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Observer

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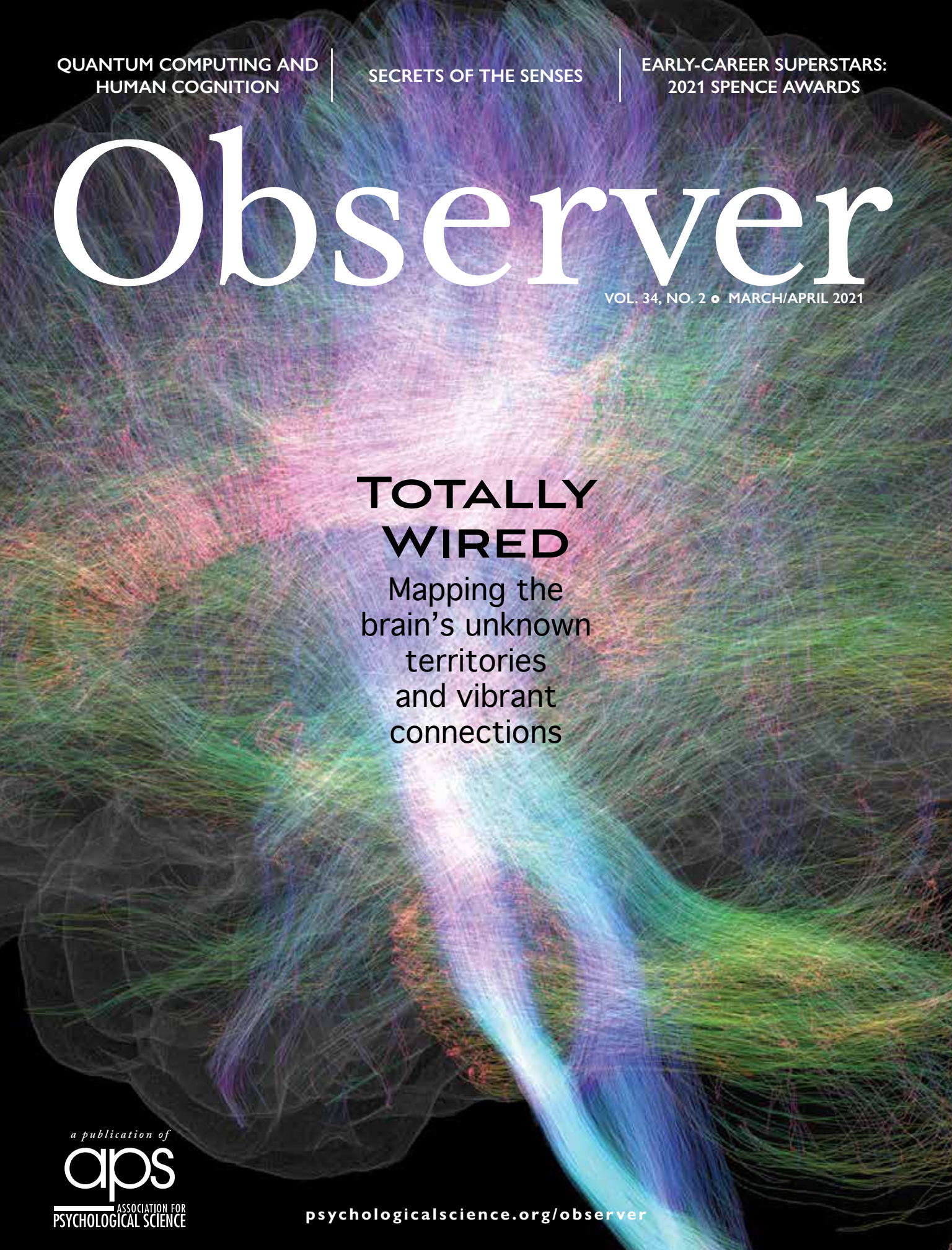

TOTALLY WIRED

Mapping the brain's unknown territories and vibrant connections

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ON THE COVER: Side view of brain tracts mapped using diffusion tractography. Colors indicate the tracts' direction; as they turn to go up and down they are more blue, forward-back is green, left-right is red. In the center, the corpus callosum is the main bundle of tracts connecting the left and right hemispheres in red. See related article on page 30.

Photo courtesy of USC Mark and Mary Stevens Neuroimaging and Informatics Institute (ini.usc.edu).

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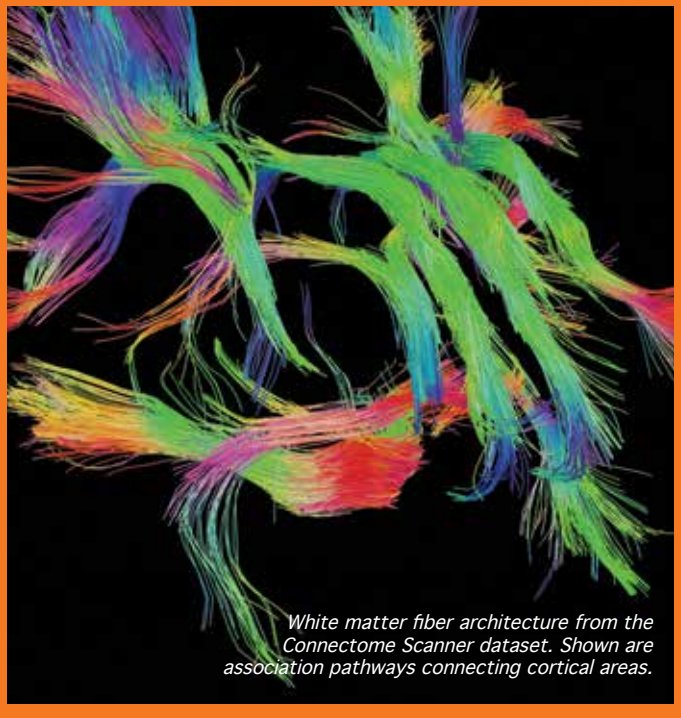

White matter fiber architecture from the Connectome Scanner dataset. Shown are association pathways connecting cortical areas.

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IN FOCUS:

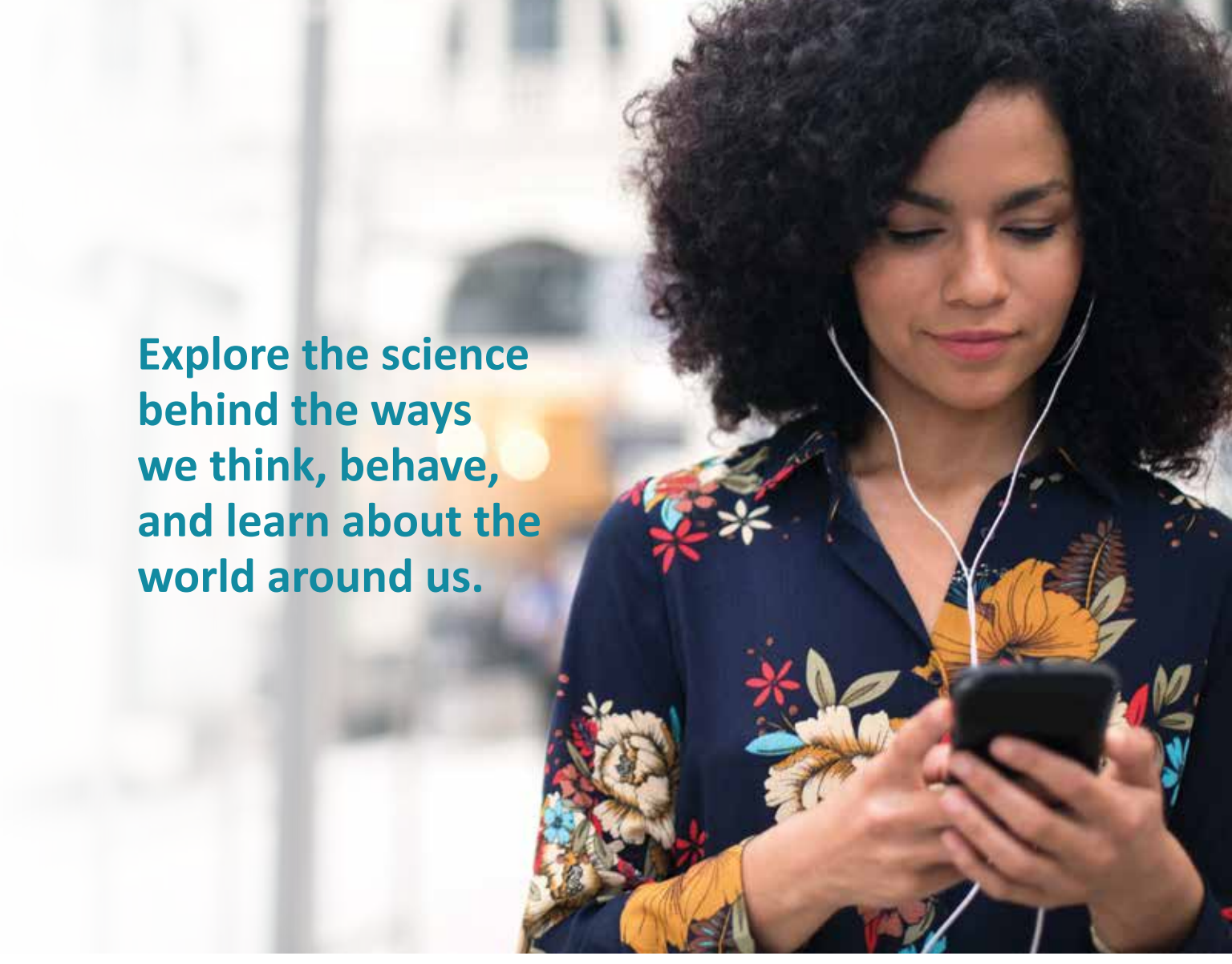
Emerging Methods in Neuroscience Research

The human brain contains more than 100 billion neurons and trillions of connections. In these six articles, we explore how psychological scientists are unpacking its mysteries in research labs all over the world.

> "The connectome is perhaps one of the most groundbreaking theories, changes, revolutions in the last 20 to 30 years of neuroscience."
>
> —FRANCO PESTILLI, "TOTALLY WIRED," PAGE 30

"The best metaphor I have to describe this state of affairs compares scientists to the crew members of a spaceship circling Earth in its orbit. Science may not proceed like an arrow. Progress is not linear. Nor does it advance only through revolutions. Science evolves on the shoulders of preceding researchers through social engagement with colleagues."

—SHINOBU KITAYAMA, PRESIDENTIAL COLUMN, PAGE 6



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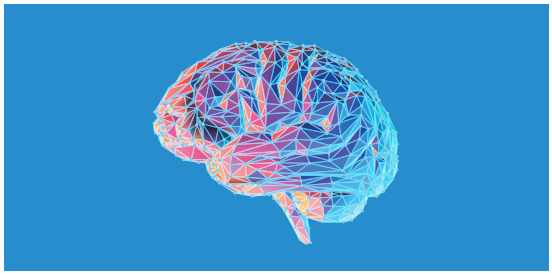

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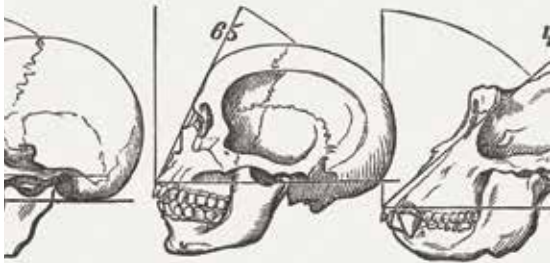

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APS Fellow Frans de Waal explores how primatology and psychology intersect on issues of culture and behavior. Listen at psychologicalscience.org/primatology-psychology.

INNOVATIVE METHODS AND SCIENTIFIC PROGRESS

By Shinobu Kitayama
APS President

We are living in a time of unprecedented methodological innovations in psychology. Neuroscience has come onto center stage in the field. Epigenetics, an area of science that examines how environments influence genes, is no longer a mere theoretical possibility. Big data is increasingly common, which has forced rapid progress in advanced statistics. And many of us are increasingly aware of the need to sample subject populations widely and broadly, both to represent everyone around the globe in our science and, simultaneously, to enrich and improve our theories. Our time, I believe, is remarkable because of these methodological innovations. Or is it?

To explore this question, it is worth reflecting on what methodological innovations in science might do to both the field and the scientists working in it. Why are methodological innovations so essential? And why are we so fortunate to work as scientists at this time of methodological innovations?

Prior analyses on this matter in science in general (e.g., Kuhn, 1962) and psychology in particular (e.g., Greenwald, 2012) undoubtedly carry some truth. Methodological innovations provide scientists with fresh ways of addressing the mysteries of nature (the human mind included) one by one, inviting and motivating new ways of thinking. As Tony Greenwald (2012) put it, "there is nothing so theoretical as a good method" (p. 99). Further, new methods sometimes invite Kuhnian paradigm shifts by producing data that do not fit existing paradigms. To this, however, I want to add emotional and social dimensions. To make this point, I first want to invite readers to revisit one scene from President Biden's inauguration on January 20. There is something in there to be learned about how science might evolve.

"The Hill We Climb"

The occasion was amazing in many ways. After the chaos and confusion that permeated the preceding weeks and months—most notably, the riot on January 6 targeting the U.S. Capitol—the ceremony was a welcome reminder that there remains light to shine over this country. The new president's address was a forceful plea for national unity. Lady Gaga pulled off a passionate rendition of the national anthem. However, the highlight of the day was claimed by Amanda Gorman, a 22-year-old Black female poet who wrote and recited "The Hill We Climb"—a powerful manifesto for redemption and hope for the future.

After witnessing Gorman's brilliant performance, I paused to consider what it was that struck everyone's minds and captured their hearts. As I see it, three components, presented in perfect balance, made her poem so moving.

Expanded consciousness. First and foremost, her words were powerful. They expanded the consciousness of everyone who listened to them. "A skinny Black girl descended from slaves" who "can dream of becoming president" is now reciting the poem for one. Here, the dark history of slavery and racism is being juxtaposed with the ideal of the American Dream. The verse further reminds everyone that the country, although currently in trouble, is not "broken but simply unfinished." Remarkably, such complex ideas are weaved into a seamless stream of unpretentious lines. When we digest the meaning that comes out of it, we are stunned by its scope. It encompasses the entire history of the United States. It shows both dark and bright elements of the nation in a single panorama.

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The emotion of awe. This panoramic view of the country's history defines the present moment, where we stand today as individuals and as a nation, while casting light into the future. By opening up this panoramic view, Gorman's words reach out to our hearts and souls. They evoke awe, which for many of us is exclusively reserved for natural wonders of massive scale. We are stunned and left motionless by the range of both the events that have occurred over this country's history and the people who lived through them. The weight of history is viscerally felt. In a single brushstroke, Gorman then placed the new president's inauguration in that history. As Dacher Keltner and Jon Haidt (2003) have proposed, the emotion of awe makes you feel small, bringing into sharp relief something that transcends any single individual and defines the moment.

Shared mission. Just as important, the awe that was induced was socially shared: Everyone on the scene, so it would appear, had this sense of awe and wonder, whether they were attending the occasion in person or watching it on TV or online. Once shared, awe fosters a collective sense of mission (Rimé, 2009, 2018). The United States has a long, problematic history, but it was founded with a purpose. It has faced difficulties, yet, as Gorman puts it, it is "simply unfinished." We all "lift our gazes not to what stands between us, but what stands before us." The sense of mission conveyed and shared among all those who watched her perform afforded a decisive moment of unity. This moment helped people transcend their personal identities to form a collective identity—a phenomenon addressed under the rubric of "identity fusion" (Swann et al., 2012). No matter how transient it might have been, a moment like this would be needed to get the social experiment of America started all over again.

"The Hill We Climb" brings forward multiple insights for our science—where it stands and how we shall try to further it in the years to come.

Scientific progress: What is it, and how does it happen?

Gorman's "The Hill We Climb" brings forward multiple insights for our science—where it stands and how we shall try to further it in the years to come. For example, the replication crisis has reminded us, as Gorman did for the country, that the project of psychological science is still "unfinished." Also, her resolve to pursue diversity would resonate strongly with us as a field (see my December 2020 column on systemic racism). However, above all these insights, I want to make one fundamental point about this column's central theme: What might innovative methods do to our science? Remember that Gorman used her words to expand the nation's consciousness, which evoked awe and wonder, defining the crucial moment of national unity. I suggest that at their best, innovative methods also have these effects. Such methods will expand the conceptual scope of our field. This expansion will evoke awe and wonder, which will, in turn, bring us together on a shared mission of seeking the truth about the human mind.

