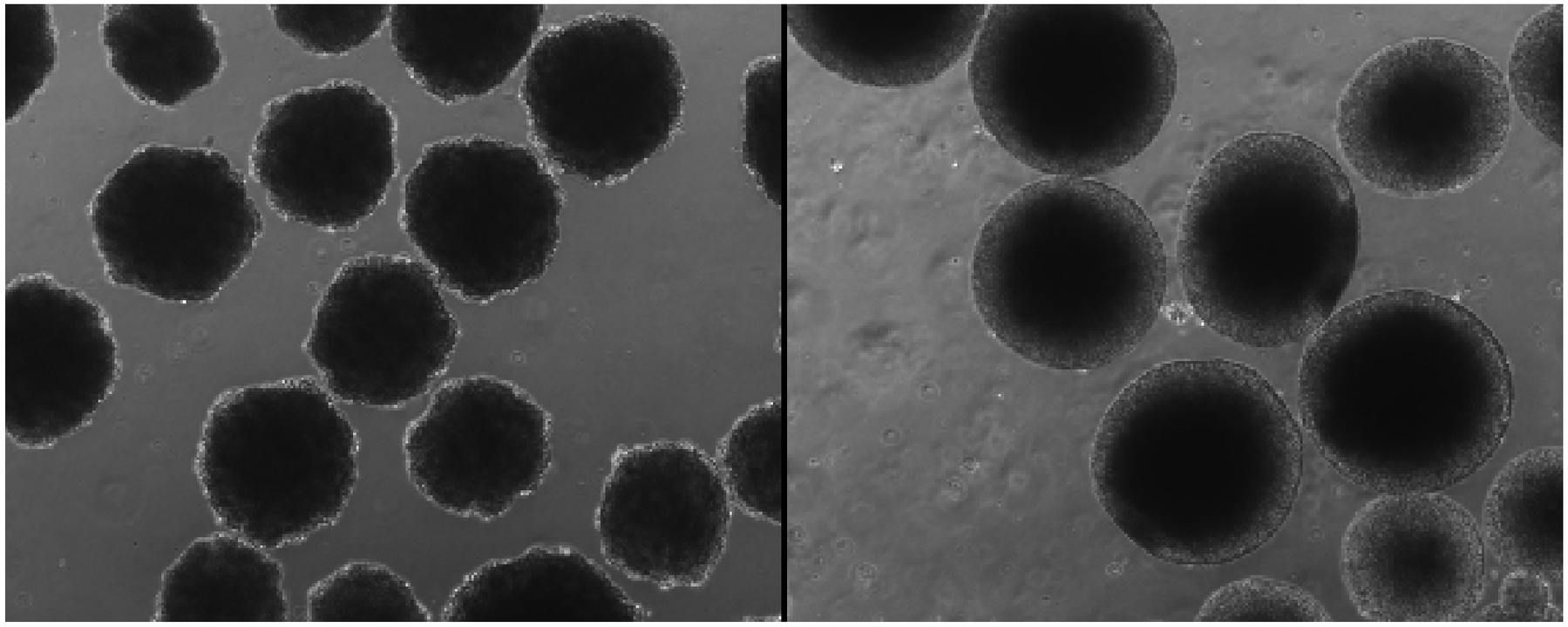
Cleber Trujillo and Alysson Muotri of the University of California, San Diego, and their colleagues compared the genomes of modern humans, Neandertals and Denisovans and found just 61 genetic alterations that distinguish modern humans from our extinct cousins—a strikingly small number. "I was expecting to find hundreds or thousands," Muotri says.

Muotri reasoned this handful of altered genes must do important things. But what? As a molecular biologist who studies brain development, he was very interested in pinpointing *sapiens*-specific changes that could significantly affect the brain. He zeroed in on a gene called *NOVA1* that is known to control the actions of hundreds of other genes and that figures importantly in the early stages

of development. *NOVA1* looked like a good candidate to evaluate in Muotri's experimental system of choice: brain organoids, clusters of cultured brain cells that form miniature versions of specific brain regions, in this case the cortex.

Our version of *NOVA1* differs from the version that Neandertals and Denisovans had by a single base pair. To figure out how that alteration affected the functioning of the gene, Muotri and his collaborators needed to know what the archaic version of the gene did. Using CRISPR technology, they replaced the modern human *NOVA1* gene in stem cells with archaic *NOVA1* and watched as those modified stem cells formed cortical organoids.

The results were striking. Whereas cortical organoids with modern human *NOVA1* are spherical, those with archaic *NOVA1* developed a popcorn shape. Not only did the archaic organoids look different, their neurons behaved differently. Neurons in organoids with archaic *NOVA1* started firing earlier than their fully modern counterparts, indicating that they matured faster than the neurons in organoids with modern *NOVA1*. And the neural networks in the organoids carrying archaic *NOVA1* didn't develop or function in the same way as those in the wholly modern organoids.



Cortical organoids carrying archaic *NOVA1* (*left*) and modern *NOVA1* (*right*) differ in shape and in neuron development.

Muotri notes that chimpanzee neurons also mature far more quickly than modern human neurons, which makes sense considering that chimps are much more independent than humans at birth. "A chimp baby will outsmart a human baby," he says. Our brains take longer to develop, but the payoff is greater cognitive sophistication in adulthood. Perhaps, Muotri speculates, the modern human variant of *NOVA1* slowed neuron maturation, giving *H. sapiens* time to develop more sophisticated brains compared with archaic humans.

J. Gray Camp, a molecular biologist at the University of Basel, who was not involved in the new work, praised the team's study. It "shows that one can resurrect an archaic human allele that has otherwise been lost to history and study it in a dish," he says. "That is pretty extraordinary."

Still, Muotri and his colleagues acknowledge that their approach has limitations. They added a single archaic gene to otherwise modern cells. It is hard to know whether the effects they observed reflect the true function of the archaic gene or whether the mash-up of archaic and modern elements in the organoids produced entirely new traits not found in modern or archaic humans.

Studying the other 60 genes for which modern humans have unique variants might help resolve these uncertainties, Muotri says, especially if researchers could create entire Neandertal cells. Such large-scale genome manipulation is not possible

yet, he says, but it might be in two or three years.

In the meantime, further insights into what makes us human may come from other experiments with organoids, which can be made to mimic not only brains but also intestines, skin and other tissues. People today carry some Neandertal DNA as a result of long-ago interbreeding between Neandertals and *H. sapiens*. Camp and his collaborators have shown that these surviving archaic alleles can be studied in organoids. They are particularly interested in how these archaic gene variants function in the intestine. "Intestinal cells have been exposed to diverse microbes, viruses, nutrients, toxins and other dynamic environmental variables over our evolutionary history," he says. "We are curious how these pressures have impacted the human intestine."

Twenty years after the publication of the first drafts of the modern human genome and 11 years after the first draft of the Neandertal genome, it is astounding to think that researchers may finally be closing in on the changes to the code of life that made us us.

—Kate Wong

The Benefits of Being Yourself Online

Research shows being authentic leads to a happier life

KLAUS VEDFELT *GETTY IMAGES*

With a steady stream of avocado toast, latte art and vintage Huji filters, Instagram advertises the kind of life to which almost anyone would aspire. If you take social media's word for it, the world is full of happy, healthy, thriving people taking luxury vacations, getting drinks with lifelong friends and promoting their passion projects online. Even amid a global pandemic and record levels of social isolation, many still fall prey to the glossy perfection of the feed.

But celebrities such as Chrissy Teigen and Dax Shepard have gone in a different direction, inspiring millions of users by sharing both the mundane and raw experiences of real life. Are people happier and more satisfied when they present themselves in a way that feels real or when they share a self-idealized version of their life? In our research, published in *Nature Communications,* we set out to tackle this question and determine how individuals' online image actually affects them.

Our starting point was a data set of more than 10,000 Facebook users who had completed a personality questionnaire and volunteered to have their Facebook profile information used for scientific purposes. This unique data set allowed us to compare the way that people see themselves (that is, their responses to the personality questions) with how they portray themselves to their social network and the world through their posts and the pages they follow (that is, computer-based predictions of their personality from Facebook posts and pages).

For example, "Jane" might think of herself as an introvert and describe

herself as such in a questionnaire. If she posted on social media in the way introverts typically do (for example, talking about reading, books or computers), her social media authenticity score would be high. In other words, her self-view would match the way she expressed herself to others. In contrast, if Jane were to describe herself as an introvert but post in a way that is typical of extraverts (for example, talking about parties or weekends out), her social media authenticity score would be low.

Mapping this authenticity score to participants' level of life satisfaction (that is, the extent to which they evaluated the overall conditions of their life as positive and desirable) showed that those who expressed themselves in a more authentic—rather than self-idealized—way reported more satisfaction with their life. A clear win for Teigen and Shepard!

Yet one of the questions that came up was: "Is this really true for everybody? Sure, if I am an emotionally stable extravert, posting authentically might be great. It's who I am but also who everybody else wants me to be. What if I am neurotic and an introvert instead? Would I benefit equally from being my authentic self?" So we went back to our data to test that. As it turns out, this worry was largely unfounded. The extent to which authentic self-expression on social media was related to participants' life satisfaction did not depend on how socially desirable their personality profiles were. In other words, both extraverts and introverts benefited equally from being true to themselves.

But does authentic expression actually lead to higher levels of life satisfaction? Or is it the case that people who are more satisfied with their lives find it easier to post authentically? To show that posting in an authentic way was indeed driving well-being, we followed up on our initial study with an experiment to demonstrate causality.

For this experiment, we recruited social media users and randomly assigned them to either post in a way that was authentic (based on their personality) or post in a way that was popular and made them look good in the eyes of others. After a week spent following these instructions, we switched the groups: the people who had initially posted in an authentic way were then asked to post in an idealized way, and vice versa. Supporting our initial finding, we discovered that after posting in an authentic way for a week, participants reported higher levels of positive affect and mood than they did after the week in which they posted to please others.