Scientific evolution. To be more concrete, consider a bit of the history of persuasion research. A cursory look at this literature shows a noteworthy transformation of the field over the years. Around World War II, the stimulus-response learning theory, championed by some luminaries, such as Clark Hull and Kenneth Spence, was a dominating force in psychology. Influenced by this theory, some social psychologists, most prominently Carl Hovland and colleagues (1953), hypothesized that for messages to impact attitudes (i.e., to be persuasive), they must be learned. The main method available back then to test this idea was to examine how well people remembered persuasive messages. To the scholars' surprise, data based on this method revealed no relationship between memory for a message and its effect on attitudes. This observation presented an empirical anomaly, which was an impetus for various innovations. One such innovation involved the notion of "cognitive response." Greenwald (1968) argued that it is not the information contained in a message but the cognitive elaborations performed on it that count. A critical methodological innovation was to have subjects list all thoughts that occurred to them while listening to and comprehending persuasive messages. Indeed, this method resolved the early anomaly by showing that the thoughts listed retrospectively predicted the observed attitude change.

Subsequently, researchers in this area have advanced the additional insight that cognitive elaboration does not account for the persuasive effect of a messenger's attractiveness or expertise. This realization led to versions of dual-process theory in this area (e.g., Petty & Cacioppo, 1986). Combined with other related ideas, these theories have coalesced into a broader notion of "thinking, fast and slow," popularized by Daniel Kahneman (2011) with his book of the same title.

Lessons from history. It bears emphasis that the target of the investigation, persuasion, has remained the same. But what researchers saw in this phenomenon varied tremendously depending on the methods brought to bear on it—in our example, recall versus thought-listing. Very different sceneries may unfold in front of you depending on what methodological lenses you wear. Thomas Kuhn (1962) famously saw the evolution of science as a series of revolutions. But no such revolution has happened in the persuasion field, and yet progress is

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visible. Perhaps his analysis is reserved for seismic changes that happen only once in any given historical time (as in the Copernican revolution). If so, Kuhn's analysis must surely be supplemented with something more pertinent to science in action on a day-to-day basis. His analysis is often contrasted with more dominant views of scientific progress as linear and steady, but those do not seem right, either.

Progress in the persuasion field is evident, but it is based on repeated, incessant efforts to get something more systematic by using many different methods. There are a lot of trials and errors in the process. Equally important, observations based on a newer method rarely refute or falsify those based on an earlier one: In our example, cognitive elaboration (thought-listing) would require, and thus presuppose, the learning (recall) of persuasive messages. The new method adds depth and conceptual richness to the content matter to encourage more comprehensive theorizing. The most current, up-to-date analysis incorporates prior analyses.

Moreover, if you think all this evolution of science is a matter of pure intellect, as is typically conceived in the philosophy of science, your view would be too myopic. In reality, scientific progress is deeply emotional. Many of us—active researchers—are excited, stunned, dismayed, moved, and, if we are lucky, deeply satisfied by some resolution after a long period of agony and cognitive dissonance. Clearly, some great scientists in history saw something bigger and vaster than anything mortals have at their disposal behind what they studied. Remember Einstein, who noted that "God does not play dice." It is also clear that none of this happens in a social vacuum. Increasingly, science is a highly social endeavor. Today, dual-process theory is a linchpin that unites multiple schools of thought that address different areas with similar ideas. For our science to be productive, we must bring together experts of all

disciplinary and methodological stripes in a dynamic whole. Collaboration is an integral part of science.

Why innovative methods are crucial. The best metaphor I have to describe this state of affairs compares scientists to the crew members of a spaceship circling Earth in its orbit. Science may not proceed like an arrow. Progress is not linear. Nor does it advance only through revolutions. Science evolves on the shoulders of preceding researchers through social engagement with colleagues. This evolution takes a spiral movement: Progress becomes possible through circling around the same object. As the spaceship metaphor makes apparent, every time we circle the same object—say, persuasion—we try out new observation methods. These methods serve as new lenses through which to observe the object. We make very different observations as a result, even though the target object remains identical. These observations invite new questions, which in turn may motivate newer methods. Every time we circle the object, we deepen our understanding and broaden our conceptualization; eventually, we approximate the theoretical framework that can accommodate all new observations. This circular effort gradually moves science forward. That progress, however, may become visible only when seen from afar.

As we observe the same object through different methodological lenses, we will be amazed by new ways in which the object presents itself. This amazement translates into a sense of awe and wonder. Many readers of my generation may remember the magical power of enchantment in Carl Sagan's (1980) exposition of celestial systems. I should add that sometimes, the innovative methods themselves are awe-evoking. For example, remember the first time you saw

Progress in the persuasion field is evident, but it is based on repeated, incessant efforts to get something more systematic by using many different methods. There are a lot of trials and errors in the process.

a colorful heat map of the brain on your computer screen. Science can be "awe-some," as Piercarlo Valdesolo and colleagues (2017, p. 215) observed. The awe will be augmented as the method is repeatedly tried and variously applied. Further, the awe will be shared by an increasingly large number of researchers in the lab. Upon further repetition and application, the sense of excitement may spread to scholars outside the lab. It may eventually reach many in the field at large. The emotions of awe and wonder may cultivate many scientists' imaginations. They also induce in-group cooperation (Piff et al., 2015) and "identity fusion" (Swann et al., 2012). The resulting collaboration will forge a commonly shared sense of mission and direction for the future. When all this happens, a new area of research will have emerged. Ultimately, the field-forming force of awe and wonder may even influence popular conceptions of the issue at hand.

Listen Online!

APS's Charles Blue and NPR science correspondent Joe Palca (psychology PhD, University of California at Santa Cruz) discuss the evolution of science over the past century in a new episode of *Under the Cortex*, the APS podcast.

Three innovations that may transform psychological science

The preceding discussion of scientific progress leads me to my next questions: Where do we stand today in psychological science? What methodological innovations will expand the scope of our understanding of the human mind? What methods could bring about awe and help us renew the sense of our mission to further the understanding of the mind? I think everyone has informed guesses. These guesses may differ, but I suspect the following three are common.

Neuroscience. My first pick is neuroscience, broadly conceived to include not only brain imaging methods, such as MRI and electroencephalogram, but also various methods in genetics, epigenetics, and neuroendocrinology. The use of brain imaging methods in particular has created a new field of cognitive neuroscience. However, the impact of neuroscience can be felt everywhere, from clinical and developmental psychology to social and cultural psychology. A key idea is neuroplasticity. Experience can and does change your brain (and body), and through those changes, it changes who you are and how you think and feel. All this happens within the constraints put forward by our evolutionary past. Importantly, however, the brain is now conceptualized as a far more open system than it once was. As I discussed in my last column, the human brain (and thus human psychology) is closely interdependent with its environment. Moreover, it is now empirically tenable to specify how life experiences affect the activation or silencing of genetic codes responsible for creating brain networks and the connections among such networks. Pioneered by Michael Meaney (2001) and Steve Cole (2014), among many others, this new approach and all insights that come with it carry the potential to transform psychological science.

Big data. With the advent of super-powered computers, the amount of available data has increased exponentially. Brain network analysis is increasingly common, supplementing or even replacing more traditional regions-of-interest analysis. Genome-wide scanning is becoming more commonplace. And we must not forget physiological and neuroendocrine data. The online collection of data from wearable devices, such as watches and wristbands, that track physiological signals is allowing us to examine mind-body connections in new ways and at levels never seen before. Just as important, a similar expansion is evident in social domains. Facebook and Twitter have supplied tons of data for careful analysis. For example, automated computer-mediated coding of millions of tweets is now among the tools added to our science. Ecological experience-sampling methods carry the potential to test theories of, say, emotion in ecologically valid settings. When all these developments are brought together, one can do some highly innovative things. For example, one can use wearables that monitor physiological data to assess the effect of experimental interventions by randomly assigning the moments that meet certain on-line criteria (e.g., momentary heart rate) to the experimental (vs. control) condition (Nahum-Shani et al., 2020). And we should not forget machine learning, which has emerged as a powerful method for data-driven inductive reasoning and hypothesis generation (Sheetal et al., 2020). Altogether, the big data has changed the field both rapidly and massively, offering tremendous opportunities for everyone interested in the mind and body at work in the real world.

Diverse samples. This last one may not come across as a methodological innovation to many in the field. But it is! Testing existing theories across divergent samples can immediately challenge those theories. In my career, an initial failure to replicate standard findings—say, the fundamental attribution error, self-serving bias, or cognitive dissonance—in Asia always forced a moment of reckoning, which was turned into new research opportunities (Markus & Kitayama, 1991). It is now abundantly clear that there is substantial psychological diversity across the globe. Hence, theories and observations based on WEIRD (Western, educated, industrial, rich, and democratic) samples can, more often than not, be myopic and, worse, ethnocentric. To address this issue, scholars have traditionally used international surveys. However, such surveys must be supplemented with experimental procedures, as well as neuroscientific, physiological, genetic, or ➡

epigenetic measurements. Some promising efforts are underway (Reinecke & Gajos, 2015). Just as the exploration of psychological mechanisms within the brain requires close collaboration with those who know the brain well (i.e., neuroscientists), exploring such mechanisms across societies demands close collaboration with sociologists, anthropologists, and other social scientists. Cross-disciplinary fertilization will for sure promote further theoretical advancement and enrich psychological theories.

Concluding thought

In "The Hill We Climb," Gorman used "hill" in two disparate senses. First, and most literally, she referred to Capitol Hill, where she stood along with all those who were to govern the nation. However, more metaphorically, she also referred to people's struggles, both past and present, to realize America's ideals, including diversity and equality. This juxtaposition of the hill that governs this country and the hill many oppressed have tried to climb foreshadowed the awe she was to inspire in the audience. Her poem expanded the consciousness of everyone who listened, struck them with new insight about who we are and, more importantly, who we want to be, and produced a common sense of mission to the future.

I cannot help but feel an equally strong hope for our field. Psychology has struggled to understand this mysterious thing called "mind" for so long. However, new methods are now available, and others are on the horizon. They promise to expand the consciousness of the field. When they do, they will undoubtedly foster the emotions of awe and wonder, which will be widely shared by all those seekers of the truth about the human mind. Methodological innovations will help our science grow and climb a hill of its own. This prospect may no longer be merely aspirational. It may be within our reach.

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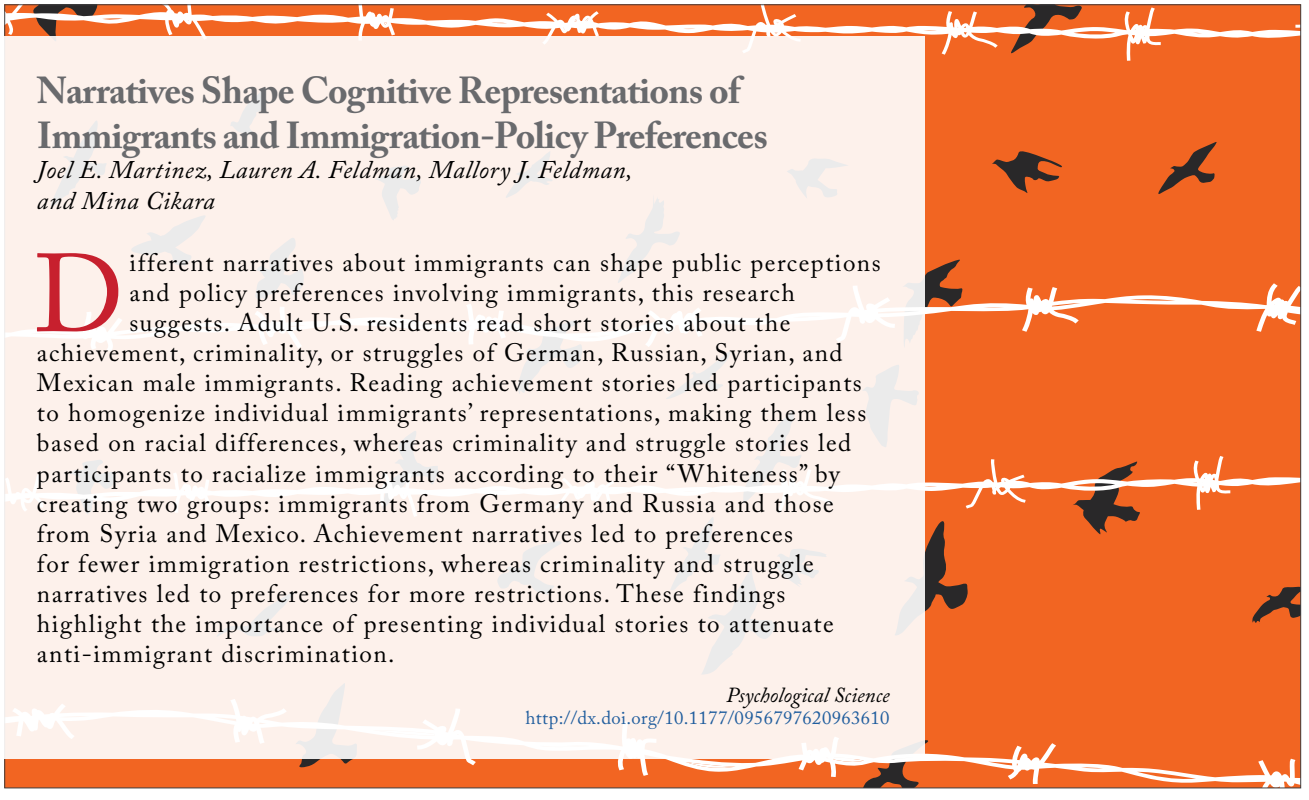


Narratives Shape Cognitive Representations of Immigrants and Immigration-Policy Preferences

Joel E. Martinez, Lauren A. Feldman, Mallory J. Feldman, and Mina Cikara

Different narratives about immigrants can shape public perceptions and policy preferences involving immigrants, this research suggests. Adult U.S. residents read short stories about the achievement, criminality, or struggles of German, Russian, Syrian, and Mexican male immigrants. Reading achievement stories led participants to homogenize individual immigrants' representations, making them less based on racial differences, whereas criminality and struggle stories led participants to racialize immigrants according to their "Whiteness" by creating two groups: immigrants from Germany and Russia and those from Syria and Mexico. Achievement narratives led to preferences for fewer immigration restrictions, whereas criminality and struggle narratives led to preferences for more restrictions. These findings highlight the importance of presenting individual stories to attenuate anti-immigrant discrimination.

Psychological Science
http://dx.doi.org/10.1177/0956797620963610

PSYCHOLOGICAL SCIENCE

The Unintended Consequences of the Things We Say: What Generic Statements Communicate to Children About Unmentioned Categories

Kelsey Moty and Marjorie Rhodes

Using generic language (e.g., "Boys play sports") may accidentally communicate social stereotypes to children (e.g., implying that girls do not play sports). Moty and Rhodes examined the inferences that 4- to 6-year-olds make about the unmentioned groups in generic claims. They found that children as young as 4.5 years old drew inferences (e.g., in discussing the imaginary groups of "zarpies" and "gorps," the statement "Zarpies are good at baking pizzas" implies that gorps are not). The tendency to make these inferences increased with age, but presenting specific statements instead of generic ones (e.g., "This zarpie is good at baking pizzas") overrode this tendency.

http://dx.doi.org/10.1177/0956797620953132

The Lure of Counterfactual Curiosity: People Incur a Cost to Experience Regret

Lily FitzGibbon, Asuka Komiya, and Kou Murayama

Why do people seek information about how things would have been if they had made a different decision, even when they cannot reverse the decision? People appear to have this counterfactual curiosity even though it does not improve and may even impair their decision-making performance. FitzGibbon and colleagues found that participants were highly motivated to incur costs (money and physical effort) to learn what they could have received while performing a task, even when that information led to regret instead of those rewards.

http://dx.doi.org/10.1177/0956797620963615

The Long-Term Effects of New Evidence on Implicit Impressions of Other People

Jeremy Cone, Kathryn Flaharty, and Melissa J. Ferguson

Learning new information about other people can update previous implicit impressions in a lasting and durable manner, this research suggests. Cone and colleagues examined whether people's implicit feelings and impressions about fictional and familiar individuals could change if they saw new evidence involving those individuals. They found that when the new information was highly diagnostic and believable, the

original implicit impressions could change and even remain changed after days, weeks, and months. These findings suggest that implicit impressions and biases may not be as resistant to change as previous research had suggested.
http://dx.doi.org/10.1177/0956797620963559

Reasoning Through the Disjunctive Syllogism in Monkeys

Stephen Ferrigno, Yiyun Huang, and Jessica F. Cantlon

The disjunctive syllogism—given A or B, if not A, then B—is a logical inference that monkeys appear to have the capacity to understand. Previous research had shown that nonhumans could reason by exclusion (not A), but their ability to deduce the dependent relation between A and B had not been tested. Ferrigno and colleagues showed that monkeys solved disjunctive syllogisms to gain their favored food, grapes, 75% of the time. These findings indicate that the cognitive capacity of deduction is not unique to humans and can occur in the absence of language.
http://dx.doi.org/10.1177/0956797620971653

Newtonian Predictions Are Integrated With Sensory Information in 3D Motion Perception

Abdul-Rahim Deeb, Evan Cesanek, and Fulvio Domini

Newtonian laws explain the motions of everyday physical objects and thus might be internalized by the brain to facilitate motion perception. This research suggests that motion perception relies on internalized regularities, or laws, not only when information is missing but also when the available information is inconsistent with the expected outcome of a physical event. Participants viewed 3D billiard-ball collisions depicting varying degrees of consistency with Newtonian laws. Their judgments of postcollision trajectories were biased toward the outcomes expected according to Newtonian laws of mechanics.
http://dx.doi.org/10.1177/0956797620966785

Levels of Processing Affect Perceptual Features in Visual Associative Memory

Rebecca Ovalle-Fresa, Arif Sinan Uslu, and Nicolas Rothen

The more deeply a person processes a verbal stimulus, the more likely they will remember it later. This is the basis for the levels of processing (LOP) account. Ovalle-Fresa and colleagues showed that the LOP can also be applied to visual mental representation. In four experiments, they found that participants memorized associations more accurately when they processed them at a deep level (i.e., by making a pleasantness judgment) than at a shallow level (i.e., by judging the presence of a perceptual feature such as a straight line). This applied to object-color associations as well as fractal-color associations.
http://dx.doi.org/10.1177/0956797620965519

CLINICAL PSYCHOLOGICAL SCIENCE

Thought Conditioning: Inducing and Reducing Thoughts About the Aversive Outcome in a Fear-Conditioning Procedure

Ann-Kathrin Zenses, Frank Baeyens, Tom Beckers, and Yannick Boddez

A fear-conditioning procedure can both induce and reduce intrusive thoughts about aversive stimuli that are conducive to fear and anxiety, this research suggests. In fear conditioning, neutral stimuli (e.g., images of colored circles) are contingently presented with aversive ones (e.g., images of mutilated bodies), and fear responses to the neutral stimuli are measured. Zenses and colleagues showed that fear conditioning can change the mere thought of aversive outcomes. They also showed that presenting positive outcomes can reduce the frequency of thoughts about negative outcomes previously associated with a neutral stimulus.
http://dx.doi.org/10.1177/2167702620954222

Evidence of Inflated Prediction Performance: A Commentary on Machine Learning and Suicide Research

Ross Jacobucci, Andrew K. Littlefield, Alexander J. Millner, Evan M. Kleiman, and Douglas Steinley

Jacobucci and colleagues use a simulation and an empirical example in suicide research to demonstrate how nonlinear machine-learning approaches and optimism-corrected bootstrap techniques might inflate the prediction estimates of clinical outcome models. Their analyses indicate that alternative methods for validating models, such as k-fold cross-validation or bootstrap sampling, might be more appropriate. They also suggest that the superior performance of machine learning over traditional approaches might be an artifact of the validation methods used and may not necessarily indicate that suicide is a complex phenomenon that requires complex theories.
http://dx.doi.org/10.1177/2167702620954216

CURRENT DIRECTIONS IN PSYCHOLOGICAL SCIENCE

Robots as Mirrors of the Human Mind

Agnieszka Wykowska

Robots can increase our knowledge about human cognition and serve as tools for research in psychological science. Wykowska gives examples in which robots have been used to study mechanisms of social cognition that require reciprocal interaction between two people (e.g., joint attention, when one person directs their attention to a location and their partner attends to it in response). The author also discusses whether and when robots are perceived as possessing human ➡

characteristics and how robots have been used to implement computational models of human cognition.
http://dx.doi.org/10.1177/0963721420978609

Learning by Drawing Visual Representations: Potential, Purposes, and Practical Implications

Shaaron E. Ainsworth and Katharina Scheiter

Using drawing to learn can be an efficient strategy. Ainsworth and Scheiter discuss diverse purposes for drawing, including active purposes (e.g., to retrieve information from memory), constructive purposes (e.g., to create visual representations that go beyond the information given), and interactive purposes (e.g., to collaborate). They suggest that these purposes could be integrated to foster engagement and learning. Ainsworth and Scheiter add that to make the most of drawing for learning, teachers should note that what students draw matters and should be assessed according to task demands.
http://dx.doi.org/10.1177/0963721420979582

Primate Vocal Communication and the Evolution of Speech

Julia Fischer

Studies of nonhuman primate communication may support our understanding of how speech evolved. Fischer describes the similarities and differences between nonhuman primate communication and human speech (e.g., primates have similar abilities to rapidly attach meaning to new sounds but differences in vocal production). The author explains that changes in neural control during vocal production, rather than comprehension, might be key to understanding the evolution of speech. She discusses questions of meaning and syntax and examines the role of social cognition, namely the motivation to communicate about the world, in human and nonhuman primate communication.
http://dx.doi.org/10.1177/0963721420979580

Pornography Use and Psychological Science: A Call for Consideration

Joshua B. Grubbs and Shane W. Kraus

Grubbs and Kraus review how research on pornography use may be relevant to several domains in psychological science, including relationship research, adolescent development research, and clinical science. Specifically, Grubbs and Kraus note that research on pornography use can be important for research on sexual and romantic satisfaction and adolescent sexual development. Also, research on the potential risks of pornography when it is excessive or when it creates moral incongruence can be relevant for clinical science.
http://dx.doi.org/10.1177/0963721420979594

PERSPECTIVES ON PSYCHOLOGICAL SCIENCE

How Computational Modeling Can Force Theory Building in Psychological Science

Olivia Guest and Andrea E. Martin

Guest and Martin suggest that using computational modeling of theories, over and above data, might help to advance psychological science. They argue that, although computational modeling is undervalued, its demands may force researchers to conceptualize, specify, and formalize intuitions that otherwise would remain untested. Thus, modeling might contribute to the creation of explanatory and predictive theories. The authors suggest that, without modeling, the field lacks transparent and open theorizing. They also explain how to formalize, specify, and implement a computational model.
http://dx.doi.org/10.1177/1745691620970585

Quo Vadis, Methodology? The Key Role of Manipulation Checks for Validity Control and Quality of Science

Klaus Fiedler, Linda McCaughey, and Johannes Prager

A proper manipulation check, which must be operationally independent of the dependent variable, ensures the intended purpose of an experiment's manipulation. Manipulation checks are critical for the viability of a theoretical hypothesis's logical premise and, therefore, for scientific quality control. Manipulation checks also contribute to clever research design, carry over to theorizing, and have implications for replication. Fiedler and colleagues propose a future methodology that replaces scrutiny in statistical significance testing (i.e., the $p < .05$) with validity control and diagnostic research designs.
http://dx.doi.org/10.1177/1745691620970602

Anatomy of a Psychological Theory: Integrating Construct-Validation and Computational-Modeling Methods to Advance Theorizing

Ivan Grahek, Mark Schaller, and Jennifer L. Tackett

Well-specified theories are as important for the development of reliable empirical psychological science as sound research methods and statistics. Grahek and colleagues discuss theory specification and development in two research traditions—computational modeling and construct validation. By identifying the commonalities and differences between theoretical reasoning in these two traditions, the authors propose an integrated method to develop psychological theories that can lead to better explanations and predictions. Grahek and colleagues also explore what a well-specified theory

should contain and how researchers can question and revise such a theory.
http://dx.doi.org/10.1177/1745691620966794

The Relationship Between Multidimensional Motivation and Endocrine-Related Responses: A Systematic Review

Richard P. Steel, Nicolette C. Bishop, and Ian M. Taylor

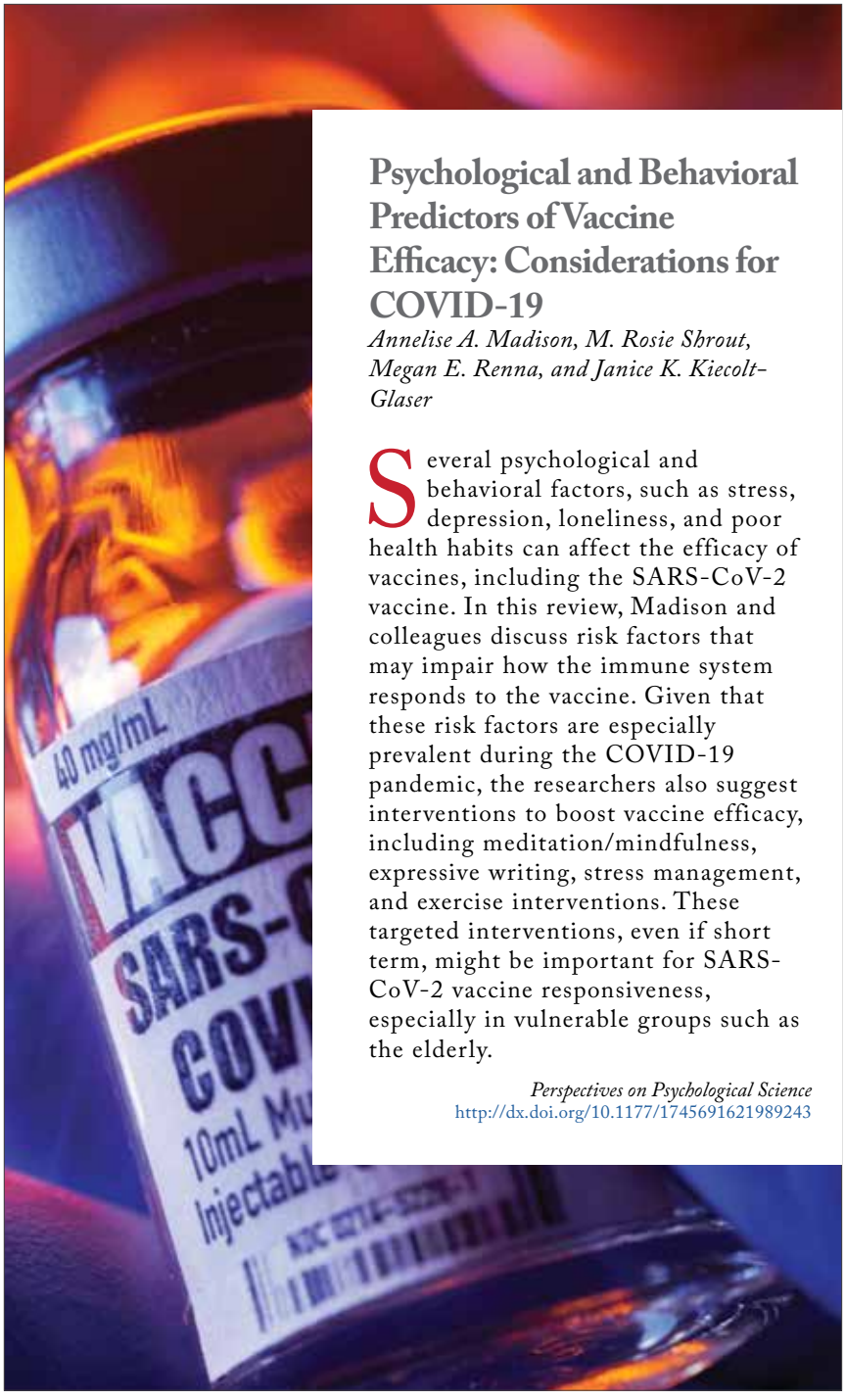
Steel and colleagues evaluated the association between motivational constructs and endocrine-related responses detected in saliva. Evidence from 41 studies, focusing on five distinct motivation theories, indicated that high-quality motivation attenuated cortisol response in evaluative environments. They also found that motivational needs for power and affiliation were associated with lower and higher levels of salivary immunoglobulin A, respectively, and that, in some cases, the need for power may play a role in increasing testosterone among winners of a contest. The researchers mapped this evidence onto a unified theory of motivation, revealing areas of theoretical overlap and compatibility.
http://dx.doi.org/10.1177/1745691620958008

ADVANCES IN METHODS AND PRACTICES IN PSYCHOLOGICAL SCIENCE

A Traveler's Guide to the Multiverse: Promises, Pitfalls, and a Framework for the Evaluation of Analytic Decisions

Marco Del Giudice and Steven W. Gangestad

Multiverse methods (e.g., specification curve, vibration of effects) estimate an effect across an entire set of possible analytical specifications to expose the impact of hidden degrees of freedom and/or obtain less-biased estimates of the effect being studied. However, when the specifications are not arbitrary but are treated as such, they can inflate the size of the multiverse, exaggerating the perceived exhaustiveness of the multiverse while making it difficult to extract relevant findings. Del Giudice and Gangestad offer a framework and conceptual tools that will help researchers make the best use of multiverse-style methods. They illustrate the framework with a simulated data set and published examples.
https://doi.org/10.1177/2515245920954925



Psychological and Behavioral Predictors of Vaccine Efficacy: Considerations for COVID-19

Annelise A. Madison, M. Rosie Shrout, Megan E. Renna, and Janice K. Kiecolt-Glaser

Several psychological and behavioral factors, such as stress, depression, loneliness, and poor health habits can affect the efficacy of vaccines, including the SARS-CoV-2 vaccine. In this review, Madison and colleagues discuss risk factors that may impair how the immune system responds to the vaccine. Given that these risk factors are especially prevalent during the COVID-19 pandemic, the researchers also suggest interventions to boost vaccine efficacy, including meditation/mindfulness, expressive writing, stress management, and exercise interventions. These targeted interventions, even if short term, might be important for SARS-CoV-2 vaccine responsiveness, especially in vulnerable groups such as the elderly.

Perspectives on Psychological Science
http://dx.doi.org/10.1177/1745691621989243

WHY AN EARLY START IS KEY TO DEVELOPING MUSICAL SKILL LATER IN LIFE

Among the many holiday traditions scuttled by pandemic restrictions this past year have been live concerts featuring skilled musicians. These gifted performers can often play with such ease that it is easy to underestimate the countless hours of practice that went into honing their craft.

But could there be more to mastering music? Is there, as some have suggested, a developmental period early in life when the brain is especially receptive to musical training? The answer, according to new research published in the journal *Psychological Science*, is probably not.

"It is a common observation that successful musicians often start their musical training early," said Laura Wesseldijk, a researcher at the Karolinska Institute in Sweden and first author on the paper. "One much-discussed explanation is that there may be a period in early childhood during which the brain is particularly susceptible to musical stimulation. We found, however, that the explanation to why an early start matters may be more complicated and interesting than previously believed."

Although the new study supports the idea that an early start is associated with higher levels of musical skills and achievement in adulthood, the underlying reasons for this may have more to do with familial influences—such as genetic factors and an encouraging musical family environment—along with early musicians' accumulation of more total practice time relative to those who start later in life

To untangle these effects, Wesseldijk and her colleagues recruited 310 professional musicians from various Swedish music institutions, such as orchestral and music schools. The researchers also used data from an existing research project, the Study of Twin Adults: Genes and Environment (STAGE). Participants from both studies were tested on musical aptitude and achievement. They also answered a series of questions that gauged how often they practiced and the age of onset of musical training. The STAGE data also provided genetic information on its participants.

By comparing the results from these two independent studies, the researchers were able to show that an earlier start age was associated with musical aptitude, both in amateurs and professional musicians, even after controlling for accumulated practice time. They then evaluated starting age in a manner that accounted for the genetic data from the STAGE study.

The results indicate that genetic factors—possibly related to musical interest and talent—have a substantial influence on the age individuals start music practice and their future musical aptitude. When controlling for familial factors, namely shared genetic and environmental influences, such as a home environment that is steeped in music, there was no additional association between an earlier start age and musicality.

A possible explanation for these results could be that children who display more talent in a particular field, such as music, are encouraged to start practicing earlier. Another possibility is that a musically active, interested, and talented family provides a musical environment for the child, while also passing on their genetic predispositions to engage in music.

See the full article with reference list at psychologicalscience.org/observer/musical-skill.

CITIZENS VERSUS THE INTERNET: HOW PSYCHOLOGICAL SCIENCE CAN CONFRONT DIGITAL CHALLENGES

Access to the Internet is essential for economic development, education, global communications, and countless other applications. For all its benefits, however, the Internet has a darker side. It has emerged as a conduit for spreading misinformation, stoking tensions, and promoting extremist ideologies. Yet there is hope.

In a recent issue of *Psychological Science in the Public Interest,* a team of researchers recommends ways that psychological and behavioral sciences can help decrease the negative consequences of Internet use. These recommendations emphasize helping people gain greater control over their digital environments.

"Psychological science can help to inform policy interventions in the digital world," said Anastasia Kozyreva, a researcher at the Center for Adaptive Rationality at the Max Planck Institute for Human Development in Germany and author on the paper. "It is crucial that psychological and behavioral sciences are employed to ensure users are not manipulated for financial gain and are empowered to detect and resist manipulation."

Specifically, psychological and cognitive sciences can complement interventions by other fields, such as law and ethics, which develop guidelines and regulations; education, which can provide curricula for digital information literacy; and technology, which can provide automated detection of harmful materials and help implement more ethically designed online choice architectures.