Our findings can't speak to the question of whether using social media is better than not using it at all. Abstaining from social media altogether might yield the highest levels of life satisfaction. But our results do suggest that if you use social media regularly, you should try not to fall prey to the perfection—instead just be yourself!

—Erica R. Bailey and Sandra Matz

Stop Doomscrolling News and Social Media

"Doomscroll Reminder Lady" Karen K. Ho explains how to step away from the screen

By Sophie Bushwick

Even when the news is depressing, we keep scrolling through it.

DEAN MITCHELL GETTY IMAGES

Sophie Bushwick is an associate editor at *Scientific American,* covering technology.

Reading through their social media feeds, Americans are likely to encounter anguished accounts of political turmoil, the coronavirus pandemic and continued fallout from cyberattacks, among other less-than-cheerful topics. And yet many can't stop scrolling even more, perhaps hoping to distract themselves from thinking too hard about any one of these ongoing problems. The practice has earned a suitably apocalyptic nickname: doomscrolling.

Last spring, Karen K. Ho, a global finance and economics reporter at the news outlet Quartz, began tweeting regular reminders to step away from the screen and do something that will actually make a doomscroller feel better—such as getting a drink of water, stretching or simply going to bed on time. "Those first couple months, I was basically talking out loud to myself," she says. But her alerts drew attention from mainstream news outlets as well as fellow social media users, and over the past year Ho's Twitter following has doubled to more than 44,000. "It was helping people feel less alone about a practice that they knew to be harmful, and me trying to offer a solution in a way that isn't antagonistic or judgmental," she explains. "I think the thing that was really surprising to people was how consistent I was, because right now, nothing's really consistent. It's all really chaotic. And they felt like somebody was looking out for them."

Scientific American asked Ho what her project has taught her about why people doomscroll—and how they can stop. "What doomscrolling does is rob future-you of the energy you need to really focus on important things," she says, "and also to take better care of yourself."

[*An edited and condensed transcript of the interview follows.*]

Doomscrolling makes us feel bad—so why do we do it?

It's a combination of a couple of things. There is the very nature of the design of these applications. It's the slot machine effect: The old way was, you would find something really funny, educational or informative, and the surprise was not knowing when that moment of dopamine or delight would hit you. Then there's the compulsion for many people to be better informed about the chaotic situation that many of us are currently in as a result of the pandemic, the uncertainty regarding the economic recession, as well as the social justice situation affecting many minorities, women and vulnerable groups in the United States and around the world. Then I think, finally, it's a very limited act of agency that people still have. You and I can't go to our favorite restaurants, entertainment venues, gyms; we can't interact with friends and loved ones due to physical distancing measures. People can't do a lot of other normal behaviors, so they're able to exercise their agency in this limited way, even if it's detrimental to their ability to get a good night's sleep or reduce their stress.

What can we do ourselves to prevent ourselves from endlessly scrolling?

I am a firm believer in using technology. New phones have ways for you to better focus: You can set manual time limits and hours in which you can't open the apps themselves. I've also used apps like the Chrome extension "Stay Focused" a couple of times, where you can set various time limits for checking [social media] on your computer. I also just manually log out on my work computer and my cell phone; I try to increase the friction required to log in and read the Web site. Then there's the emergency function: you literally just change the account password and give it to someone else so you can't log in.

I use a lot of operations management and scientific methods to get myself to not look at my phone. If you're going to pick up your phone more [at night], you have to put a book where your phone would normally be

when you're not at work, to read that before you go to bed. One of the best tips is, I watch a lot of TV and movies with subtitles—like in foreign languages. Because you can't look at your phone, you have to read what's on the screen to understand what's going on. When it's warmer, do things outside where you can't look at your phone. (When spring comes I'm going to bike so much!) Also, I find other tactile hobbies, like puzzles or Lego, to be really helpful. A lot of people have turned to writing cards and letters as an alternative activity during the pandemic. Some people like cooking, some people bake—it's really about personal psychology. Like, if you're fidgeting, it's just you feeling anxious about something. That's why you're checking Twitter, so that you're not thinking about the anxiety. Can you call a friend or a family member that you haven't spoken to in a while instead of looking at your phone?

It's also about reminding myself constantly of things that sound really hokey and mindful. What I really remind myself of, repeatedly, is that when I die, Twitter means nothing. No one will be like, "I went viral a lot." They'll be like, "Did I have enough energy to do my job pretty well? Do the people that we love know that we love them?" I think those are the things to really invest energy in.

Is there any way to snap yourself out of a scrolling session once you start?

Prevention is always better than [trying to stop] while you're in the middle of it. But if you're in the middle of it—that's why I send the reminders. I'm trying to meet people where they already are. There are several other Twitter accounts, like @tinycarebot, that are designed to catch you in the middle of doing it. And then there's also alarms. I set alarms on my phone to be loud and obnoxious and say, "Hey, it's late. You should probably be going to bed." It's just setting yourself up, even before you start—ask "What are the processes to improve your rates of success?" Even if you go down the wrong path, how can you course-correct?

What are some other things to know about doomscrolling?

The thing to remember is that there are limits to individual responsibility, and reminders to take care. Fundamentally, it is an irrational response to a reasonable emotion—like about how frustrating it is to see the vaccine rollout be screwed up, or the lack of mask mandates. There are lots of medical people who follow me because of the reminders, a lot of science reporters and health reporters, and they're doomscrolling because of repeated systemic failures by people in power. Doomscrolling existed for the Black community long before everybody else discovered it in 2020: When Black Americans are killed or hurt by police officers, there's a hashtag for their name.

A lot of doomscrolling is that feeling of lack of direction, and helplessness. Doing something, having a series of steps for people to do, I find reduces their stress. So that's why you see me recommend drinking water or stretching, because unconsciously people let these things slide. When in doubt, I also find donating money makes you feel less helpless. It's not fair that people should [only] think about all of these huge, big-picture problems; this small thing you can do is go to sleep right now, instead of staying up late. **M**

Evolution Could Explain Why Psychotherapy May Work for Depression

Persistent rumination may be an attribute that lets us think our way out of despair—a process enhanced through talk therapy

By Gary Stix

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A consensus has emerged in recent years that psychotherapies—in particular, cognitive-behavioral therapy (CBT)—rate comparably to medications such as Prozac and Lexapro as treatments for depression. Either option, or the two together, may at times alleviate the mood disorder. In looking more closely at both treatments, CBT—which delves into dysfunctional thinking patterns—may have a benefit that could make it the better choice for a patient.

The reason may be rooted in our deep evolutionary past. Scholars suggest humans may become depressed to help us focus attention on a problem that might cause someone to fall out of step with family, friends, clan or the larger society—an outcast status that, especially in Paleolithic times, would have meant an all-but-certain tragic fate. Depression, by this account, came about as a mood state to make us think long and hard about behaviors that may have caused us to become despondent because some issue in our lives is socially problematic.

A recent article in *American Psychologist*, the flagship publication of the American Psychological Association, weighs what the possible evolutionary origins of depression might mean for arguments about the merits of psychotherapy versus antidepressants. In the article, Steven D. Hollon, a professor of psychology at Vanderbilt University, explores the implications of helping a patient come to grips with the underlying causes of a depression—which is the goal of CBT and is also in line with an evolutionary explanation. The anodyne effects of an antidepressant, in contrast, may divert a patient from engaging in the reflective process for which depression evolved—a reason perhaps that psychotherapy appears to produce a more enduring effect than antidepressants. *Scientific American* spoke with Hollon about his ideas on the topic.

[*An edited transcript of the interview follows.*]

Gary Stix is a senior editor at *Scientific American.* He writes the blog Talking Back at ScientificAmerican.com.

You described in your recent article the idea that humans evolved a propensity toward depression as a means to restore emotional and psychological equilibrium. That allows people to stay well integrated within their social milieus. So can you explain how depression may be a product of evolution that can actually protect us?

In the late 2000s I read a paper by the evolutionary biologist Paul Andrews. It was masterful, very thoughtful—and I totally disagreed with it. The main premise was that depression was an evolved adaptation that serves to make people ruminate.

Why did you disagree?

For clinicians, we think of rumination as a terrible thing that at best is a symptom of depression and at worst leads to something that deepens the depression. We've always thought of it as a kind of exhaust out the tailpipe that is not really helpful.

But the work of Andrews and his colleague J. Andrew (Andy) Thomson recounted that in our evolutionary past, what got you depressed was some kind of major problem—probably a social problem—that might get you excluded from the tribe. And what you had to do is sit down and think about things.

Most of us can think of anxiety as being a useful function because anxiety takes us away from danger. It's quick, it's rapid—the reaction that occurs after stepping on a snake that might be poisonous when you're out in the woods. But most folks don't think of depression as

having any function. It's just something unpleasant. The trick is to figure out what the purpose of depression is—and when Andrews and Thomson looked at what goes on when you get depressed, they found that a lot of energy went to the brain.

And the reason for that is to help us to think more carefully about the things that are going wrong and first to understand what's the cause. That answers the question: How come I'm feeling so bad? And the second thing is: How can I do a good job of figuring out a solution to a problem?

So you don't have to move rapidly in depression; the bad thing has already happened. You don't have to get out of the way of a poisonous snake or a leopard. But you do have to solve some kind of complex social problem, and rumination is what gets you there. So as opposed to being an unpleasant by-product of being depressed, rumination is actually the reason why depression evolved. And it helps you solve complex social problems.

You seem to now be giving some credence to the ideas of Andrews and Thomson. How does this line of thinking actually play out in people's lives? At what point does depression and the social problems that need to be ruminated on begin?

These complex social problems often gear up in adolescence when young people start to ask: Am I going to have a boyfriend and girlfriend? How do I get a boy or girl to like me? Am I going to do okay in school? Are my parents happy with me? Am I going to get to go to college? Will I be able to find a job?

How does your expertise in psychotherapy—and specifically cognitive-behavioral therapy—jibe with the evolutionary theory of depression?

Cognitive therapy in this context becomes a bit of a natural. It teaches people how to ruminate more effectively. Cognitive theory holds that people got depressed because they hold inaccurate beliefs about themselves. This can be combined with the additional notion that people can get stuck. For example, if something bad happens, you start thinking that you're a failure, you're a loser. For most people, depression motivates them to think more deliberately about the causes of their problems and the solutions they can apply. In most instances in our ancestral past, this worked well enough; most depressions remit spontaneously even in the absence of treatment. Cognitive therapy, at the least, hurries the process along and, at the most, helps unstick that subset of individuals who get stuck making negative ascriptions about themselves, typically about personal competence or lovability.

The solution is to essentially teach them the scientific method so they get unstuck. We ask a patient to ask themselves: What do you think is the cause of the problem? What other explanations could there be? What's the evidence supporting one or the other? And we especially encourage patients who get stuck to pit what are called their stable trait theories—"I am incompetent" or "I am unlovable"—against a more behavioral explanation: "I chose the wrong strategies."

One area that you've worked on is whether CBT has a more enduring effect than drugs, and you're interested in how that might provide evidence for the evolutionary basis for depression.

Basically we have good clinical evidence that cognitive therapy is at least as effective as medications in the short run and more enduring in the long run. CBT may get people thinking carefully about their problems in a way that facilitates coming to a resolution, whereas medications may just anesthetize the stress that underlies a depression.

Are you going to test that idea in some way?

I've got colleagues in Vietnam, where they're quite interested in a study we want to do in which we compare folks treated to recovery with CBT versus folks treated to recovery with medication—and compare those against a control that uses Chinese herbal medicine, which is widely believed there to be effective. And if it's really the case that antidepressant medications suppress symptoms in a way that worsens the underlying course of depression, then those patients should be more likely to have recurrences when we take them off the medications than when we take them off the Chinese herbal medicine. If it's really true that CBT truly has an enduring effect that protects against depression, then patients treated to recovery should be less likely to recur following treatment termination than patients who recover on Chinese herbal medicine. In essence, the Chinese herbal medicine serves as an ideal nonspecific control because it provides neither the coping skills taught in cognitive therapy nor the pharmacologically active serotonin-related ingredient provided by antidepressant medications. We have a trial that we want to do that should answer the question, but it hasn't yet been done.

Doesn't some evidence exist along these lines already, though?

There are more than half a dozen studies that indicate that patients treated to remission with cognitive therapy are less likely to relapse following treatment termination than patients treated to remission with antidepressant medications—and a pair of studies that suggest that this enduring effect may extend to the prevention of recurrence. What we do not know is where all this fits within the proposed evolutionary context: whether cognitive therapy has an enduring effect or whether antidepressant medications may be detrimental in terms of prolonging the life of the underlying epi-

sode—as evolutionary theory suggests. What is needed is a nonspecific control that neither has enduring effects or the anesthetizing effects caused by the medication. Whether cognitive therapy truly has an enduring effect or whether antidepressant medications have a detrimental effect remains to be determined. The comparison of each to a nonspecific control like Chinese herbal medicine should allow us to determine in absolute terms which is which.

You've talked about the difficulties in trying to measure whether there really are enduring effects in this type of trial.

It also is possible that the enduring effects observed for cognitive therapy (relative to antidepressant medications) have to do with changes that occur during the course of a clinical trial. Although we randomize patients to cognitive therapy versus antidepressant medications at the outset of the trial, we typically lose about 15 percent of the sample because of attrition and another 25 percent as a nonresponse to either intervention. That means only about 60 percent of the sample initially randomized makes it into the comparison of subsequent rates of relapse. If different kinds of patients remit to cognitive therapy than to antidepressants, that could bias any subsequent comparisons.

Do you think that these insights about CBT could have an impact for severe depression?

I don't know, and I wouldn't necessarily assume that they would. For psychotic depression, you'd go to electroconvulsive therapy first. I'm not sure that the analytical rumination hypothesis will apply to psychotic depressions or that it needs to. For every evolved adaptation, there are instances in which the mechanism evolved breaks down and the condition can be considered to be an actual disease or disorder. **M**

How the Brain Responds to Beauty

Scientists search for the neural basis of an enigmatic experience

By Jason Castro

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Jason Castro is an associate professor and chair of the neuroscience program at Bates College.

PURSUED BY POETS AND ARTISTS ALIKE, BEAUTY IS EVER ELUSIVE. We seek it in nature, art and philosophy but also in our phones and furniture. We value it beyond reason, look to surround ourselves with it and will even lose ourselves in pursuit of it. Our world is defined by it, and yet we struggle to ever define it. As philosopher George Santayana observed in his 1896 book *The Sense of Beauty,* there is within us "a very radical and wide-spread tendency to observe beauty, and to value it."

Philosophers such as Santayana have tried for centuries to understand beauty, but perhaps scientists are now ready to try their hand as well. And while science cannot yet tell us what beauty is, perhaps it can tell us where it is—or where it isn't. In a recent study, a team of researchers at Tsinghua University in Beijing and their colleagues examined the origin of beauty and argued that it is as enigmatic in our brain as it is in the real world.

There is no shortage of theories about what makes an object aesthetically pleasing. Ideas about proportion, harmony, symmetry, order, complexity and balance have all been studied by psychologists in great depth. The theories go as far back as 1876—in the early days of experimental psychology—when German psychologist Gustav Fechner provided evidence that people prefer rectangles with sides in proportion to the golden ratio (if you're curious, that ratio is about 1.6:1).

At the time, Fechner was immersed in the project of "outer psychophysics"—the search for mathematical relations between stimuli and their resultant percepts. What both fascinated and eluded him, however, was the much more difficult pursuit of "inner psychophysics"—relating the states of the nervous system to the subjective experiences that accompany them. Despite his experiments with the golden ratio, Fechner continued to believe that beauty was, to a large degree, in the brain of the beholder.

So what part of our brain responds to beauty? The answer depends on whether we see beauty as a single category at all. Brain scientists who favor the idea of such a "beauty center" have hypothesized that it may live in the orbitofrontal cortex, the ventromedial prefrontal cortex or the insula. If this theory prevails, then beauty really could be traced back to a single region of the brain. We would experience beauty in the same way whether we were listening to Franz Schubert song, staring at a Diego Velázquez painting or seeing a doe denning under the starlight.

If the idea of a beauty center is correct, then this would be a considerable victory for the theory of functional localization. Under this view—which is both widely held and widely contested—much of what the brain does is the result of highly specialized modules. To simplify the idea a bit, we could imagine assigning Post-it notes to areas of the brain with job descriptions underneath: "pleasure center," "memory center," "visual center," "beauty center." While some version of this theory is likely true, it's certainly not the case that any kind of mental state you can describe or intuit is cleanly localized somewhere in the brain. Still, there is excellent evidence, for example, that specific parts of the visual cortex have an exquisite selectivity for motion. Other, nonoverlapping parts are quite clearly activated only by faces. But for every careful study that finds compellingly localized brain function, there are many more that have failed to match a region with a concrete job description.

Rather than potentially add to the mix of inconclusive, underpowered studies about whether the perception of beauty is localized to some specific brain area in their recent investigation, the Tsinghua University researchers opted to do a meta-analysis. They pooled data from many already published studies to see if a consistent result emerged. The team first combed the literature for all brain-imaging studies that investigated people's neural responses to visual art and faces and that also asked them to report on whether what they saw was beautiful or not. After reviewing the different studies, the researchers were left with data from 49 studies in total, representing experiments from 982 participants. The faces and visual art were taken to be different kinds of beautiful things, which allowed for a conceptually straightforward test of the beauty center hypothesis. If transcendent, capital-B

There is no shortage of theories about what makes an object aesthetically pleasing. Ideas about proportion, harmony, symmetry, order, complexity and balance have all been studied by psychologists in great depth.

beauty was really something common to faces and visual art and was processed in the capital-B-beauty region of the brain, then this area should show up across studies, regardless of the specific thing being seen as beautiful. If no such region was found, then faces and visual art would more likely be, as parents say of their children, each beautiful in its own way.

The technique used to analyze the pooled data is known as activation likelihood estimation (ALE). Underneath a bit of statistical formality, it is an intuitive idea: we have more trust in things that have more votes. ALE takes each of the 49 studies to be a fuzzy, error-prone report of a specific location in the brain—roughly speaking, the particular spot that "lit up" when the experiment was conducted, together with a surrounding cloud of uncertainty. The size of this cloud of uncertainty was large if the study had few participants and small if there were many of them, thus modeling the confidence that comes from collecting more data. These 49 points and their clouds were then all merged into a composite statistical map, giving an integrated picture of brain activation across many studies and a means for saying how confident we are in the consensus across experiments. If a single small region was glowing red-hot after the merge (all clouds were small and close together), that would mean it was reliably activated across all the different studies.

Performing this analysis, the research team found that beautiful visual art and beautiful faces each reliably elicited activity in well-defined brain regions. No surprises here: it is hoped that the brain is doing something when you're looking at a visual stimulus. The regions were almost completely nonoverlapping, however, which challenged the idea that a common beauty center was activated. If we take this at face value, then the beauty of a face is not the same as the beauty of a painting. Beauty is plural, diverse, embedded in the particulars of its medium.