Although there is no silver bullet that could solve all the problems of the digital world, Kozyreva and her colleagues describe three approaches

to help mitigate the negative consequences. The first is to design Internet infrastructures that "nudge" people's behavior toward more positive outcomes, such as systems with default privacy-respecting settings. The second is relying more on "technocognition," which are technological solutions informed by psychological principles, such as creating obstacles to sharing offensive material online.

The final approach is improving people's cognitive and motivational competencies through "boosts," which are tactics that enhance people's agency in their digital environments and improve reasoning and resilience to manipulation. Examples of a boost include preventively inoculating users against common manipulative practices and providing easy-to-use rules for digital literacy.

"These cognitive tools are designed to foster the civility of online discourse and protect reason and human autonomy against manipulative choice architectures, attention-grabbing techniques, and the spread of false information," said Kozyreva.

Reference

Kozyreva, A., Lewandowsky, S., & Hertwig, R. H. (2020). Citizens versus the Internet: Confronting digital challenges with cognitive tools. *Psychological Science in the Public Interest*, 21(3), 103–156 https://doi.org/10.1177/1529100620946707

See the Research Topic on Myths and Misinformation at psychologicalscience.org/topics/myths-and-misinformation.

STRENGTHENING CONTACT TRACING USING WITNESS INTERVIEWING TECHNIQUES

A single person infected with COVID-19 can unknowingly set off an outbreak simply by going about their normal day-to-day activities. Efficient contact tracing is one of the few weapons against the spread of the virus, along with social distancing and mask-wearing, at least until a higher percentage of the population is vaccinated.

In a recent article in *Perspectives on Psychological Science*, APS Board member Maryanne Garry (University of Waikato, New Zealand) and colleagues explored the impact of human memory on the efficacy of contact tracing and the challenges of making it more efficient.

Contact tracing is a process by which public health officials identify people (contacts) who have been exposed to a person infected with a pathogen or other hazard. By ensuring that people at risk for infection don't come into contact with others and targeting treatment toward those most likely to be infected, contact tracing can interrupt transmission among people and slow the spread of an infection, Garry and colleagues explained, citing Eames and Keeling (2003).

However, "contact tracing's ability to prevent further transmission is only as effective as the quality of the information that people provide," the researchers noted. That's where the human-memory element enters into the equation. An infected person must provide contact tracers with complete and accurate information about their contacts and activities both before and after they realized they were sick. Because of contact tracing's reliance on memory, contact tracers face the same five challenges as people who interview witnesses, Garry and colleagues explained. Witnesses are known to:

- unwittingly omit information (e.g., common daily activities that do not stand out in memory),
- be imprecise (e.g., because it is difficult to recall distance and time with precision),
- make mistakes (because recalling information is a reconstructive process prone to errors—e.g., false memories),
- have vulnerabilities (e.g., the infectious patients identified by health authorities are often sick), and
- sometimes be reluctant to report what they recall (e.g., because they fear punitive consequences).

One way to improve the effectiveness of contact tracing is to treat infected people like important witnesses to the spread of a virus and use an approach informed by research on memory and witness interviewing, Garry and colleagues noted. "[Interviewing] protocols typically provide a structured yet flexible combination of psychologically informed techniques and, broadly speaking, significantly increase the amount of information elicited with little meaningful cost to accuracy."

Conducting an effective interview, they noted, includes:

- developing a good rapport with the witness;
- managing the witness's expectations about their role in the interview to help overcome reluctance to report information;
- asking questions and providing instructions that promote detail and accuracy—for example, using a questioning strategy that does not steer witnesses toward any particular response but helps them mentally place themselves in past encounters with contacts; and
- using retrieval-support techniques (e.g., incorporating a timeline or an event history calendar).

See the full article with reference list at psychologicalscience.org/observer/contacting-tracing-interviews.

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HYPNOTIC SUGGESTIONS CAN MAKE A COMPLEX TASK EASY BY HELPING VISION FILL IN THE BLANKS

Popular folklore and anecdotal evidence suggest that people in a hypnotic or suggestible state can experience sensory hallucinations, such as perceiving sounds and sights that are not actually there. Reliable scientific evidence of these experiences, however, has been notoriously challenging to obtain because of their subjective nature.

New research published in the journal *Psychological Science* provides compelling evidence that hypnotic suggestions can help highly susceptible people "see" imaginary objects, equipping them with the missing details needed to solve an otherwise challenging visual puzzle.

"Hypnosis holds intriguing effects on human behavior," said Amir Raz, a researcher at McGill University and coauthor on the paper. "The careful, systematic study of hypnotic phenomena can answer important questions about mind-body interactions and advance novel therapies in medicine, psychology, and dentistry."

See the Human Brain Research Topic at psychologicalscience.org/topics/the-human-brain.

For their research, Raz and his colleagues divided 32 participants into two groups: those who were found to be highly hypnotizable and those who were less suggestible. The participants viewed an array of disconnected lines moving around on a display screen. The lines, if lengthened and connected, would have formed various geometric shapes, such as diamonds or triangles.

Participants had to determine whether the rotation of the incomplete geometric figures was clockwise or counterclockwise. This task was inherently difficult because the disconnected lines lacked the visual cues necessary to easily assess the direction of rotation. The participants' success rate was approximately 50-50, or no better than chance.

The participants were then given the hypnotic suggestion to imagine that something was blocking out part of each shape being observed. Afterward, they repeated the same task of determining the direction of rotation.

The results revealed that participants who were highly susceptible to hypnotic suggestion successfully "hallucinated" visual occluders on top of moving objects. This added imaginary element enabled the participants to better visualize the full geometric shapes and more accurately determine their direction of rotation. On average, their success rate improved to approximately 70%, a statistically significant change.

The participants in the less hypnotizable group, however, were no more likely to complete the observational task following hypnotic suggestion. "Although these results are consistent with our hypothesis, the data surprised us by revealing the decisive and robust nature of the effect," said Raz.

Previous work on hypnosis has often highlighted its capacity to suppress or remove certain perceptual experiences. The new research shows compelling evidence that a hypnotic suggestion can also enhance or introduce perceptual experiences.

"Our findings support the idea that, at least in some people, suggestions can add perceptual information to sensory input," said Raz. "This observation adds meaningful weight to theoretical, clinical, and applied aspects of the brain and psychological sciences."

Reference

Landry, M., Castanheira, J. D. S., Sackur, J., & Raz, A. (2020). Difficult turned easy: Suggestion renders a challenging visual task simple. *Psychological Science, 32*(1), 39–49. https://doi.org/10.1177/0956797620954856

CULTURAL CONDITIONING IN PROGRESS: CHILDREN ARE MORE LIKELY TO PRIORITIZE THE NEEDS OF ANIMALS

It may seem natural for people to consider humans more intrinsically valuable than other animals—but cultures vary significantly when it comes to which animals are valued, and to what extent. Historically, scholars have argued that we start life with a small "moral circle" that expands to include animals, along with more people, as we develop more mature moral concepts. But research in *Psychological Science* suggests that children may be more inclined than adults to prioritize the lives of animals.

"Across cultures and throughout history, we have used animals for food, clothing products, medical experimentation, and entertainment, and we are often indifferent to their suffering," wrote Matti Wilks (Yale University) and colleagues Lucius Caviola (Harvard University), Guy Kahane (University of Oxford), and APS Fellow Paul Bloom (Yale University). "Our findings suggest that the common view that humans are far more morally important than animals appears late in development and is likely socially acquired."

Wilks and colleagues investigated the development of this cognitive bias, referred to by some philosophers as "speciesism," by confronting adults and children ages 5 to 9 with a moral dilemma. In the hypothetical scenario, two boats are sinking, one containing between one and 100 humans and the other containing between one and 100 pigs or dogs.

In an initial study of 207 children and 222 adults in the United States, participants were asked to decide which boat they would choose to save.

Children's and adults' responses were found to be remarkably different.

When asked to choose between saving one human and one dog, for example, 35% of children prioritized the human, 28% prioritized the dog, and the remaining 37% could not decide. When adults were faced with the same scenario, 85% chose to save the human, with just 8% electing to save the dog, and 7% unable to reach a decision.

In a more extreme scenario, 71% of children chose to save 100 dogs over one human, whereas 61% of adults chose to save one human over 100 dogs.

These findings suggest that we may be culturally conditioned to view humans as morally superior to other animals, similar to how we acquire other social biases, the researchers wrote.

An animal's intelligence and capacity to experience suffering appears to play only a limited role in this bias, the researchers noted. Pigs and dogs, for example, possess roughly comparable intelligence, but many people in Western societies consider one a food animal and the other a beloved companion. Wilks and colleagues found American children and adults with regular exposure to dogs to have less bias for humans over "man's best friend"—but only the children with regular dog exposure reported less bias for humans over pigs.

"The hypothesis that speciesism is at least partly a socially acquired ideology could also explain why there are different cultural manifestations of speciesism; for example, in certain cultures, people eat dogs, whereas other cultures consider cows holy," the researchers said.

See the full article with reference list at psychologicalscience.org/observer/children-prioritize-animals.

APS COVID-19 Resources

A collection of psychological science research and insights from the APS community.

psychologicalscience.org/covid-19

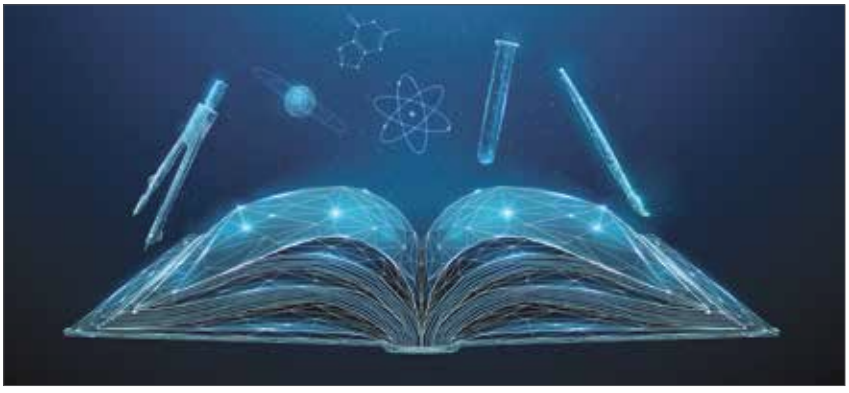
APS MEMBERS NAMED TO NASEM COMMITTEE EXAMINING BEHAVIORAL ONTOLOGIES

APS members and other psychological scientists will conduct a National Academies of Sciences, Engineering, and Medicine (NASEM) study to explore the development of behavioral ontologies that can help spur new research.

In cosponsorship with APS, NASEM is initiating a consensus study on developing a shared ontology for behavioral science research. NASEM recently named a slate of 16 individuals who will serve on the committee overseeing the study; eminent psychological scientists are members of the panel.

"We are pleased to see several APS members are members of the study committee," said APS Executive Director Robert Gropp. "This study offers the promise of new tools that can catalyze exciting and important new research. We are eagerly anticipating the committee's findings."

Among the psychological scientists named to the study committee are APS Past President Lisa Feldman Barrett (Northeastern University), Karina Davidson (Columbia University Medical Center), and APS Fellows Randall W. Engle (Georgia Institute of Technology, also an elected member of the National Academy of Sciences), Catherine Hartley (New York University), Carla Sharp (University of Houston), and Timothy J. Strauman (Duke University), among other experts from the areas of health, biomedicine, information science, and more.



"The goal of this study is to define the scope of ontology development for behavioral science research (BSR), summarize the state of behavioral ontology development and use in BSR, and identify compelling use cases as well as approaches, gaps and challenges that need to be addressed in order to facilitate widespread ontology use in BSR," according to NASEM's announcement.

This project is organized by NASEM's Board on Behavioral, Cognitive, and Sensory Sciences. APS is a sponsor, along with U.S. funders of scientific research and other groups.

APS will keep members apprised on the activities of this committee as it begins its work. Although NASEM is based in the United States, there will be opportunities for psychological scientists and others around the world to contribute to this ongoing work.

Learn more about NASEM's study, "Accelerating Behavioral Science Through Ontology Development and Use," at nationalacademies.org/our-work/accelerating-social-and-behavioral-science-through-ontology-development-and-use.

ICYMI: European Parliament Approves 7-Year EU Budget

In December, the European Parliament approved a 7-year EU budget that will provide funds through 2027.

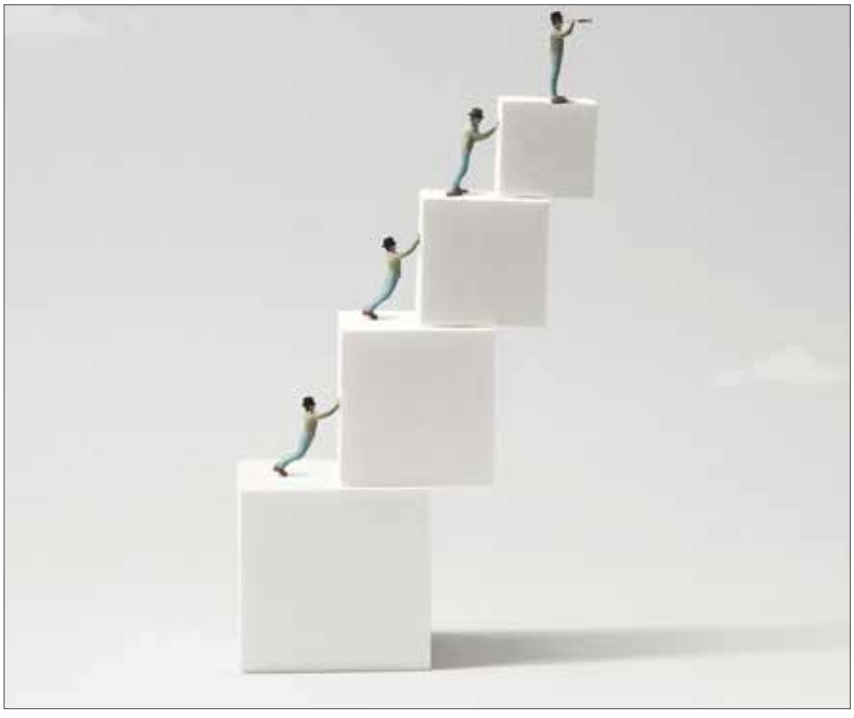
The importance of this budget passage is underscored by the need for a strong recovery during and after the pandemic, as well as Europe's continued success and prosperity.

The budget includes €95.5 billion in funding for Horizon Europe, the next EU research funding program, and roughly €16 billion in funding for the European Research Council (ERC).

Find more information about the EU budget, the ERC, and ERC-funded psychological science at psychologicalscience.org/tag/european-research-council-erc.

MAKING SECONDARY DATA A PRIORITY

By Heather Kappes



At last count, the Office of Evalution Sciences estimates there to be more than 200 teams worldwide working on applying behavioral insights to improve government services. More and more psychologists are likely to join these teams in the coming months and years. Although PhD students and postdocs don't have to look farther than their nearest advisor or instructor to find examples of an academic career, they may have a harder time getting a feel for what it would be like to work with a government team.

The end of January 2021 finds me approaching the midpoint of my fellowship with the Office of Evaluation Sciences (OES). In many ways, the time has flown by; it has me realizing how short a year can be and hoping that some of the projects we're talking about now will make real progress before I rotate off the team. Many former fellows stay involved with OES as academic affiliates, working part-time on specific projects—and I hope I will, too. But still, I'd love to see at least one of these fledgling ideas become something concrete that I'll be free to talk about when I'm back to teaching and university life. (Most government work stays under wraps until it's complete.)

One element of OES work that's somewhat unique is that the office only uses administrative data that's already being collected by government agencies. Other behavioral insights teams sometimes use this kind of data, but they also conduct surveys or online experiments to measure new outcomes. At OES, one of the building blocks to deciding if a project is a good fit is whether there are administrative data capturing the outcome of interest.

The government collects a lot of data, so usually something relevant to a particular research question exists; it might be physicians' vaccination rates, the number of tax credits that filers claim, or energy use in public housing units. But just because the data exist doesn't mean they're easy to get ahold of, even for another government entity like OES. I've been learning about the world of data-sharing agreements. If you're curious about these agreements, you might enjoy the relevant chapter from a new handbook from the Abdul Latif Jameel Poverty Action Lab. As the author explains, negotiating the boundaries of who can receive what and under which restrictions they can use it can be a months-long process. That's quite a change if you're used to Mechanical Turk data that arrive an hour after you post your study.

One thing I like about using administrative data is that you can be pretty sure that the outcome is something that policymakers care about, since they're bothering to measure it. What's less convenient is that this kind of data usually doesn't give much insight into the psychological mechanisms that underpin an effect. We can see that someone clicks a box or submits a form, but we don't know what they're thinking or feeling while they do it. Just another reason why—from my perspective—lab and online experiments, and even qualitative data,

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are a necessary complement to big field experiments with administrative data.