It is possible the hypothesized beauty center actually does exist and just failed to show up for a variety of methodological reasons. And to be sure, this one analysis hardly settles a question as profound and difficult as this one. Yet that raises an important point: What are we trying to accomplish here? Why do we care if beauty is one thing in the brain or 10? Would the latter make beauty 10 times more marvelous or diminish it 10-fold? More pertinent: How do we understand beauty differently if we know where to point to it in the brain? It will probably be many years, perhaps even generations, before we have something like a neuroscience of aesthetics that both physiologists and humanists will find truly compelling. But we can be sure that beauty's seductions will keep calling us back to this messy, intriguing and unmapped place in the interim. **M**

Humans Are Pretty Lousy Lie Detectors

Whenever we hear someone speak, we form an opinion about their believability. But our eyes and ears can lead us astray

By Christiane Gelitz

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Christiane Gelitz is a psychologist and an editor at *Spektrum der Wissenschaft*.

On television, it all looks so simple. For a fraction of a second, the suspect raises the corner of his mouth. He is happy because he thinks the investigators are wrong about where he planted the bomb. But when his interrogator mentions the correct place, the terrorist's face betrays a flash of rage. And he shrugs his shoulders as he pronounces his innocence. The evidence is open and shut as far as the expert is concerned: The suspect's body language contradicts his words. He is lying.

The expert on microexpressions in the TV series *Lie to Me* is the alter ego of Paul Ekman, age 86, a world-renowned researcher of lying and emotion. He not only advised the creators of the program but has also been called on by numerous U.S. agencies, such as the FBI and CIA. Ekman's credo is that the truth is written on our face.

This idea has a long tradition. An ancient Indian text from about 900 B.C. describes the behavior of an attempted poisoner as follows: "He does not answer questions, or they are evasive answers; he speaks nonsense, rubs the great toe along the ground, and shivers; his face is discolored; he rubs the roots of the hair with his fingers."

In commenting on a case at the beginning of the 20th century, Sigmund Freud wrote, "He that has eyes to see and ears to hear may convince himself that no mortal can keep a secret. If his lips are silent, he chatters with his finger-tips; betrayal oozes out of him at every pore." Since the middle of that century, security experts in the U.S. have been trying to separate truth from fiction by using lie detectors. Among other things, so-called polygraphs register how sweat production, heart rate and breathing change when certain questions are asked. But in everyday life we use the same instruments as our ancestors in distinguishing truth from falsehood: our eyes and ears.

From 1971 to 2004 Ekman was a psychology professor at the University of California, San Francisco, where he is now emeritus. Starting before that time, he became the first researcher to examine, on a large scale, how observable changes in the face and body reflect truth telling or lying. In the 1960s he formulated his theory of universal facial expressions for the basic emotions: anger, disgust, enjoyment, fear, sadness and surprise. Ekman categorized the facial muscles involved in producing these expressions in what he called the Facial Action Coding System. He and his co-author Wallace V. Friesen laid the groundwork for Ekman's popular theory of lies in their 1969 paper "Nonverbal Leakage and Clues to Deception," which dealt with patients' nonverbal signals. The core idea: emotions that one seeks to conceal are sometimes betrayed by facial expressions and movements of the arms, hands, legs and feet. A prime example is a momentary facial expression that lasts no longer than a quarter to a half a second and is virtually invisible to an unpracticed observer.

Such microexpressions that reveal concealed emotions do not, however, occur all that often, according to Ekman. We are more apt to observe emotions that are broken off or incomplete. For example, if we try to fake fear or sadness, the characteristic creases on our forehead may not show. And the eye muscles may not be involved in a false smile. Ekman does not believe that such discrepancies are proof of falsehood. He merely thinks they are indications that something might be off. That is why repeated and varied clues are necessary; one is not enough. In his book *Telling Lies,* Ekman claims that, in laboratory experiments, truth and lies can be told apart by facial expression alone with an accuracy of more than 80 percent—and that the figure reached 90 percent when factors such as facial and body movements, voice and language were all included in one analysis.

But these statistics may be misleading. According to Maria Hartwig of the John Jay College of Criminal Justice, such claims are "simply implausible." The research literature, in contrast, suggests that success rates are generally barely above chance. Even when Ekman requires extensive training of testers, he has apparently

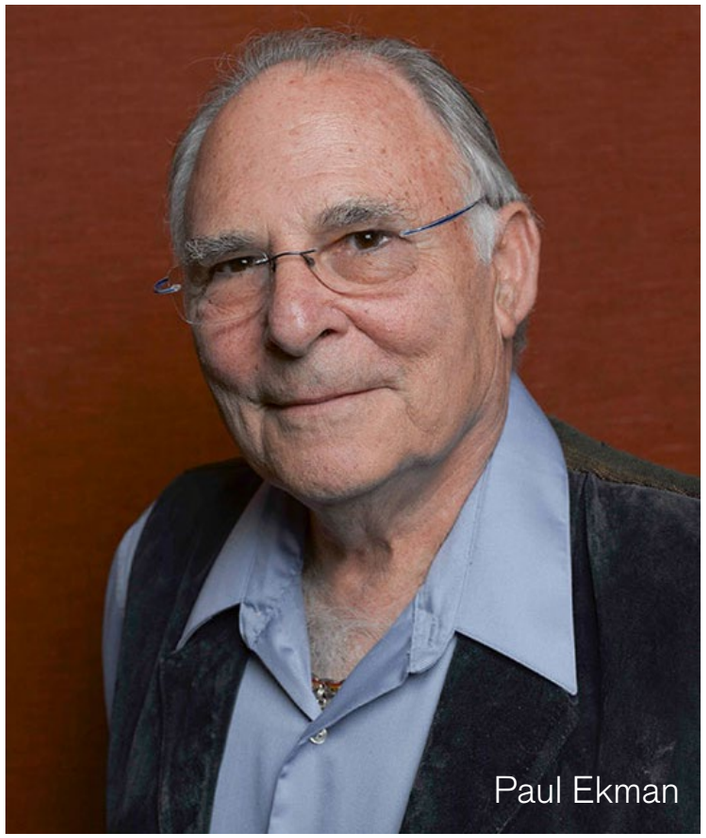
not published a single study that confirms his figures.

Legal psychologist Kristina Suchotzki of Johannes Gutenberg University Mainz in Germany says, "Many researchers don't take Ekman's idea of using microexpressions to uncover deception especially seriously." And it is not only because of a lack of empirical evidence. The theory is itself inadequate. "Just because someone is afraid during an interrogation doesn't mean they're lying," she says. "You cannot infer a deception from an emotion."

Suchotzki is the German researcher most active in the field of lying. She focuses on evidence of mental effort that may be associated with false statements. It is simply not easy to lie. One must make an effort to hide the truth, come up with a plausible alternative story, put oneself in the interrogator's shoes and keep a tight rein on feelings that could give up the game—while seeming authentic the whole time. "Up to now emotions and cognitions have been studied separately," Suchotzki says. "I want to bring both together and bring clarity to what happens in the mind when one is lying." And she does not think that using microexpressions to recognize deception is an especially promising approach. "There are simply no studies that support Ekman's claims," Suchotzki says.

One of the few independent studies on this theme was conducted by psychologists Stephen Porter and Leanne ten Brinke in 2008. Their test subjects were asked to conceal their true feelings on viewing sad, fear-inducing and joyous pictures. If they tried to mimic a different emotion, their facial expressions were more often dissonant or incongruous. Microexpressions were seen in 2 percent of all snapshots. They occurred in 22 percent of all test subjects—though not only when they tried to cover up their feelings.

There is one thing that Ekman and his critics agree on, however: humans are generally very poor lie detectors. The most cited hit rate comes from a meta-analysis and is based on about 25,000 test subjects. They guessed right



Paul Ekman

in only 54 percent of cases—just barely better than chance. For audiotapes alone, the success rate was 63 percent, which means it was significantly higher than it was for videotapes with or without sound. Apparently the image distracts the viewer from noticing relevant clues. And it does not matter that a professional—a police officer, judge or psychiatrist—has more frequent occasion to deal with lying: the so-called experts did no better than the proverbial person on the street.

But what happens when an individual knows someone as well as their own child? A Canadian experiment studied whether parents can recognize their children's lies better than other parents or undergraduates. All three study groups looked at videos in which eight- to 16-year-old kids and teenagers told the truth or lied about whether they had peeked at answers to a test. Parents looking at their own children were no better at distinguishing the truth from a lie than were other parents or undergrads. Participants in all three groups might as well have tossed a coin, although they tended to trust their own judgment—and, in particular, the parents assessing their own children tended to believe them.

One of the study's co-authors, Kang Lee, a psychologist at the University of Toronto, could not let this subject go. During a TED Talk, he presented a photograph of his son lying. Lee used a method called transdermal optical imaging, which measures blood flow in the skin, to see what was behind his son's neutral facial expression. He calls what he discovered the Pinocchio effect: during a lie facial, blood flow decreases in the cheeks but increases in the nose.

In response, however, Suchotzki notes, "The idea that blood perfusion could be an indicator of lying is absurd. Such claims are dangerous because they suggest that such practices might be useful in public spaces, such as airports." This kind of effect might be evident in a controlled laboratory experiment, she says, but no technology can resolve the fact that characteristics of lying can be observed in suspects who are telling the truth. "There is no such thing as a clear-cut sign of lying—only indications that may allow us to conclude that a lie may have been told," Suchotzki adds.

In a meta-analysis performed by a team led by psychologist Bella DePaulo, 14 of 50 nonverbal characteristics were observed to be more frequently associated with lying, most especially dilated pupils and tenseness. But the most telling was the impression made by the statements themselves. False statements tended to be hesitant, ambivalent and unsure. A German meta-analysis of 41 studies found something different, however. Psychologists at Justus Liebig University Giessen found that lying was particularly associated with evidence of self-control: fewer movements of the hands, legs, and feet and less head nodding.

"The effects are so minute and unstable that they cannot help us to identify lying in practice," Suchotzki says. Linguistic characteristics have been shown to be more

STEVEN DEWALL *GETTY IMAGES*

telling. "But these effects are not large, and the findings do not justify optimism," she adds.