To come back to the "time flies" theme, OES recently concluded recruiting for the 2021–2022 set of fellows. Sharing the advert on psychology listservs and with psychology contacts made me think about things that psychologists could do to prepare for this type of role. One of those things is gaining comfort analyzing secondary data. That doesn't have to mean negotiating a data-sharing agreement. There are lots of large survey-response data sets (the World Values Survey, for instance) that are publicly available. Some people in our field specialize in working with this type of data; the challenges include finding proxy measures (it's rare that a survey question was asked exactly the way you would have asked it) and cleaning and managing large data sets. If I were advising my grad-school self, I'd tell her to get experience doing this. (Oh, and APS has a useful resource for ideas about that!)

Learn more about OES in "Federal Agents of Change: Behavioral Insights Power Evidence-Based Efforts to Improve Government" (psychologicalscience.org/oes-webinar).

UK ECONOMIC AND SOCIAL RESEARCH COUNCIL RESEARCH GRANT

Cognitive scientist Jennifer Culbertson, director of the Centre for Language Evolution at the University of Edinburgh, shares insights on this grant opportunity.

External grant funding can provide an essential source of support to psychological science, helping researchers to tackle bigger questions, recruit more participants, purchase key infrastructure, facilitate student training, and more. In APS's "Inside Grants" column, you'll hear about the emerging research these grants are supporting.

The Economic and Social Research Council (ESRC) is one of the seven research councils, along with Innovate UK and Research England, that make up UK Research and Innovation, a nondepartmental public organization funded by the UK government. With a budget of more than £202 million, ESRC is the United Kingdom's largest funder of social, behavioral, and economic research.

A core grant mechanism offered by ESRC is the research grant, which supports research projects, large-scale surveys, and methodological developments. Proposed projects can draw from the wider sciences, but the social sciences—defined by ESRC as disciplines that study society and the manner in which people behave and influence the world—must represent at least 50% of the research focus and effort.

Grant Information

- Country: United Kingdom
- Organization: UK Research and Innovation
- Council: Economic and Social Research Council
- Grant Mechanism: Research grant
- Amount: £405,256

Jennifer Culbertson, the director of the Centre for Language Evolution at the University of Edinburgh, received a research grant from ESRC in 2017 for the project "Connecting Cognitive Biases and Typological Universals in Syntax" (gtr.ukri.org/projects?ref=ES/N018389/1). APS spoke with Culbertson regarding her research, her grant, and more.

Jennifer Culbertson

What research are you currently conducting?

My research uses experimental methods, mainly from developmental psychology, to study how humans learn language. I'm particularly interested in understanding the relationship between human learning and commonalities we see across languages. For example, my ESRC grant grew out of work I did showing that learners consistently infer particular word-order rules in an artificial language, even if they are not explicitly taught those rules. These same rules crop up again and again across languages, and this work suggests that something about how humans learn shapes them. This finding was limited, however, in that it targeted only English-speaking learners. The grant aims to extend it to a diverse set of populations, including a non-WEIRD (Western, educated, industrialized, rich, democratic) population in rural Kenya. We're really excited about what this population can tell us about universal preferences across learners, but the data collection process is very tricky and has been delayed by COVID-19, unfortunately.

Talk about how psychological science informs your research process. How has ESRC funding helped support this aspect of your research?

I was trained as a cognitive scientist, so from the beginning of my research career I've always been interested in pursuing interdisciplinary questions and using a multidisciplinary toolbox of methods. It's important to me that my research be framed in broad terms as addressing questions about the psychological underpinnings of human language. But beyond that, I draw inspiration from psychology in the set of methods I use to tackle these questions. My ESRC grant, for example, has as one of its overarching goals to generate new sources of evidence for linguistics using tools from psychology. I think psychologists have been really creative in coming up with methods, and linguistics can and should benefit from that. On a more practical note, I've also been

Jennifer Culbertson conducting fieldwork in Kenya with project collaborators David Adger and Patrick Kanampiu. *Photo courtesy of Jennifer Culbertson*

heavily influenced by the open science movement that has grown out of issues with reproducibility in the sciences (including psychology).

How has government funding supported your research efforts?

This grant has allowed me to put together an amazing team to conduct research in three different countries. This would have been impossible without government funding. While the University of Edinburgh offers staff some funds for conducting research, we do not typically get large start-up packages, so grant funding is particularly critical for early-career researchers. The ESRC is one of a relatively short list of funders of basic social science research in the United Kingdom.

Getting others excited about our work is hard but absolutely crucial, and frankly I think it also helps us clarify to ourselves what the most important aspects are.

What was the application process like?

The application process was a long one for me. I first put in the application in the fall of 2015 and didn't start the grant until the beginning of 2017. This included two rounds of evaluation by outside reviewers and a panel and two response letters on my part (somewhat unusual, I think). But I didn't find the paperwork to be all that onerous. The main challenge was to communicate the substance of the grant in a convincing way and stretch myself to consider how to increase the impact of the work beyond academia.

What advice do you have for researchers applying for grants from ESRC?

I would say that the most important thing is to be able to communicate why your research is important to a broad audience. It seems obvious, but we sometimes take for granted that others in our general subject area will know or understand what makes our research questions important. It's not true. Getting others excited about our work is hard but absolutely crucial, and frankly I think it also helps us clarify to ourselves what the most important aspects are. Beyond that, look at the evaluation criteria and make sure you are addressing them all in a way that reviewers and panel members can see clearly. ●

For more about the ESRC research grant, visit ukri.org/opportunity/esrc-research-grant.

Interested in learning more about funding opportunities for psychological scientists? Visit the Funding and Policy page on the APS website at psychologicalscience.org/policy for updates.

Join us for a Meeting of the Minds in May 2021!

The 2021 APS Virtual Convention will combine program components from both the APS Annual Convention and the International Conference on Psychological Science (ICPS) into an interactive online two-day event. Register now for this can't-miss event featuring:

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  - Industry Job Market: Careers in Tech, Non-Profit, and Government
  - Virtual Mentoring: How to Maximize the Experience as a Mentor and Mentee (Horror Stories Included)
  - Three-Minute Thesis Pitch Contest
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- **Virtual Exhibit Hall** – The 2021 APS Virtual Convention will feature exhibitors and sponsors to showcase the latest research tools and trends, publications, and more. Chat with exhibitors in real-time and set up appointments for focused conversations.

Register now for the best rates! Early Registration deadline: April 15

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APS President
University of Michigan, USA

Speakers include:

Hazel Rose Markus
Stanford University, USA

Michael Meaney
The Douglas Research Centre, McGill University, Canada

Robert Sellers
University of Michigan, USA

Fred Kavli Keynote Addresses Presented by:

Credit Nana Kofi Nti

Jennifer L. Eberhardt
APS President Elect
Stanford University, USA

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University of Oxford, UK

Bring the Family Address Presented by:

Dan P. McAdams
Northwestern University, USA

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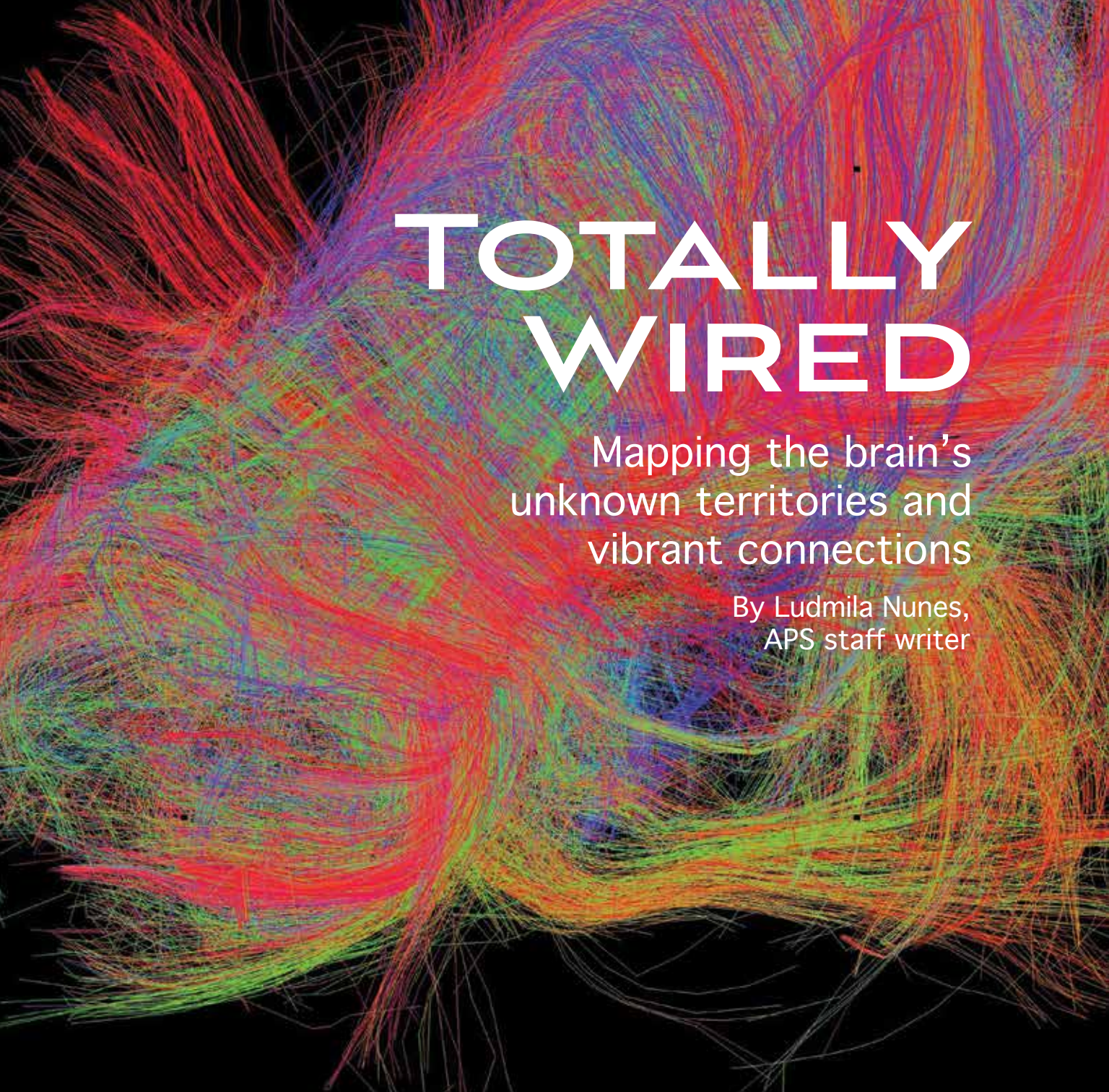


Totally Wired

Mapping the brain's unknown territories and vibrant connections

By Ludmila Nunes,
APS staff writer

"The brain is a world consisting of a number of unexplored continents and great stretches of unknown territory."

—Santiago Ramón y Cajal, winner of the 1906 Nobel Prize in Physiology or Medicine

Image courtesy of the USC Laboratory of Neuro Imaging and Athinoula A. Martinos Center for Biomedical Imaging, Consortium of the Human Connectome Project (humanconnectomeproject.org)

Imagine being able to see our brains as a map. By visualizing connections as the equivalents of highways and sideroads serving large cities or rural areas, we could potentially understand how our neural circuits treat information and guide our behavior—as well as how the nervous system's structure and function are linked. In practical terms, understanding the human brain's connections and pathways might enable researchers to better understand how certain thoughts and behaviors are originated and maintained. Among other applications, this understanding could provide insights about how the brain develops and ages and how certain diseases or disorders, such as Alzheimer's disease and psychosis, are related to specific changes in neural pathways.

There's only one problem. The creation of such a map—dubbed the "connectome" almost simultaneously by Olaf Sporns of Indiana University and Patric Hagmann of Lausanne University Hospital (Switzerland) in a 2005 instance of "multiple discovery"—would require researchers to map every connection between neurons in the brain and the rest of the human nervous system. That challenge led Sporns and other researchers to start a brand-new field of neuroscience. In an interview with the *Observer*, Franco Pestilli, a neuroscientist from the University of Texas at Austin, elaborated on the thinking at the time: "The idea of a network—the concept that we shouldn't be studying only neurons and areas, but also how these areas and these neurons are communicating—resulted in a theoretical shift, a new direction and new needs in neuroscience."

Although researchers have the technology to completely map the nervous systems of organisms with hundreds to thousands of neurons, mapping the connections among the billions of neurons in the human brain is much more difficult. We know the most about the connectomes of tiny animals, such as worms or larvae. The first such successful mapping was in 1986, when John Graham White, a molecular biologist, along with Sidney Brenner and other colleagues from the University of Cambridge, mapped the 7,000 neuronal connections of the *Caenorhabditis elegans,* a 1 mm worm that has only 302 neurons. To create the first complete connectome, they used electronic microscopy, deducing the nervous system of the *C. elegans* from reconstructions of electron micrographs of serial sections.

Despite the challenges of mapping the entire human brain network, researchers all over the world are making remarkable progress. One notable effort toward that end is the Human Connectome Project (HCP)—a massive collaboration, funded by the National Institutes of Health (NIH), that seeks to use neuroimaging to map connectivity in the brain.

Overview of the Human Connectome Project

The HCP is a massive NIH-funded collaboration to use neuroimaging to map connectivity in the brain. Launched in 2009, it relied on diffusion imaging to trace how various regions of the brain are connected in both healthy individuals and people with various neurological disorders and diseases.

Researchers all over the world continue to use HCP data and the procedural protocols created by the HCP. New computational methods are helping them analyze these data and study them in tandem with other data sets (neuroimaging, genetic, clinical, etc.) to gain new insights on the brain.

Find out more at humanconnectomeproject.org.

"The HCP has been a pioneer in the development of algorithms and approaches that map the brain's connections in exquisite visual detail, allowing us not only to see them but to quantify their differences," said HCP Co-Principal Investigator Arthur Toga (director of the Mark and Mary Stevens Neuroimaging and Informatics Institute at the University of Southern California) in an email to the *Observer*. "That's an important requirement in understanding the differences between populations and individuals."

The genome on steroids

The human brain contains more than 100 billion neurons (Braitenberg & Atwood, 1958) and trillions of connections. These connections form functional neural networks that underlie all human behavior and cognition.

Pestilli compares the brain to the Internet. Just as billions of computers are connected to the Internet by cables of one kind or another, the billions of neurons in the brain are connected by the "cables" within white matter. The characteristics of those cables define the speed and quality of communication within any brain.

This micrograph shows *Caenorhabditis elegans*, a transparent nematode (roundwork) about 1 mm in length, with only 302 neurons. The human brain has more than 100 billion.

"Fifty percent of the brain volume is neurons, but the other 50% is not—it is the white matter wrapping the neuronal axons—the cables that connect neurons in different areas," said Pestilli. "But about 80% of neuroscience is about the neurons, and less than 20% of neuroscience is about the cables. The connectome is a lot about these cables and connections."

From an anatomical point of view, the connectome is "the ensemble over all brain neurons of axonal origin, termination, and trajectory relative to other structures," wrote Arthur Toga and colleagues in 2012. "Information concerning connectivity is essential for understanding fundamental cognitive operations, systems-level brain activity, conditional structure-function models of brain, and debilitating brain diseases."

Although "the" human connectome can provide a general map of the human brain, each person's connectome is unique, even among genetically identical individuals (i.e., identical twins). Moreover, in a 2010 TEDGlobal Talk, the neuroscientist Sebastian Seung (Princeton University) highlighted that every person's connectome changes over time; structures of neurons change, new synapses are created and others lost, and synapses become larger or smaller. These changes depend, among other factors, on the person's neural activity (electric and chemical), which in turn depends on their mental experiences, such as perceptions, thoughts, cognitions. Thus, ultimately, a person's experiences can change their connectome. This means that every connectome is different.

In his 2010 TEDGlobal Talk, Sebastian Seung (Princeton University) described the process of mapping the brain's wiring. View it at ted.com/talks/sebastian_seung_i_am_my_connectome.

In fact, the term "connectome" was inspired by the efforts to sequence the human genetic sequence—the genome. Just as the genome is mostly the same across all people but shows individual-level variations conferring differences in appearance and health, the human connectome is very similar across people but has individual-level variations in connectivity, reflecting differences in behavior, cognition, personality, and mental health.

One major difference presents an additional challenge to the completion of the human connectome: It's hundreds of thousands of times larger than the human genome.

What we have mapped

Spanish neuroscientist and artist Santiago Ramón y Cajal (1852–1934) was one of the first researchers interested in mapping the structure of the brain in humans as well as other species, such as birds and cats. At the turn of the 20th century, he developed the first known studies and illustrations of the brain's microscopic structure. These captured the complex nature of neurons and the central nervous system's pathways, connections, and functions.