Psychologist Aldert Vrij of the University of Portsmouth in England, one of the most active researchers of lying, does not think much of nonverbal characteristics of deception either. In an overview study, he, Hartwig and their colleague Pär Anders Granhag of the University of Gothenburg in Sweden wrote that such signals are "faint and unreliable." The researchers are pinning their hopes more on linguistic clues—although these are hardly more associated with lying than nonverbal ones. Yet they can be induced and strengthened by questioning techniques, as several experiments (including those conducted by Vrij's team) have demonstrated. Such extensive research on nonverbal characteristics does not exist.

It is no wonder that is the case: language is simply easier to record. Reliably capturing facial expressions and gestures requires specially trained observers or more complex wiring of the face and body. Researchers have only recently been increasingly experimenting with computer-assisted methods such as automatic facial recognition. This technology promises new understandings because it can process enormous data streams and identify complex patterns.

Vrij, Hartwig and Granhag admit that more subtle nonverbal characteristics—qualities such as subcategories of facial expressions of the sort that Ekman had defined—have either been overlooked or ignored. If we look closer, we find, for example, that true statements are more often accompanied by demonstrative gestures and that lies are more frequently paired with metaphorical ones, such as a fist as a symbol of strength. Perhaps researchers will discover even more signs, or a combination thereof, when other methods are used.

When Hartwig and psychologist Charles Bond combined various behavioral characteristics in a meta-analysis with thousands of test subjects, they were able to identify about two thirds of the lies correctly. Most studies merely test selected characteristics. In general, lab experiments do not re-create realistic conditions. There is no genuine interaction between the investigator and the subject. Even more crucially, the deception is made on demand. And no one can say with certainty the extent to which, and under what, conditions lab findings can even be generalized to real offenses.

To make the test subjects feel they have some skin in the game, they are generally promised money if they are convincing. Suchotzki has tried out more challenging measures in the service of science: In one study with her colleague Matthias Gamer of the Julius Maximilian University of Würzburg in Germany, participants were questioned about a fake theft they had committed. The researchers told half of the subjects they would receive a weak electric shock if a computer deemed their statement to be unbelievable. In that group, Suchotzki and Gamer observed a slower pulse rate during untrue responses, along with increased sweating of the hands. Fear of potential consequences increased these differences.

Of course, Suchotzki's lab subjects actually had nothing to fear if they did not sound convincing. The ramifications were much more serious for involuntary subjects of an investigation in a field study conducted by ten Brinke and Porter. The researchers analyzed videotapes of 78 individuals who turned to the public in their efforts to find a missing family member. About half of them were later found guilty of having killed the missing person.

The guilty and the innocent subjects did not differ in terms of body language, as a comparison of 75,000 still images showed. The authors reported, however, that the faces of the guilty ones exhibited more signs of concealed emotions, such as simulated happiness and sadness. Distressed individuals who were actually innocent conveyed "full-face sadness and distress," ten Brinke and Porter wrote.

In another analysis, the guilty used twice as many vague wordings, such as "Somebody's got to know something, somewhere. I think so. I think there's somebody who's got to be running scared, who knows what they're doing." Genuine appeals sounded clearer and more immediate: "You can't imagine what Sarah means to us. We are a strong family, and we don't survive well apart. We need her home now, today, quickly as we possibly can."

But as impressive as such studies may sound, they still do not resolve the problems of research on lying. The differences are small; the indicators are ambiguous. These results only represent averages, and at best, they offer coarse potential indications in individual cases. A confidently spoken lie can seem more believable than a stuttered truth. That is because most people base their judgment on how confident, clear and unambiguous a statement seems, according to a meta-analysis performed by Hartwig and Bond. When individuals overlook a deception, it is not because they pay attention to the wrong signals. They mostly fail when a person who elicits trust lies or when a seemingly unbelievable person tells the truth.

We can pay a heavy price for not knowing what is going on in another's mind. It would seem that evolution should have given us a good feel for the truth, and yet we are easily led astray. Perhaps that is the downside to coexistence in society. The harmless lies of everyday life have taught us credulity.

Still, why do so many people think that they can recognize lying? Let us turn the question around: How would it be if lies and truth looked the same, like two eggs? How would it be if the guilty got away, and the innocent paid the price in their stead? Hartwig finds the thought hard to bear. "We want to believe that liars give themselves away," she says. **M**

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Detecting Alzheimer's Gets Easier with a Simple Blood Test

New assays could reduce the need for costlier, more invasive brain scans and spinal fluid measures

By Esther Landhuis

GETTY IMAGES

Esther Landhuis is a freelance science journalist in the San Francisco Bay Area.

When a patient complains of forgetfulness, a neurologist might not know immediately whether it results from normal aging, reduced blood flow to the brain—or, more ominously, Alzheimer's disease. For much of the past century, a definitive Alzheimer's diagnosis could only be made during an autopsy. Brain imaging and spinal fluid tests now make it possible to spot the disease in patients even before the initial symptoms appear. But these invasive tests are expensive and generally limited to research settings that are not part of routine care for the millions of people suffering from the most common neurodegenerative disorder.

An era in which an Alzheimer's diagnosis can begin in a doctor's office is now arriving. Advances in technologies to detect early signs of disease from a blood sample are helping doctors to identify the memory-robbing disorder more accurately and to screen participants more quickly for trials of potential treatments for the more than five million people in the U.S. afflicted with Alzheimer's. (Estimates predict that by 2030, there will be 76 million people worldwide who will receive a diagnosis of Alzheimer's or other dementias.)

A blood test developed by C_2N Diagnostics in St. Louis, Mo., is now available to most of the U.S. as a routine lab test—regulated under the CMS Clinical Laboratory Improvement Amendments (CLIA) program. It has also received a CE mark as a diagnostic medical device in the European Union—indicating it has met safety, health and environmental protection standards for the region.

"The development of a blood-based test for Alzheimer's disease is just phenomenal," says Michelle Mielke, a neuroscientist and epidemiologist at the Mayo Clinic. "The field has been thinking about this for a very long time. It's really been in the last couple of years that the possibility has come to fruition."

The C_2N test, called PrecivityAD, uses an analytic technique known as mass spectrometry to detect specific types of beta-amyloid, a protein fragment that is a pathological hallmark of disease. Beta-amyloid proteins accumulate and form plaques visible on brain scans two decades before a patient notices memory problems. As plaques build up in the brain, levels of beta-amyloid decline in the surrounding fluid. Such changes can be measured in spinal fluid samples—and now in blood, where beta-amyloid concentrations are significantly lower. PrecivityAD is the first blood test for Alzheimer's to be cleared for widespread use and one of a new generation of such assays that could enable early detection of the leading neurodegenerative disease—perhaps decades before the onset of the first symptoms.

PrecivityAD is meant for 60- to 91-year-olds with early signs of cognitive impairment. The prescribing physician ships patient blood samples for analysis at C_2N's lab and receives results within 10 business days. The results—a probability score that reflects the likelihood of an amyloid-positive brain scan—are calculated using a proprietary algorithm that incorporates the person's age with measurements of beta-amyloid and a protein called apolipoprotein E that is known to influence Alzheimer's disease risk.

Rather than serving as a stand-alone tool, the results are meant to enhance the accuracy of a clinical diagnosis by distinguishing Alzheimer's dementia from memory loss caused by other conditions. The test costs $1,250 and is not currently covered by insurance, although a financial assistance program can bring out-of-pocket costs down to between $25 and $400 for eligible patients, says C_2N's chief executive Joel Braunstein.

By comparison, beta-amyloid tests using positron-emission tomography (PET) brain imaging typically cost around $5,000 and are typically not covered by insurance, and those that sample cerebrospinal fluid (CSF) usually cost from $800 to $1,000. Compared with these more invasive and burdensome procedures, the ease and lower cost of blood tests open up many exciting possibilities for clinical use and therapeutic development," says Adam Boxer, a neurologist at the University of California,

San Francisco. “Blood tests can be collected from people repeatedly in remote locations or in their homes.” No drugs have yet been approved that change the course of Alzheimer’s. But readily available early tests could improve treatment by letting patients take measures to stay healthy, affording them an opportunity to plan for an uncertain future and participate in clinical trials.

From a preventive standpoint, blood tests could “help identify who’s at risk,” Mielke says. Testing could also be used to screen potential participants for experimental drugs. In some past trials of beta-amyloid-reducing treatments, 15 to 30 percent of patients who met clinical criteria for Alzheimer’s turned out not to have brain amyloid. Nowadays trials often require participants to show evidence of disease pathology through PET scans or CSF measures. Prescreening with a cheap blood test could halve the number of PET scans needed to enroll volunteers, according to a study published on January 22 in the journal *Brain*.

This would lower the cost of trials, which means “more potential treatments can be tested, and that increases the chances of finding a cure,” says Elisabeth Thijssen, a researcher studying blood biomarkers for Alzheimer’s at Amsterdam University Medical Centers in the Netherlands. Blood tests would be particularly helpful in identifying patients for trials of potential drugs that could be most effective long before the first symptom of cognitive decline.

Looking for beta-amyloid is not the only option. Some researchers believe other disease markers—for example, certain forms of the protein tau—could prove more promising when incorporated in blood tests for Alzheimer’s. Beta-amyloid levels start to drop very early in the disease process and then reach a plateau, whereas tau markers go up later and continue to rise. That observation suggests amyloid tests could work better for early detection, whereas tau levels are more meaningful at later stages of the disease, when someone is on the verge of decline or already symptomatic, says Oskar Hansson, a neurologist at Lund University in Sweden. In 2020 Thijssen and Hansson published separate studies showing that tau blood tests could distinguish Alzheimer’s from other neurodegenerative diseases nearly as well as CSF measurements and PET scans. Quanterix, a company in Billerica, Mass., has developed an immunoassay that detects amyloid and tau in conjunction with other neurological markers and inflammatory proteins. So far these tests are not available outside of research settings.

“We researchers are super enthusiastic” about these tests, Thijssen says. Most studies have been conducted in extensively studied groups of patients in neurology clinics, however. “Now we have to make the step into the real world,” she says. When a new patient comes in with memory complaints, “is a blood test going to help physicians make a proper diagnosis?”

Patients in other settings may have other ailments that could affect the accuracy of assays. Some medical conditions can influence the levels of blood proteins, possibly skewing test results. “If somebody has chronic kidney disease, that can affect the clearance of proteins,” Mielke says. “Individuals with a high body mass index tend to have higher blood volume, so that could reduce protein levels.”

U.C.S.F. neurologist Gil Rabinovici agrees that “all these markers need to be validated in more diverse and generalizable cohorts.” He is helping to lead a new study that will test blood assays against amyloid PET scans in 5,000 patients recruited at 350 clinical sites—with an emphasis on patients from Black and Latinx populations, which are historically underrepresented in dementia research. **M**

Jack Turban is a fellow in child and adolescent psychiatry at the Stanford University School of Medicine, where he researches the mental health of transgender youth. His writing has appeared in the *New York Times*, the *Washington Post*, the *Los Angeles Times*, and more. Follow him on Twitter @jack_turban

POLICY & ETHICS

Trans Girls Belong on Girls' Sports Teams

There is no scientific case for excluding them

JAMES OLIVER *GETTY IMAGES*

In February 2020 the families of three cisgender girls filed a federal lawsuit against the Connecticut Association of Schools, the nonprofit Connecticut Interscholastic Athletic Conference and several boards of education in the state. The families were upset that transgender girls were competing against the cisgender girls in high school track leagues. They argued that transgender girls have an unfair advantage in high school sports and should be forced to play on boys' teams.

Conservatives around the country have jumped on the question. Attorney General Merrick Garland was pressed on the issue during his confirmation hearing in March 2021. State legislators around the country are pushing bills that would force trans girls to compete on boys' teams. In describing the Connecticut case in the *Wall Street Journal*, opinion writer Abigail Shrier expressed a representative argument: when transgender girls compete on girls' sports teams, she wrote, "[cisgender] girls can't win."

The opinion piece left out the fact that two days after the Connecticut lawsuit was filed by the cisgender girls' families, one of those girls beat one of the transgender girls named in the lawsuit in a Connecticut state championship. It turns out that when transgender girls play on girls' sports teams, cisgender girls can win. In fact, the vast majority of female athletes are cisgender, as are the vast ma-

jority of winners. There is no epidemic of transgender girls dominating female sports.
Attempts to force transgender girls to play on the boys' teams are unconscionable attacks on already marginalized transgender children, and they don't address a real problem. They're unscientific, and they would cause serious mental health damage to both cisgender and transgender youth.

Policies permitting transgender athletes to play on teams that match their gender identity are not new. The Olympics have had transgender-inclusive policies since 2004, but a single openly transgender athlete has yet to even qualify. California passed a law in 2013 that allows trans youth to compete on the team that matches their gender identity; there have been no issues. U SPORTS, Canada's equivalent to the U.S.'s National Collegiate Athletic Association, has allowed transgender athletes to compete with the team that matches their identity for the past two years.

The notion of transgender girls having an unfair advantage comes from the idea that testosterone causes physical changes such as an increase in muscle mass. But transgender girls are not the only girls with high testosterone levels. An estimated 10 that allows trans youth to compete on the team that matches their gender identity; there have been no issues. U SPORTS, Canada's equivalent to the U.S.'s National Collegiate Athletic Association, has allowed transgender athletes to compete with the team that matches their identity for the past two years. The notion of transgender girls having an unfair advantage comes from the idea that testosterone causes physical changes such as an increase in muscle mass. But transgender girls are not the only girls with high testosterone levels. An estimated 10 percent of women have polycystic ovarian syndrome, which results in elevated testosterone levels. They are not banned from female sports. Transgender girls on puberty blockers, on the other hand, have negligible testosterone levels. Yet these state bills would force them to play with the boys. Plus, the athletic advantage conferred by testosterone is equivocal. As Katrina Karkazis, a senior visiting fellow and expert on testosterone and bioethics at Yale University, explains, "Studies of testosterone levels in athletes do not show any clear, consistent relationship between testosterone and athletic performance. Sometimes testosterone is associated with better performance, but other studies show weak links or no links. And yet others show testosterone is associated with worse performance." The bills' premises lack scientific validity.

Claiming that transgender girls have an unfair advantage in sports also neglects the fact that these kids have the deck stacked against them in nearly every other way imaginable. They suffer from higher rates of bullying, anxiety and depression—all of which make it more difficult for them to train and compete. They also have higher rates of homelessness and poverty because of common experiences of family rejection. This is very likely a major driver of why we see so few transgender athletes in collegiate sports and none in the Olympics.

On top of the notion of transgender athletic advantage being dubious, enforcing these bills would be bizarre and cruel. Idaho's H.B. 500, which was signed into law but currently has a preliminary injunction against its enforcement, would essentially let people accuse students of lying about their sex. Those students would then need to "prove" their sex through means that could include an invasive genital exam or genetic testing. And what happens when a kid comes back with XY chromosomes but a vagina (as occurs with people with complete androgen insensitivity syndrome)? Do they play on the boys' team or the girls' team? This is just one of several conditions that would make such sex policing impossible.

It's worth noting that this isn't the first time people have tried to discredit the success of athletes from marginalized minorities based on half-baked claims of "science." There is a long history of similarly painting Black athletes as "genetically superior" in an attempt to downplay the effects of their hard work and training.

Some have even harkened back to eras of "separate but equal," suggesting that transgender athletes should be forced into their own leagues. In addition to all the reasons why this is unnecessary that I have already explained, it is also unjust.
As we have learned from women's sports leagues, separate is not equal. Female athletes consistently have to deal with fewer accolades, less press coverage and lower pay. A transgender sports league would undoubtedly be plagued with the same issues.

Beyond the trauma of sex-verification exams, these bills would cause further emotional damage

to transgender youth. While we have not seen an epidemic of transgender girls dominating sports leagues, we have seen high rates of anxiety, depression and suicide attempts. Research highlights that a major driver of these mental health problems is rejection of someone's gender identity. Forcing trans youth to play on sports teams that don't match their identity will worsen these disparities. It is a classic form of transgender conversion therapy, a discredited practice of trying to force transgender people to be cisgender and gender-conforming.

Although this stance can be hard for cisgender people to understand, imagine if someone told you that you were a different gender and then forced you to play on the sports team of that gender throughout all of your school years. You'd likely be miserable and confused.

As a child psychiatry fellow, I spend a lot of time with kids. They have many worries on their minds: bullying, sexual assault, divorcing parents, concerns they won't get into college. What they are not worried about is transgender girls playing on girls' sports teams.

Legislators need to work on the issues that truly impact young people and women's sports—lower pay to female athletes, less media coverage for women's sports and cultural environments that lead to high dropout rates for diverse athletes—instead of manufacturing problems and "solutions" that hurt the kids we are supposed to be protecting.

David J. Lewkowicz is a senior scientist at Haskins Laboratories and an adjunct professor in the Yale Child Study Center.

COGNITION

Masks Can Be Detrimental to Babies' Speech and Language Development

The good news is that parents can take action to compensate

GETTY IMAGES

My daughter's friend was recently alarmed when she was told that her two-year-old must wear a mask in preschool. Her little girl already struggles to make herself understood, and her mother worries that the mask will make it harder for her daughter to be understood and that she will have trouble telling what her masked peers and teachers are saying.

Now that the face mask has become the essential accoutrement of our lives, the COVID pandemic has laid bare our fundamental need to see whole faces. Could it be that babies and young children, who must learn the meaning of the myriad communicative signals normally available in their social partners' faces, are especially vulnerable to their degradation in partially visible faces?

Faces are a complex and rich source of social, emotional and linguistic signals. We rely on all of these signals to communicate with one another through a complex and dynamic dance that depends on each partner being able to read the other's signals. Interestingly, even when we can see

whole faces, we often have trouble telling what other people are feeling. For instance, as psychologist Lisa Feldman Barrett has noted, we can interpret a smile as meaning "I'm happy," "I like you" or "I'm embarrassed." So seeing partially visible faces robs us of a plethora of linguistic signals that are essential for communication.

Babies and young children see and hear communicative signals and learn to attach meanings to them through their everyday interactions with their caregivers and social partners. Take, for example, a baby at a birthday party or in a day care center where several masked people can be heard and seen talking. To figure out which face goes with which voice, that baby must learn that the mouth is the source of spoken language and that looking at the mouth is essential for figuring out whether a particular person's face goes with a particular voice.

We wanted to know whether and when babies might discover the importance of a talker's mouth. So in one study in my laboratory, we showed videos of talking faces to babies of different ages and tracked their attention by using an eye-tracking device. We discovered that babies begin lip-reading at around eight months of age. Crucially, the onset of lip-reading at this age corresponds with the onset of canonical babbling, suggesting that babies begin lip-reading because they become interested in speech and language. By lip-reading, babies now gain access to visual speech cues which, as Janet Werker and her colleagues at the University of British Columbia have shown, are clearly perceptible to them. So the lip-reading now enables babies to see the visible speech cues that they need to figure out which face goes with which voice. Of course, babies cannot access visible speech cues if others are wearing masks.

More important, our discovery of lip-reading came from a study of only English-learning infants and thus, we were not sure if this was a universal behavior seen in babies learning any language. To answer this question, in subsequent studies with my collaborators, Ferran Pons and Laura Bosch of the University of Barcelona, we examined Spanish- and Catalan-learning infants' response to talking faces and found that they also begin lip-reading at around eight months of age. Intriguingly, we also found that bilingual Spanish- and Catalan-learning babies lipread more than their monolingual counterparts, indicating that bilingual babies rely more on visual speech cues to help them keep their two languages apart.