Other advances followed. Ramón y Cajal received the 1906 Nobel Prize in Physiology or Medicine for research in which he subjected thin slices of brain tissue to a silver-nitrate staining procedure (the Golgi method). This allowed him to visualize the nervous system under light microscopy, similar to the method used to capture images on photographic plates. Using a microscope, he saw that neurons resembled "trees growing" and inferred that, given their form, they must conduct electrical information in only

The Connectome Coordination Facility,

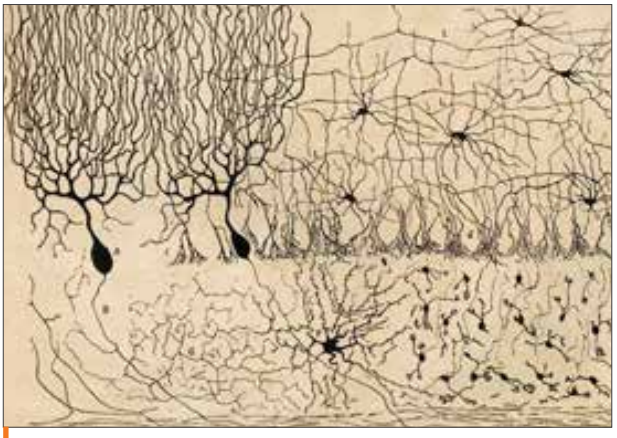
funded in 2015, maintains a central data repository for HCP data and offers advice to the research community. Current CCF studies have three aims:

STUDYING THE HEALTHY YOUNG ADULT BRAIN: These studies support the original data set of 1,200 healthy young adults by distributing image data from multiple imaging modalities, as well as behavioral, demographic, and individual-differences data. The CCF also helps to disseminate HCP-style data acquisition protocols to other studies to maximize comparability among studies.

STUDYING THE BRAIN AS IT RELATES TO GROWTH AND AGING: The CCF supports and disseminates protocols for life span studies aimed at mapping how the brain grows and ages. These include studies with babies (ages 0–5), children (ages 5–21), and adults (ages 36–100); studies on the developing prenatal and neonatal brain; and studies on the adolescent brain and cognitive development.

STUDYING THE BRAIN AS IT RELATES TO DISEASE: These studies apply HCP-style data collection to groups of subjects at risk for or suffering from disorders or diseases affecting the brain. Projects include the study of connectomes relevant to diseases and disorders such as Alzheimer's disease, aging and dementia, brain degeneration, psychosis, anxiety and depression, visual loss and blindness, and epilepsy, among others.

Find out more about the CCF at humanconnectome.org.



A drawing of the cells of the chick cerebellum by Ramón y Cajal (c. 1905), from *Estructura de los centros nerviosos de las aves* (*Structure of the Nerve Centers of Birds*). Source: Wikimedia Commons, Public Domain.

one direction—from the dendrites to the axons. He also concluded that each neuron is connected to other neurons and communicates with other neurons through small gaps—the synapses.

A century later, researchers are still attempting to create a comprehensive map of the complete connectivity structure of the brain. In a 2012 article, Toga and colleagues noted that, for the foreseeable future, a comprehensive description of the complete connectome of even a single human brain might be viewed as unattainable.

In the decades after White and his colleagues mapped the first full connectome of *C. elegans* in 1986, other researchers computed partial connectomes, including the visual cortex of the macaque (Felleman & Van Essen, 1991), the thalamocortical system in the cat (Scannell et al., 1999), the mouse retina (Briggman et al., 2011) and primary visual cortex (Bock et al., 2011), and the common marmoset's occipital white matter tracts (Kaneko et al., 2020).

As for mapping the neural pathways of the human brain, it was in 2009 that NIH launched the Human Connectome Project and, within it, two major research consortia to map the human brain's connections in high resolution, using complementary approaches to map the brain's wiring. One HCP consortium set out to comprehensively map the brain circuitry of 1,200 healthy adults—twin pairs and their siblings from 300 families—using methods of noninvasive neuroimaging and to provide insights about the organization of brain networks and the genetic and environmental contributions to brain structure and function. The other consortium set out to create a new magnetic resonance scanner optimized for measuring connectome data. This scanner maps the brain's fibrous long-distance connections by tracking the motion of water, which makes different types of tissues detectable so that the white matter in the brain (where the long extensions of neurons reside) can be sharply seen.

In the intervening years, the HCP has yielded a rich data set on the structural and functional connectivity of a large sample of adults. It has also helped to develop improved methods of imaging, data acquisition, analysis, and sharing. As stated on the NIH website, "HCP has produced stunning maps of neural fibers crisscrossing the brain. It has revolutionized the mapping of connections in the human brain, and has laid foundational groundwork for using brain imaging measures of connectivity as an aid in diagnosis of disease."

What we can learn—some examples

Using the technical advances provided by the HCP, researchers are expanding their knowledge of the organ's normal development and aging and assessing disruptions in connectivity that might underlie clinical symptoms. Moreover, they're able to superimpose demographic, genomic, and cognitive/behavioral data on the connectome to permit inferences about genetic and environmental influences on connectedness.

In the area of clinical research, consider the **Alzheimer's Disease Connectome Project**. Coordinated by principal investigators Barbara Bendlin (University of Wisconsin–Madison) and Shi-Jiang Li (Medical College of Wisconsin), its goal is to develop robust technology to accurately stage Alzheimer's disease across its progression in individual subjects. Ultimately, this would contribute to the creation of better tools to evaluate the brain progression of the disease, which affects about 30 million people worldwide and generally progresses for 3 to 9 years after the initial diagnosis, ultimately leading to a complete loss of bodily functioning and death.

Also in the clinical area, the **Human Connectome Project for Early Psychosis**, coordinated by Alan Breier (Indiana University) and five other researchers, aims to acquire high-quality imaging, behavioral, clinical, cognitive, and genetic data on a group of early psychosis patients and make those data available to the research community for future studies. This could contribute to a better understanding of neural network disruptions in psychotic illnesses and inform more targeted treatment interventions in the illnesses' early stages, preventing their progression and even chronicity (brain changes are usually not reversible in psychosis). In 2020, the researchers released initial data from the project, including subjects' structural MRI, resting state fMRI, diffusion MRI, and clinical and behavioral data.

Franco Pestilli and his lab created an online platform—Brainlife.io—that makes it easier to effectively use and share neuroscientific analytical and visualization tools that normally require a lot of expertise to implement. Read more about it on page 62.

Project Closeup: The Lifespan Human Connectome Project in Development (HCP-D)

Coordinated by APS Fellow Deanna Barch (Washington University in St. Louis), HCP-D leverages technological and analytical progress in brain imaging to chart developmental changes in brain connectivity at unprecedented levels of detail. A longitudinal component focuses on the pubertal period (ages 9–17).

Project overview

- Participants are approximately 1,400 healthy 5- to 21-year-olds in four sites around the United States from diverse geographical, ethnic, and socioeconomic backgrounds.
- Brain imaging sessions are acquired using a 3T Siemens Prisma platform and include structural, functional (resting-state and task-based), diffusion, and perfusion imaging.
- Behavioral measures are a battery of cognitive tasks and self-reports. The parents of minor participants also complete a battery of instruments to characterize cognitive and emotional development and environmental variables relevant to development.
- Participants also provide biological samples of blood, saliva, and hair, enabling assays of pubertal hormones, health markers, and banked DNA samples.
- HCP-D will ultimately comprise approximately 1,750 open-access data sets.

Building on the HCP

"We used a range of imaging approaches, including measures of gray matter structure, task-based imaging (measures of emotion, cognitive control, and reward processing), and both structural and functional connectivity," Barch explained. "These methods all built upon the advances of the first Human Connectome Project, but with adaptations for development, including an even stronger focus on controlling movement and being able to address movement."

"There are many projects now looking at brain connectivity in a variety of conditions across the life space (depression, anxiety, psychosis, etc.), and our data help inform typical developmental patterns to which data in these other populations can be compared," she said.

The next challenge

Barch defines the next big challenge for HCP-D as developing "methods to harmonize these data with the data from the original young adult Human Connectome Project, since the scanners changed and the initial HCP used slightly different protocols. In general, this will be the challenge for all of the [HCP] projects—how to integrate the data across different populations and platforms to develop a really integrated picture of brain development across the life span."

"We are going to focus on sophisticated analyses of the data, particularly the relationships to puberty, which is really critical to understanding both typical development and conditions that tend to arise as puberty evolves, such as depression or suicidal ideation," Barch said

Wiring in action: Mapping the impact of collision sports

Athletes in many collision sports, especially American football, are exposed to repetitive head impacts that may affect the structure of the brain even if they don't result in diagnosed concussions. Franco Pestilli's lab has performed several studies on these impacts, including investigating whether college football players, cross-country runners, and non-athlete students show differences in their brains' white matter structures, which determine the quality and type of connections between neurons.

In one study, the researchers used an anatomically informed, personalized-medicine tractography approach to determine which major white matter tracts showed the greatest degree of difference in tensor measures among these three student populations (Caron et al., 2018). Results indicated that differences in white matter, especially in longer fiber tracts, were greatest for football players. These findings suggest that head impacts' effects may depend on the geometric properties of white matter tracts and support the hypothesis that multiple head impacts can cause structural changes in white matter that are detectable with diffusion MRI and tractography.

In another study—the first investigation into the effects of repetitive head impacts using open-source data-processing platform Brainlife.io—researchers in Pestilli's lab used two models of the diffusion-weighted MRI signal (Caron et al., 2020). Each model's parameters were mapped in both cortical and subcortical brain structures, as well as in the major white matter tracts. Both models showed that football players had consistently higher measures of microstructure than non-athletes, possibly because of neuroinflammatory mechanisms.

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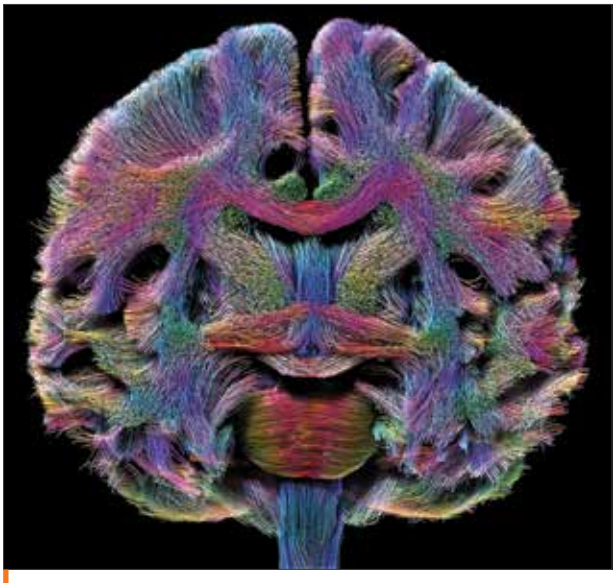

Slice image showing brain connections measured using diffusion tractography. *Photo courtesy of USC Mark and Mary Stevens Neuroimaging and Informatics Institute (ini.usc.edu).*

In the developmental area, the **Lifespan Human Connectome Project in Development** (HCP-D) study aims to advance researchers' knowledge about how typical development and childhood experiences, such as learning to read or interact socially, can shape brain wiring. This project is coordinated by APS Fellow Deanna Barch (Washington University in St. Louis) and eight other principal investigators. COVID-19 has interrupted data collection, but the researchers are "now starting to look at trajectories of brain development from ages 8 to 21 in terms of cortical thickness and white matter, both by themselves and in relationship to cognitive and affective function," said Barch in an email to the *Observer*. The team released their first set of data in 2020, including data from structural MRI, resting-state fMRI, task fMRI, and diffusion MRI for more than 800 subjects.

HCP protocols can also support research aimed at developing understanding of cognitive processes that may be impaired in clinical populations. In a project called **Dual Mechanisms of Cognitive Control**, a team led by APS Fellow Todd Braver (Washington University in St. Louis) focuses on understanding the psychological and neural mechanisms that give rise to cognitive-control processes, which are not only important for domains such as attention, working memory, episodic memory, and decision-making but are also thought to be sources of functional impairment for individuals who suffer from mental or neuropsychiatric disorders. This project is relevant to public health because it can provide information on the brain basis of normal human variation in mental functions such as attention, memory, decision-making, and intelligence. This could improve understanding of

Diffusion tractography image showing arcuate pathways in the brain. *Image courtesy of Jim Stanis and the USC Mark and Mary Stevens Neuroimaging and Informatics Institute (ini.usc.edu).*

the relationship between normal functioning and mental health disorders and the risk factors for such disorders.

Studying brain connections can also tell us which connections are "good" or "bad." Pestilli and his lab have been applying new technologies to understand white matter and advance the neuroanatomical understanding of the brain. White matter—oligodendrocytes—is the matter that wraps axonal projections in the brain, influencing the axons' quality, explained Pestilli. Going back to his Internet metaphor, just as cables can be made of different materials ranging from copper (slow and unreliable) to optical fiber (fast and reliable), white matter can have different structures that make connections between neurons fast or slow, reliable or unreliable.

Pestilli's lab has done computational work to analyze these connections and distinguish "good" and "bad" connections. This type of analysis can also bring clarity to neuroanatomy. For instance, Pestilli and his colleagues identified a connection between the ventral and dorsal streams in the brain (supposedly responsible for "what" and "where" information, respectively, in the visual system). This connection—the vertical occipital fasciculus—is located early in the streams, suggesting that the two streams are highly interactive very early on. Curiously, other researchers suggested this connection many years ago, but it took new technologies to actually prove it. This finding clarifies a structural aspect of the brain, with implications for cognition. Pestilli's lab is currently exploring whether human cognition might have a basis in dorsal-ventral communication.

The future of network neuroscience

"The connectome is perhaps one of the most groundbreaking theories, changes, revolutions in the last 20 to 30 years of neuroscience," said Pestilli. A groundbreaking aspect of the

HCP, in turn, is that it has advanced the field at the level of informatics and through culture changes such as the push for data sharing, he believes.

Other major shifts have occurred in that time. For example, the study of networks in the brain has expanded, and today the rapidly growing field of network neuroscience is "attracting physicists, highly computationally skilled trainees, and experts in the field of neuroscience," Pestilli said. There is also the ongoing push to improve reproducibility by allowing the reuse of data, code, and informatics tools. He credits APS Fellow Russ Poldrack (Stanford University) as a major driver behind this push, noting that the goal is to not only "promote reproducibility but also accelerate discovery by allowing easy reuse of assets."

Perhaps not surprisingly, the combination of a fast-growing interdisciplinary field and the push to make data and tools more shareable and reusable has made neuroscience more complicated. "The complexity of analysis is growing day by day," Pestilli said.

A detailed view of an axial slice from a diffusion-tensor imaging data set. The coloring indicates the principal diffusion direction, with red going left-right, green going anterior-posterior, and blue going inferior-superior. *Image courtesy of the USC Laboratory of Neuro Imaging, Dr. Vishal Patel and Athinoula A. Martinos Center for Biomedical Imaging, Consortium of the Human Connetome Project (humanconnectomeproject.org).*

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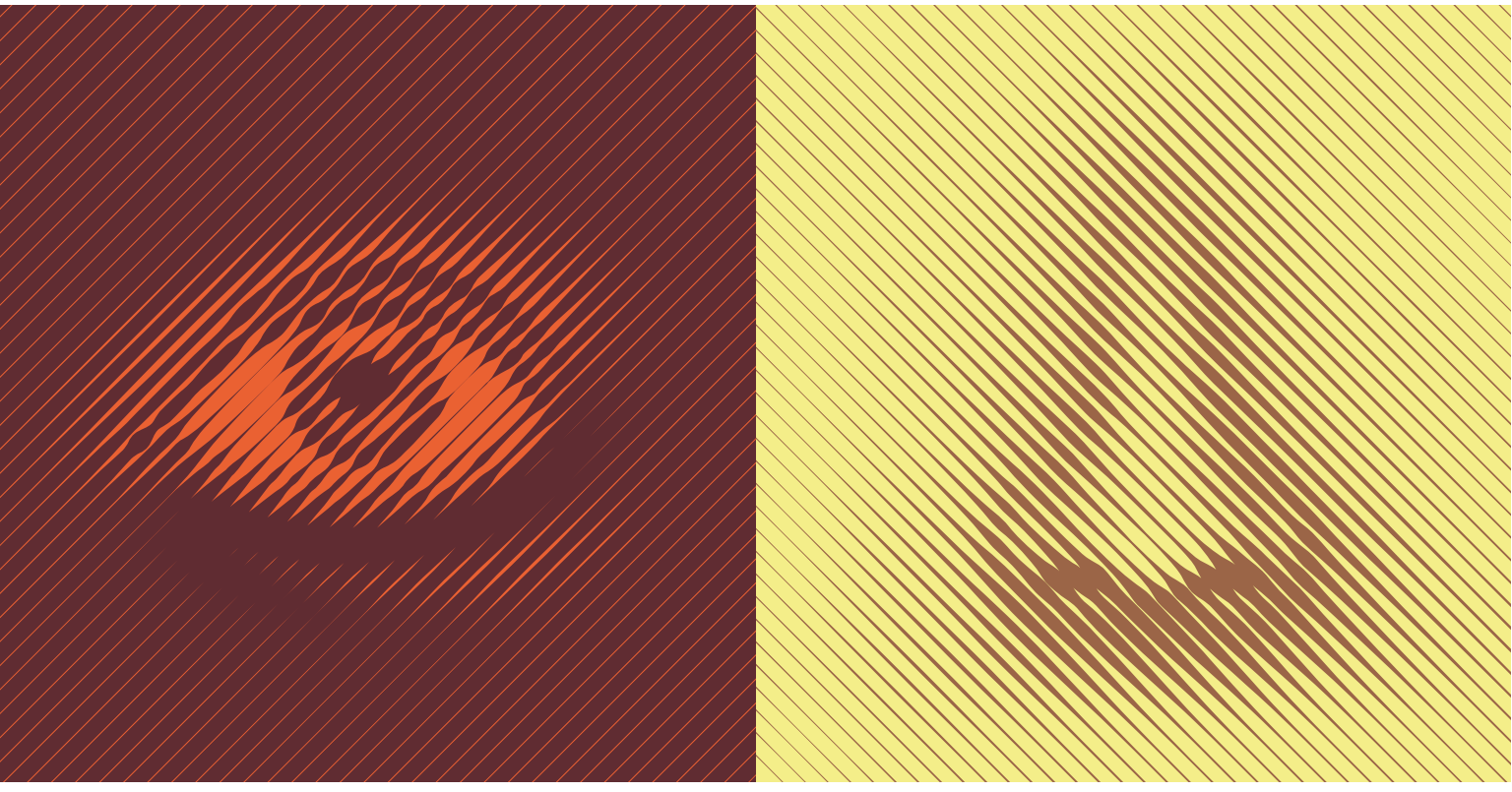


SECRETS OF THE SENSES

Using neuroscience to challenge how we see and hear

By Kim Armstrong, APS staff writer

Congenital amusia, a neurodevelopmental disorder that limits an individual's ability to process subtle distinctions in pitch, is often referred to simply as tone deafness.