Crucially, once lip-reading emerges in infancy, it becomes the default mode of speech processing whenever comprehension is difficult. This is illustrated by our latest studies in which my Spanish colleagues, their graduate student Joan Birules and I found that four- to six-year-old bilingual children lip-read more when they are confronted with speech in an unfamiliar than in a familiar language. Similarly, we found that adults who are expert second-language speakers lip-read more than their monolingual counterparts when presented with speech in their second language. These findings are consistent with other evidence that adults resort to lip-reading when confronted with speech-in-noise, accented speech or foreign-language speech.

Overall, the research to date demonstrates that the visible articulations that babies normally see when others are talking play a key role in their acquisition of communication skills. Research also shows that babies who lip-read more have better language skills when they are older. If so, this suggests that masks probably hinder babies' acquisition of speech and language.

Of course, the news is not all bad. Babies spend much of their time at home with their unmasked caregivers. It is only in day care or when out and about with their parents that they do not see whole talking faces. Therefore, it may only be those situations that may have long-term negative consequences for babies. We need more research to tell us if this is the case.

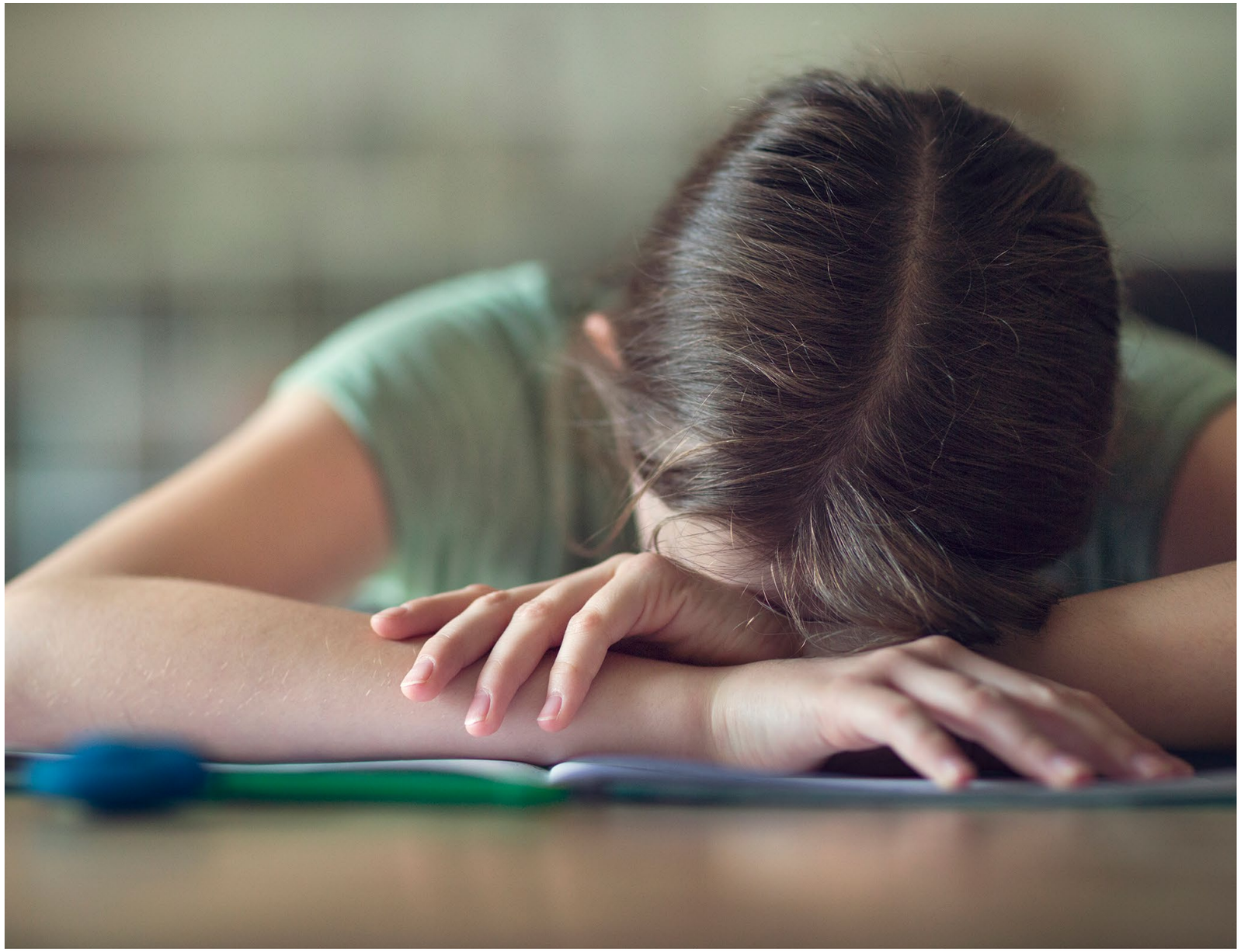
In the meantime, how can we ensure that one's daughter's friend's little girl will, at a minimum, understand her masked peers and teachers? The best advice is that, when outside the home, we should follow CDC's guidance and always wear a mask; in contrast, when home and unmasked, we should engage in as much face-to-face communication with our babies as possible so that they can see and hear our talking faces in their full splendor. Practicing the latter will ensure that babies' young brains, which are highly adaptable, will have the opportunity to compensate for the perceptual deprivation that they experience outside the home.

Branko van Hulst is a resident in child and adolescent psychiatry at Leiden University Medical Center (LUMC) and a postdoctoral researcher at University Medical Center Utrecht (UMCU).
Sander Werkhoven is an assistant professor at the ethics Institute of Utrecht University.
Sarah Durston is a full professor of developmental disorders of the brain at UMC Utrecht.

NEUROLOGICAL HEALTH

We Need to Rename ADHD

Calling the condition a disorder falsely implies we know of a cause located in the brains of people diagnosed with it—and we don't



ELVA ETIENNE *GETTY IMAGES*

"A rose by any other name would smell as sweet." It is an oft-used quote—and for good reason. Juliet tragically underestimated the impact of the Montague surname. She was not the first, nor the last, to underestimate the power of the names we give.

In psychiatry, handbooks determine which names (or classifications) we give to the difficulties that people face. We use them so that when we say ADHD, schizophrenia or depression, people have a more or less consistent idea of what we mean. Moreover, it enables us to study groups of people with the same classification and learn about treatments and prognostics.

A severe and often overlooked side effect of this practice, however, is that these names implicitly suggest causality. The classificatory terms we use all refer to disorders that cause symptoms and therefore suggest that we understand the causes of the problems. Which we do not. At the very least, the term "disorder" suggests a common causal structure, which goes against all our current knowledge on causal heterogeneity in psychiatry. Moreover, these classifications are applied to individuals and thus suggest that causes lie mainly with the affected individual.

The most common psychiatric handbooks (*DSM-5* and *ICD-11*) are clear on the status of

their classifications: they are purely descriptive and are not based on underlying causes. Still, in practice, we say things like "he is inattentive at school because he has ADHD." It is a circular statement: a child is inattentive because of his inattentiveness. When we say that someone has an attention deficit, we are inclined to look for the cause of the problem. But when we say someone has an attention-deficit disorder, we might wrongly assume we have already found the cause. Or, in a milder version, assume the cause to be located somewhere in the (brain of the) individual.

On the surface, this may seem like a silly, innocent mistake. Yet social scientists have shown time and again that this systematically places the problem with the individual and diverts our focus away from the context (for example, family/school/work) where traits lead to problems.

One clear example is the relative age effect in ADHD. The youngest students in class get diagnosed with ADHD more often and receive more ADHD medication than their older classmates. It is the mirror image of the well-known relative age effect in professional sports, where relative maturity in young athletes is mistaken for talent. It seems that in ADHD diagnostics, relative immaturity can be mistaken for ADHD—a consequence of these children being unfairly and unfavorably compared with their older classmates.

So how does this work? How does our system of psychiatric classification divert our attention away from the context of the child and its problems? When a relatively young child presents with attention problems, an ADHD classification is readily available. It is a name that is comprehensible to clinicians, parents and teachers alike. Moreover, as the term "ADHD" implicitly refers to a known cause, this name seems to provide both a distinct explanation (*quod non*) and a clear perspective for treatment. As a result, one element of the child's context, being young compared with his classmates, is overlooked. And as such, a possible starting point for interventions is missed. The question "How can we best handle this child's difficulties in this particular context?" is replaced by "How can we best treat his ADHD?"

Furthermore, the individual context has an even more elusive counterpart: the societal context. For instance, school systems with greater flexibility for delayed school entry (if that fits a child's development better) also seem to have lower rates of ADHD.

Elements in a child's individual context that may be overlooked include a divorce, sleeping problems or poverty. But clinicians are trained to consider individual contexts and are therefore equipped to evade some of the risks of false causality (with the exception of the relative age effect). In contrast, a child's societal context (for example, state regulations on class size or the implementation of a debt-relief program) lies well beyond the view of mental health professionals. We would like to argue that the biggest risk lies here: by presenting psychiatric classifications—ADHD in this case—as explanations rather than descriptions, we risk overlooking a variety of societal options to increase children's well-being.

In any case, ADHD does not cause attention problems any more than low socioeconomic status causes poverty. Attention problems are just that, problems that are part of the definition of ADHD.

We propose a very basic modification to our current system of psychiatric classification that has the potential to bring the strength of descriptive classifications into balance with the pitfalls of falsely assuming a known and common cause. Our modification is as simple as it is effective: drop the term "disorder" from all classifications. Just drop it. In the case of ADHD, call it attention-deficit (and/or) hyperactivity. Nothing is lost in terms of definition, ease of communication or accessibility to research. Nor does it detract from the significance of the problems that people face. The only thing we would lose is the false suggestion that when we use a psychiatric name we understand the causes of the problem at hand. In its place, we would gain an incentive to see a child in his full context and explore all options for improvement.