"A person with amusia does not hear the difference between a musical melody and a slightly mistuned version of it very well," explained neurolinguist Caicai Zhang of the Hong Kong Polytechnic University. They may also struggle to recognize a familiar tune or, in the case of people with a subtype of amusia known as beat deafness, have difficulty synchronizing with a rhythm.

Referring to these deficits as "deafness" might suggest to a layperson that individuals with amusia are unable to hear certain tones, but the millisecond-to-millisecond analysis made possible by neuroscience tells a different story.

These individuals' ability to receive auditory input appears to be largely intact on a mechanical level, Zhang explained. Instead, her work supports the notion that amusia may arise from the brain's reduced ability to direct conscious attention to distinguishing between similar tones.

That is, amusic brains may be able to receive all of the same pitch information that more musically inclined brains do; they just may not be set up to process it as deeply. In fact, some studies have even found that people with amusia can imitate pitch patterns that they cannot consciously perceive.

"[Amusic brains] can actually track the pitch changes as well as typical listeners who are not paying attention to the pitch stimuli, but these brains become dysfunctional when they have to pay attention to and actively detect the pitch changes," Zhang said of the distinction.

Noting notes

The difference comes down to whether amusia influences conscious or unconscious processes in the brain, Zhang and colleagues Gang Peng, Jing Shao, and William S.-Y. Wang (Hong Kong Polytechnic University and Shenzhen Institute of Advanced Technology, China) wrote in a 2017 *Neuropsychologia* article. This is the kind of split-second distinction that neuroscience is uniquely equipped to address.

"As with any other neurodevelopmental disorder, to fully understand amusia we need to look beyond the behavioral symptoms and probe into the neural substrates," Zhang said. "Given the excellent spatial and temporal resolution of functional fMRI [functional magnetic resonance imaging] and

EEG [electroencephalogram], they are especially suited for understanding 'where' and 'when' the impairment occurs in the brain of people with amusia."

Previous research with speakers of nontonal languages, such as English, has found amusia's tonal deficits to be reflected in reduced activity in these individuals' right inferior frontal gyrus, an area often associated with music processing. But comparatively little work has investigated how amusia manifests in the brains of tonal-language speakers, wrote Zhang and colleagues.

Pitch processing is particularly essential for individuals who speak tonal languages such as Cantonese and Mandarin, Zhang and colleagues explained, in which words are distinguished not only by their pronunciation but by their pitch (high, mid, or low; rising, flat, or falling). The Cantonese word for "doctor," for example, is spoken with a high tone; pronounced the same way and spoken with a low tone, the word becomes "second." Amusia may present differently in the brain for speakers of tonal languages than for speakers of nontonal languages.

Zhang and colleagues investigated pitch processing in their 2017 fMRI study of 22 Cantonese speakers, half of whom had amusia. While the researchers observed them under fMRI, the participants heard a set of three Cantonese words distinguished only by their contrasting tones ("doctor," "meaning," and "second") and a set of three piano notes that matched the pitch of those words.

In response to these linguistic and musical stimuli, participants with typical pitch-processing abilities exhibited activity in the right superior temporal gyrus (an area associated with language processing) and cerebellum (an area associated with habituation to stimuli). Individuals with amusia, on the other hand, did not exhibit such activity. Additionally, the first group of participants exhibited reduced activity in the right middle frontal gyrus (an area associated with reorienting attention) and precuneus (an area associated with episodic memory and self-consciousness) when the stimuli were repeated. By comparison, amusic individuals' activation remained unusually strong, as if they were hearing the words and tones for the first time.

"This seems to suggest a deficit in attending to repeated pitch stimuli, or encoding repeated pitch stimuli into working memory," Zhang and colleagues wrote.

Amusia and attention

In another study, published in *NeuroImage: Clinical* in 2019, Zhang and Shao further investigated how amusia influences attention and memory by studying how Cantonese speakers with and without the condition account for variation in different individuals' speech. This ability, referred to in the context of speech as talker normalization, allows listeners to use the relative differences between tones to recognize the phonemes, or units of sound, that make up a language despite differences in individual speakers' vocal ranges. This ability is particularly important for speakers of tonal languages, but it also allows speakers of any language to, for example, recognize a song when it is played in a different key, Zhang and colleagues explained.

In this study, 48 participants, half with amusia, listened to recordings of single individuals and alternating pairs of speakers reading the same three tonally distinct Cantonese words used in the previous study. Participants were tasked with pressing a button each time they detected a tonal change. During the task, the electrical activity in their brains was monitored by EEG for a period of about 800 milliseconds.

As expected, participants with amusia were less accurate at identifying tonal changes. The pattern of their brain activity, or event-related potentials, in response to the linguistic stimuli also differed noticeably from that of typical listeners. Participants in both groups showed significant activity during the first time range, when listeners are thought to engage in auditory processing. From there, participants with amusia were slower to exhibit their next burst of activity, when listeners are thought to begin directing conscious attention toward novel stimuli, and then exhibited reduced activity during time ranges associated with attentional skills and categorization.

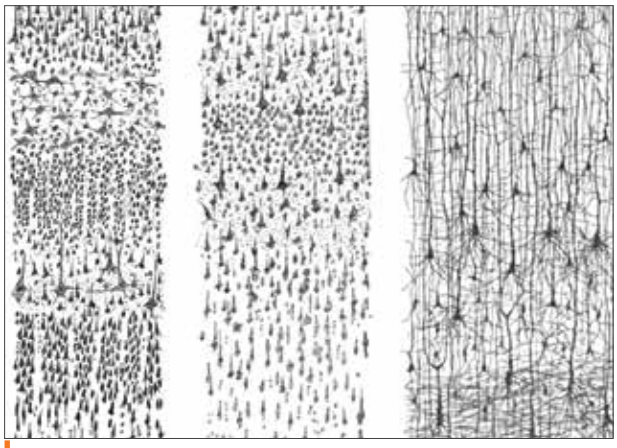
"These findings are largely consistent with the hypothesis that amusics are relatively intact in early auditory processing, and are primarily impaired in later, conscious perceptual evaluation or categorization of pitch stimuli," Zhang and Shao wrote.

Feedback, feedforward

Amusia appears to reduce sensitivity to pitch at least in part by hindering the brain's ability to store and recall tones it has experienced before. A typically functioning brain uses information about previous sensory experiences to make moment-to-moment predictions about current experiences in order to process inputs more efficiently.

"The brain does more than adapt to repeated inputs," explained André M. Bastos (Massachusetts Institute of Technology) and colleagues in a 2020 study published in the *Proceedings of the National Academy of Sciences*. "A wide variety of evidence indicates that it makes mental models of the world that actively generate predictions."

This process, known as predictive coding, allows the brain to inhibit the processing of expected stimuli while "feeding forward" stimuli that violate those predictions for further processing. This additional processing of unpredicted stimuli, known as prediction errors, allows the brain to update its mental models. In the 2020 study, Bastos examined the neural mechanisms involved in processing predictions by implanting laminar neural recording probes in the brains of two macaque monkeys that had been trained to perform a simple visual matching task.



Psychologists divide the cerebral cortex into layers based on differences in the density and distribution of neurons, which differ across the brain. Left to right, this illustration by Santiago Ramón y Cajal (*Comparative Study of the Sensory Areas of the Human Cortex, 1899*) depicts an adult visual cortex, an adult motor cortex, and the less specialized cortex of a 1½-month-old infant. *Wikimedia Commons*

Laminar neural recording allows researchers to monitor electrical activity at different frequencies in the brain by implanting thin metal probes through the cortex. The probes can then detect the flow of electrical activity within the "microcircuit" formed by the cortex's layers as well as activity coming into the cortex from sensory receptors and in or out of other areas of the brain involved in higher-level processing.

In the case of the visual cortex, Bastos and colleagues explained in a 2015 study published in *Neuron*, neural recording reveals a pattern of activity in which the superficial top layer of the cortex sends "feedforward" sensory information from the eyes in the form of gamma waves (40–90 Hz) to meet a prediction sent from the bottom layers of the cortex using information from higher visual areas of the brain, in the form of alpha/beta waves (8–30 Hz).

In their 2020 study, Bastos and colleagues found that when incoming sensory information did not match a prediction, the discrepancy (or "error") generated more neuronal spiking and high-frequency gamma waves, through which the sensory info was sent for further processing elsewhere in the brain. When stimuli fit with the expected pattern—that is, when the brain's prediction was found to be correct—Bastos and colleagues instead detected more low-frequency alpha/beta waves in the cortex's bottom layers, indicating a top-down process that inhibited the production of gamma waves and, thus, further processing of the stimuli. In this case, the macaque could be said to be "seeing" its prediction, not what was really in front of it.

"When stimuli are predictable, these rhythmic, layer-specific mechanisms prepare and inhibit columns in the sensory cortex that process the predicted stimulus," Bastos and colleagues wrote. "In the absence of these pathway-specific prediction signals, sensory samples receive stronger processing."

This suggests that there are not specialized circuits for computing prediction errors in the brain, the researchers noted. Instead, predictive routing uses the same cortical circuitry regardless of whether a visual input requires additional processing. When a prediction is correct, the alpha/beta waves are able to inhibit further processing because the prediction is routed through the same circuitry that would otherwise have processed unexpected information. Bastos and colleagues refer to this model "predictive routing". The central idea is that the brain optimizes information processing by reducing neural traffic along predictable routes.

"The brain exploits predictability," the researchers explained. "It makes cortical processing more efficient."

The brain is always adjusting the degree to which it relies on prediction and updating its mental model of the world, Bastos said. In a highly familiar environment, predictions are likely sufficient to guide us with only occasional updates from our surroundings. But in more dynamic or new environments, he continued, we need to rely less on predictions and more on bottom-up sensory data, otherwise we risk mistaking an inaccurate model of the world for reality. An overly tight and negative internal model of the world may underlie brain disorders such as depression, for example, Bastos explained. Future research may help uncover whether drugs and other therapies can help people to shift the balance of how their brain relies on predictions and sensory inputs, as well as the extent to which this process can be consciously controlled.

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IBM Q System One is the world's first-ever circuit-based commercial quantum computer, introduced by IBM in January 2019. *Source: IBM.*

QUANTUM LEAP

Quantum computers may bring enormous advances to brain research

By Charles Blue, APS staff writer

"Nature isn't classical, dammit, and if you want to make a simulation of Nature, you'd better make it quantum mechanical, and by golly it's a wonderful problem, because it doesn't look so easy."
—Richard Feynman, "Simulating Physics With Computers"

Though a young and relatively underdeveloped technology, quantum computing may one day transform our understanding of complex natural systems like Earth's climate, the nuclear reactions inside of stars, and human cognition.

Quantum computers achieve unprecedented calculating capabilities by harnessing the bizarre properties of matter on the subatomic scale, where electrons exist as clouds of probability and pairs of entangled particles can interact instantaneously, irrespective of their distance apart.

But how far are we from fully realizing this new class of computers? What are its prospects to advance the study of artificial intelligence? And, when, if ever, will psychological scientists be able to write programs that unlock some of the secrets of human cognition?

For now, a daunting list of technological innovations stand in the way of answering these questions. We can, however, take a glimpse at the current frontier of quantum computing and consider the technological gaps that remain.

Science fiction to technological fact

From the Earth-orbiting satellites first proposed by Arthur C. Clarke to the remote-controlled mechanical arms envisioned by Robert Heinlein, science fiction has often presaged technological innovations.

A lesser known but equally influential example of speculative science fiction appeared in "When Harlie Was One," written by David Gerrold and published in the early 1970s. Harlie (short for Human Analog Replication, Lethetic Intelligence Engine) was a newly created computer endowed with artificial intelligence that struggled with the same emotional and psychological dilemmas that many human adolescents face. To help guide it to adulthood, Harlie had the support of a psychologist named David Auberson, who tried to understand its immature yet phenomenally analytical mind.

This story about the intersection between human psychology and computer technology explored both the promise of artificial intelligence and the fundamental inability of biological and electronic brains to understand each other's motivations and mental states.

Though we are likely centuries away from this kind of self-aware artificial intelligence, modern computers already apply so-called fuzzy logic (computing based on variables, not just zeros and ones) to solve a wide array of problems. They also use artificial intelligence algorithms to guide autonomous vehicles and neural networks to crudely mimic certain aspects of human cognition.

The challenge of comparing brains and computers

If you are looking for the most powerful graphics processing unit on the market today, you will find devices that contain about 54 billion transistors. Going a step further, if you had access to a supercomputer, you would have the power of 2.5 trillion transistors. These ginormous numbers, however, still pale in comparison to the biological wiring of the human brain, which contains, by one calculation, upwards of one thousand trillion (10^{15}) synapses (AI Impacts, n.d.). This illustrates that for all our advances in computer hardware, we are still many orders of magnitude away from engineering the raw calculating power of the human brain.

In a special supplement to *Nature*, "The Four Biggest Challenges in Brain Simulation," science writer Simon Makin explored this vast divide by outlining four hurdles to quantum modeling of the brain: scale, complexity, speed, and integration.

Researchers have taken some early steps toward bridging the differences in scale between synapses in the human brain and transistors in a classical computer by creating scaled down models of the brain. According to Makin, the most detailed simulation incorporating biophysical models was that of a partial rat brain, with 31,000 neurons connected by 36 million synapses.

Beyond the limitations of scale, there is a vast difference in complexity between the operations of classical computers and cognition in the human brain on the molecular level. Though research teams are creating databases of brain-cell types across species to study brain function on the cellular level, there are limits to the data researchers can collect, given that some data on the human brain cannot be gathered noninvasively.

In comparing brains to computers, Makin also noted that speed means more than the raw processing power of a computer chip. Computer analogs also must also take into account the amount of time it takes a brain to develop and learn new skills. To overcome this temporal difference, computers would have to run faster than real time, which is not yet possible for complex simulations.

Finally, Makin addressed what he calls the integration problem. A top-down approach in which partial models of brain regions are combined into a brain-wide network needs to be combined with a bottom-up approach using simulations based on biophysical models. In the end, he noted that some aspects of mind "such as understanding, agency, and consciousness, might never be captured" by a computer model of the brain.

Bridging the divide between quantum computing

A quantum computer operates by controlling the behavior of fundamental subatomic particles like photons and electrons. But unlike larger agglomerations of matter—atoms, molecules, or people—subatomic particles are notoriously unruly. This is both a blessing and a curse when using them to make computations.