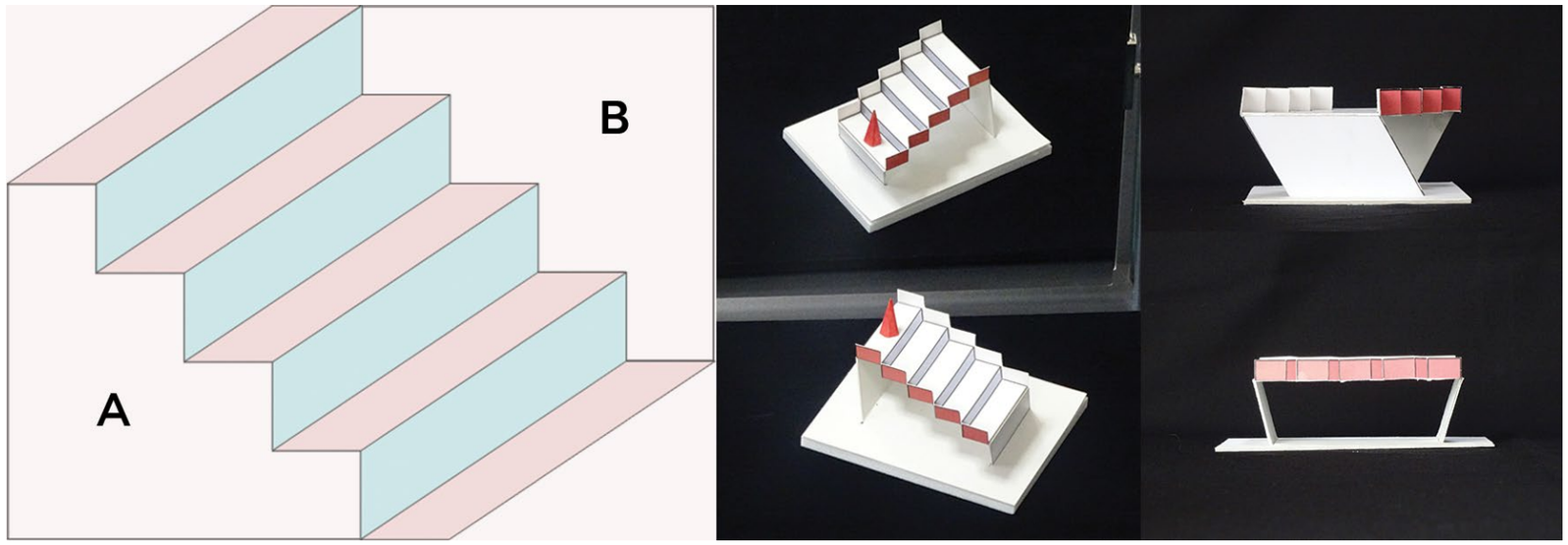
Could it be this simple? Could it be that the omission of a single word can change the way we approach children and parents in need of help? We would like to come back to the lesson Juliet learned the hard way: never underestimate the power of the names we give—not for what they are but for what they represent.

Meet ADH: Attention-deficit (and/or) hyperactivity. No surname.

Stephen Macknik and **Susana Martinez-Conde** 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*.

The Ups and Downs of an Impossible Staircase

A 3-D reimagining of a classic illusion reveals new depths



In *Schröder's Stairs* (*left*), the A wall appears closest to you, but if you flip the image upside down, the B wall will seem closest instead. Kokichi Sugihara's version brings this classic 2-D illusion into 3-D space. Notice how the red cone switches from the top step to the bottom one in the mirror image (*center*). In reality, the 3-D object is based on a flat drawing of stairs supported by angled polygon legs (*right*). The perceptual result is an ascending staircase from a given perspective and a descending staircase from a different perspective. (*Scroll to the next page for a closer look at Kokichi Sugihara's version.*)

Relativity, a lithograph print by Dutch artist M. C. Escher, portrays a world with three orthogonal sources of gravity, in which people climb and descend stairwells that seem to go uphill both ways. The disconcerting artwork is based on *Schröder's Stairs*, a two-dimensional ambiguous image named after its eponymous creator, German natural scientist Heinrich G. F. Schröder. Although Escher popularized and expanded on Schröder's concept, he kept it on a bidimensional plane. But can *Schröder's Stairs* exist in 3-D space?

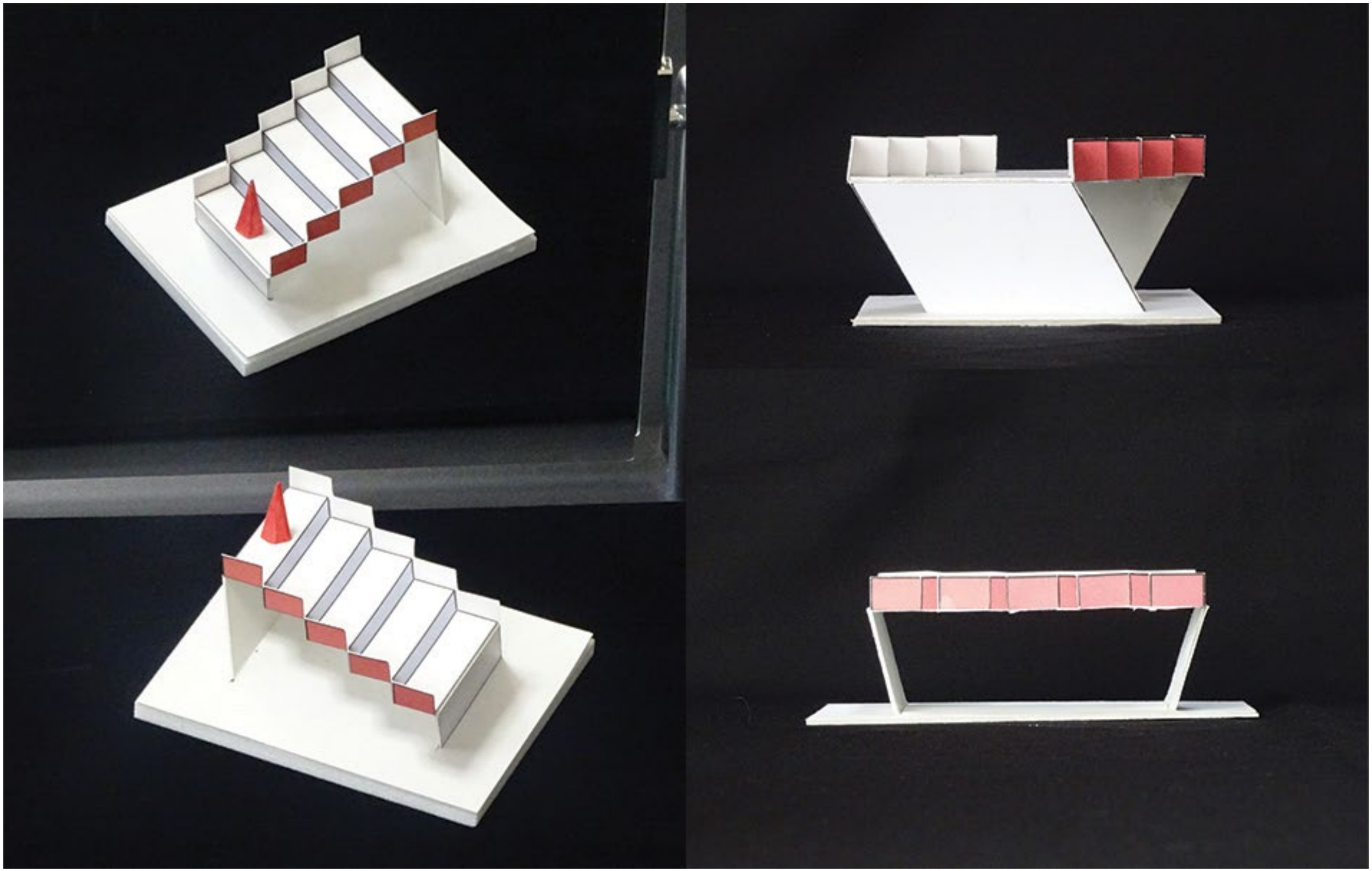
A 2013 YouTube video created by Michael Lacanilao, then a film and animation graduate student at the Rochester Institute of Technology (R.I.T.), featured a "real-life Escherian Stairwell." Alas, it was a clever hoax. "Quite obviously no physics-defying 'Escherian Stairwell' exists in the real world," explains the fact-checking Web site Snopes. "The video was a bit of trickery created through the use of deceptive camera angles, careful editing, and digital effects."

Whereas a true instantiation of an Escherian Stairwell remains out of reach, a new illusion by mathematician Kokichi Sugihara of Meiji University in Japan, winner of the 2020 Best Illusion of the Year Contest, might have come as close to it as physically possible in our reality.

Sugihara's *3D Schröder's Staircase* shows that we interpret 3-D objects as a function of our perspective. The images above showcase the same staircase from two different but simultaneous perspectives (by means of a mirror). As a result, we see a traffic cone at the top of the stairs in one perspective, but that cone appears to be at the bottom of the stairs in the second perspective. In reality, the stairs are as flat as a pool table but are shaped just so, with mathematical precision. Thus, the same drawn-on line intersections appear to be concave from one viewpoint but convex in its mirror-image. And the "stairs" go down from one perspective and up from the other.

The perceptual dissonance may have to do with our brain's predilection for rectangular shapes "among infinitely many possible interpretations," Sugihara says. "The brain usually tries to interpret [a planar-face object] as an object with as many rectangles as possible, which in this case is a staircase."

KOKICHI SUGIHARA



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