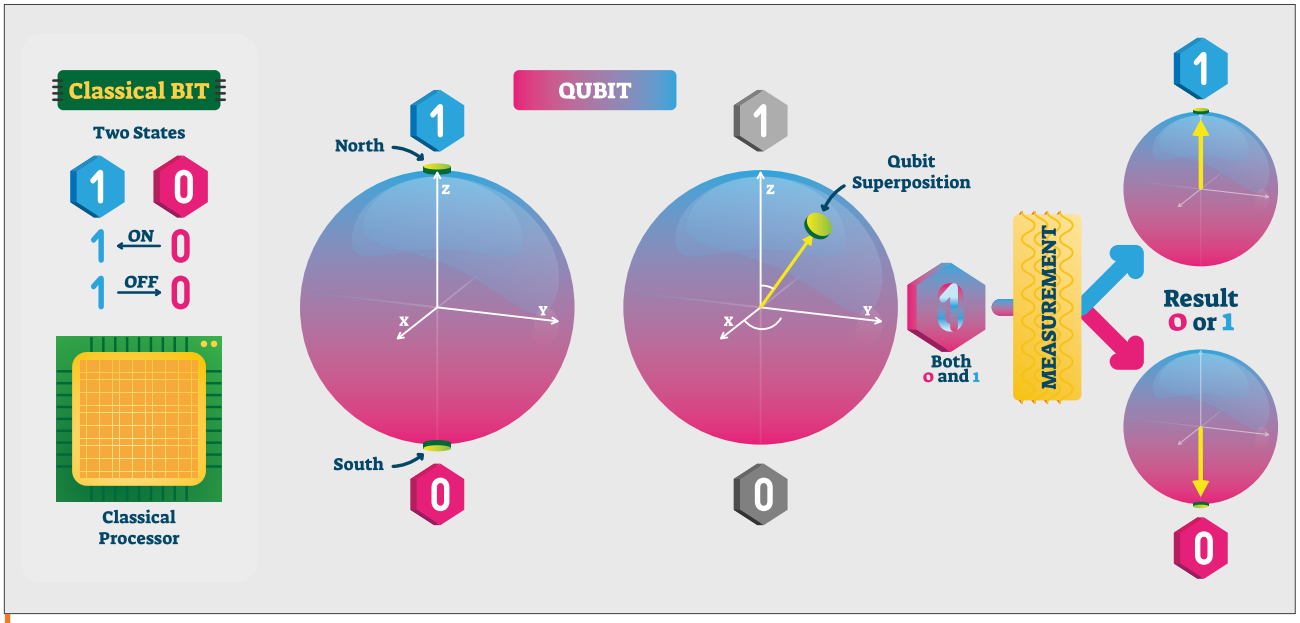
It is a blessing because it enables quantum computers to perform specific tasks at almost unimaginable speeds. For example, today's basic quantum processors can manipulate vast amounts of incomplete or "fuzzy" data, making them ideal for factoring large numbers, which is a key step along the path to secure quantum cryptography.

It is a curse because the more powerful the quantum computer, the harder it is to control, program, and operate.

The fundamental difference between a classical computer and a quantum computer boils down to how they manipulate "bits," or single pieces of data. For a classical computer, bits are just vast streams of zeros and ones, the binary code of machine language.

A quantum bit, however, is not so rigid. It can be a zero, a one, or an infinite range of possibilities in between. This is the quantum property known as superposition, made famous by Schrödinger's thought experiment that rendered an unobserved cat both alive and dead at the same time.

The fluid nature of quantum bits, or qubits, as they are known, means they can be manipulated in ways that classical bits cannot. This is essential because simulating nature with classical computers is technically difficult from both a hardware and a software perspective, as you must account for all possible variables. Quantum computers, with their greater degrees of freedom, do not need to rely on such programming brute force; they simply mimic the system.



In classical computing, bits can exist in only one of two states, either a 1 or a 0. In quantum computing, a quantum bit (qubit) can be a 0, 1, or any combination of the two in a state called superposition. The qubit can then be used to perform calculations, like factoring very large numbers. Once the qubit is measured, however, it instantly collapses back into either a 0 or a 1, giving computer operators the data they need.

That's not to say brute force isn't necessary with quantum computers. It just comes at the front end.

To get fundamental particles to use their quantum properties, researchers must first cool them to just a fraction of a degree above absolute zero. (IBM's Q System One quantum computer uses layer upon layer of refrigeration to reach such extreme temperatures. The cascading design has been dubbed "the Chandelier.")

Next, engineers use magnetic fields to fix the qubits in their proper state and microwave pulses to either flip the state of each bit to zero or one or put it in superposition. Multiple pulses can also entangle two qubits, making them intrinsically bound.

But the challenges don't stop there. Quantum researchers also need to find a way to program the system with sophisticated algorithms, keep the quantum state stable so it doesn't lose information, and add sufficient qubits to mimic the system being studied, including neural networks.

"Quantum neural networks have been explored to some degree, and while this is promising, a big challenge is to get classical data into a quantum computer," said Michael Hartmann, a professor of theoretical physics at the University of Erlangen–Nuremberg in Germany. "That is, quantum computers can handle a huge amount of data—an amount that grows exponentially with the number of qubits. Hence one would think they are ideal for machine learning. Yet, to make use of the great capacities of quantum computers, you need to offer them the data as a quantum state. It is a huge effort to store such a large amount of classical data—and classical is the format of the data we have—into a quantum state."

Also, unlike in classical computing, where it's possible to simply add more bits to solve a problem, the hardware in quantum computing is not yet reliable enough to simply scale up. The more qubits you add, the more computing power you get, but you also introduce an increased chance of error into the system, among other structural problems.

"Hence, while better hardware is obviously needed in quantum computing and will remain a main goal for the next decade or more, there is also a need for concepts on how to best use 'quantumness' to model decision-making cognition," said Hartmann. "My own judgment is that this is a very intriguing direction to explore, but we are really only at the very beginning."

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See article with complete reference list online.

CAPSTONE OF A QUEST

A collaborative initiative, years in the making, brings EEG/ERP curricula and training online to the undergraduate masses

By Leah Thayer, APS staff writer

Last fall, college students and faculty in 33 countries leapfrogged generations of their peers and predecessors by going online to download animations, interactive simulations, video tutorials, and other classroom materials on cognitive electrophysiology. Through a collaborative initiative called PURSUE, these users became early adopters of a project intended to democratize and accelerate training in the fast-growing field of electroencephalography (EEG), a cognitive electrophysiology method that allows researchers to directly measure event-related potentials (ERPs) and other brain activity using an electrode cap. The results could lead to new and better applications of these techniques, which have been used for decades, to understand human behavior and create brain-computer interfaces.

PURSUE stands for Preparing Undergraduates for Research in STEM Using Electrophysiology. The project began with a $4,200 grant from the APS Fund for Teaching and Public Understanding of Psychological Science in 2014 and has since received two awards totaling $2.6 million from the National Science Foundation.

Launched with introductory materials last August, the PURSUE website (pursueerp.com) has both learning and teaching sections and offers a range of resources by request. These include animations, simulations, and videos that clarify key concepts, along with sample syllabi, slides, curated readings, data processing labs, sample ERP data, and more. Faculty are free to adapt the materials as needed. Ongoing work involves developing and testing full-semester

course materials as well as facilitating implementation through faculty training workshops, according to Cindy Bukach, the project's principal director and an associate professor of cognitive neuroscience and the MacEldin Trawick Chair in Psychology at the University of Richmond.

Given that COVID-19 has suspended most in-person electrophysiological data collection and hands-on training, Bukach and her co-principal investigators, Catherine Reed (Claremont McKenna College) and Jane Couperus (Mount Holyoke College), have also enhanced PURSUE with pre-released draft versions of certain materials, creative adaptations of class exercises using online breakout rooms, and practical guidance—such as advising students to use a basic swim cap to complete an online activity on electrode placement and cap configurations.

The widespread use and relatively low cost of collecting EEG/ERP data makes training in this area particularly valuable, Bukach noted.

Learn more about the APS Fund for Teaching and Public Understanding of Psychological Science at psychologicalscience.org/smallgrants.

"By synchronizing experimental events to the EEG signal (a technique known as event-related potentials/ERP), we can link brain and behavior," Bukach explained. "The millisecond precision of the EEG signal makes this method ideally suited to study the timing and organization of cognitive processes that underlie both conscious and unconscious human behavior, including thoughts, emotions, and actions."

She also outlined the method's practical medical and performance-enhancement applications, such as brain-computer interfaces that bypass muscle movements to control devices such as wheelchairs, prosthetics, and keyboards.

At the same time, there are relatively few training opportunities for electrophysiology, especially at the undergraduate level.

"The majority of undergraduate students get only a cursory introduction to EEG/ERP—perhaps a few slides in a cognitive neuroscience class, or a single lecture devoted to EEG/ERP," Bukach said.

PURSUE Milestones

PURSUE
Preparing Undergraduates for Research in STEM Using Electrophysiology

2011: At the annual UC-Davis/SDSU ERP Boot Camp, APS Fellow Steve Luck (University of California-Davis) suggested securing a grant to help faculty at undergraduate institutions teach electrophysiology. Attendees Cindy Bukach (University of Richmond) and Catherine Reed (Claremont McKenna College) began mulling the idea over.

2014: Bukach, by then on sabbatical, received a grant of $4,200 from the APS Fund for Teaching and Public Understanding of Psychological Science. This enabled her to meet with co-principal investigators Reed, Jane Couperus (then at Hampshire College), and Paul Kieffaber (College of William & Mary) to flesh out an initial modular course design, identify key pedagogical principles, develop a faculty survey, and identify materials that would best enhance undergraduate learning.

2015: A grant application to the National Science Foundation's Improving Undergraduate STEM Education (IUSE) program produced review notes that helped the team clarify the project scope and develop a better assessment plan. They also developed an initial introductory lecture and animation series that they used in their own classes, providing initial assessment data for a second grant application.

2016: The revised IUSE grant application secured an initial NSF IUSE award of $600,000. Over the next 3 years, Bukach, Reed, and Couperus (Kieffaber was unable to continue by this time) developed resources, including an introductory set of modules, a database of 300 participants based on six "core experiments" developed by Steve Luck and Emily Kappenman (San Diego State University), and a "learning community" of faculty from six other institutions who attended summer workshops and helped develop and test the teaching materials.

2020: The team received an NSF Level 2 award of almost $2 million to assess and refine or revise materials for the full-semester course, support the adaptation and implementation of the full-semester course with a series of implementer workshops, improve and update the PURSUE website, and disseminate the full-semester materials. In August, final versions of the introductory materials launched at pursueerp.com.

Benefits of Collaborative Course-Building

"Collaborative course-building results in a rich and creative set of materials, increases inclusivity, spreads the workload, and is incredibly rewarding and motivating," said PURSUE principal director Cindy Bukach. "Moreover, these relationships provide much-needed faculty support, including professional development advice, sharing best practices for remote learning, or just having a group of faculty to share the joys and frustrations of our job."

Bukach also cited the value of including student collaborators in developing course material. "Including the target audience during development helps achieve the correct complexity level and increases student engagement. Students involved in the project reached a deep level of learning as they contemplated the best way to teach others, and they developed a wide variety of skills in a variety of domains, including neuroscience, statistical analysis, video editing, graphic design, and programming."

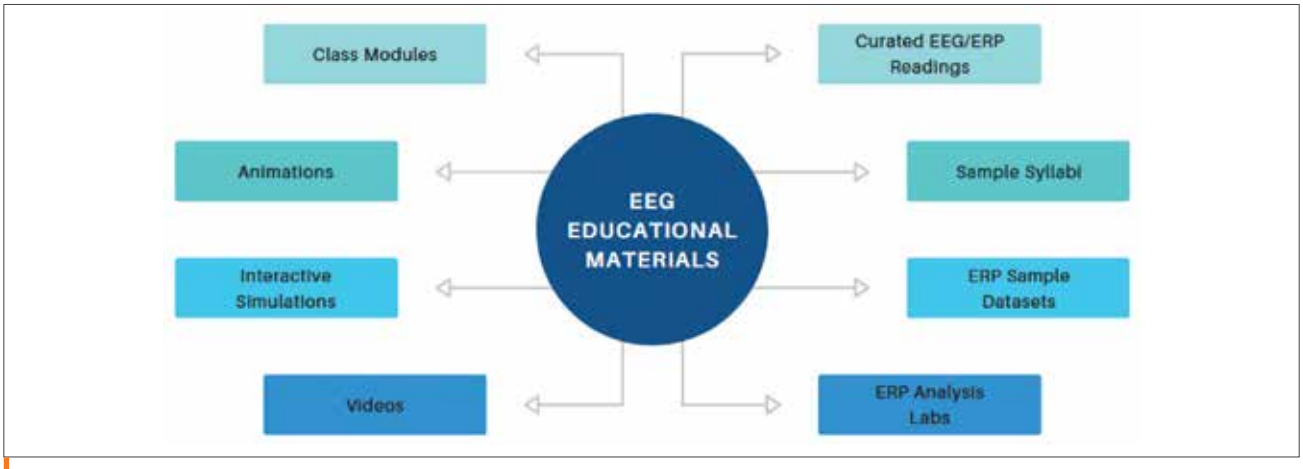
And even if they learn how to cap participants and collect data, most students lack a conceptual understanding of experimental design and the knowledge and skills to help with data analysis, which prevents them from meaningfully contributing to an EEG/ERP design.

"We suspected that the limited training was due to the complexity of existing training materials," she said, adding that 86% of faculty surveyed felt there was a moderate or great need for teaching materials.

In the initial months of PURSUE's rollout, feedback has been positive, Bukach said. Users span the globe, from Algeria to Uruguay, and included nearly 4,300 undergraduate students and 1,200 graduate students during the first semester. In feedback from original participating faculty, 100% judged the materials to be extremely or very useful. Unexpectedly, Bukach added, the materials were also put to use outside undergraduate classrooms, by users in industry, medicine, research institutions, and in at least one online high school class.

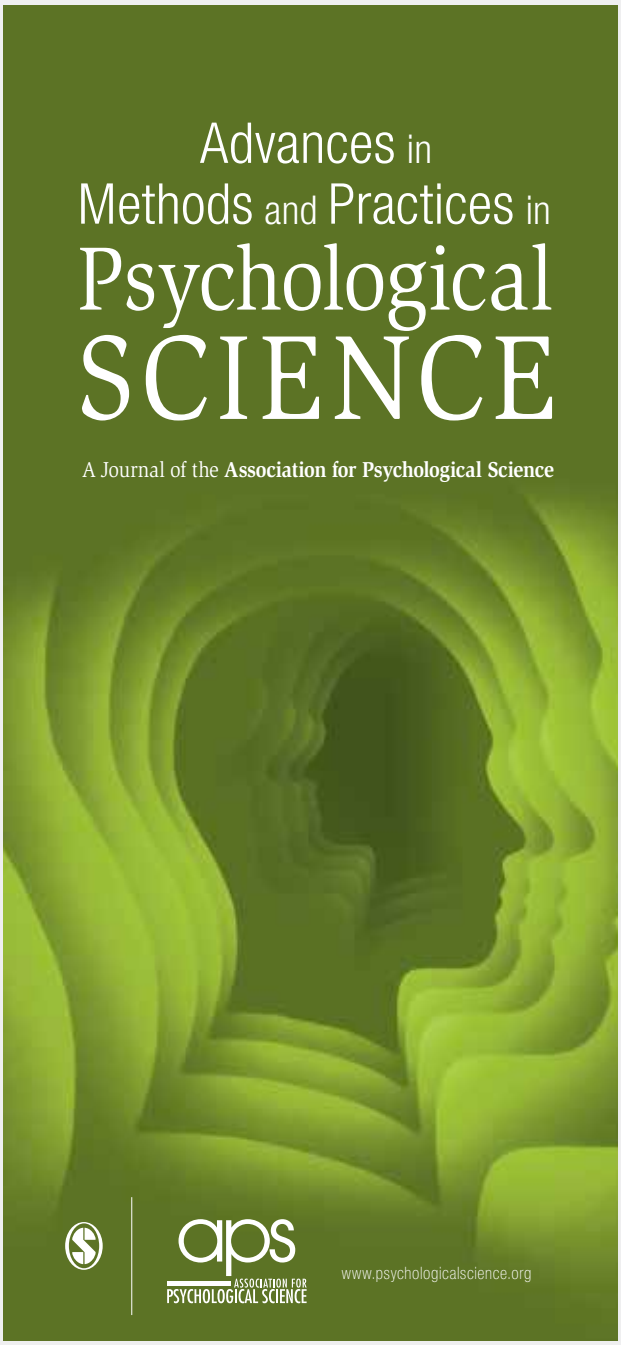
This broad user base will likely expand as new statistical tools are developed for EEG/ERP and new practical applications emerge, Bukach noted. She cited an exciting new advance involving using decoding methods on EEG/ERP data "to gain a more powerful window on neural signal interpretation." She also anticipates a growing influence of neuroscience evidence on policy, law, and marketing and expects the open science movement to lead to more accessible data sets.

"These changes make it all the more important for undergraduates to receive high-quality training in the foundational principles of cognitive electrophysiology," Bukach said.



The PURSUE website (pursueerp.com) has a range of resources available on request, including animations, simulations, videos, sample syllabi, and more. Faculty are free to adapt the materials as needed.

AMPPS is OA



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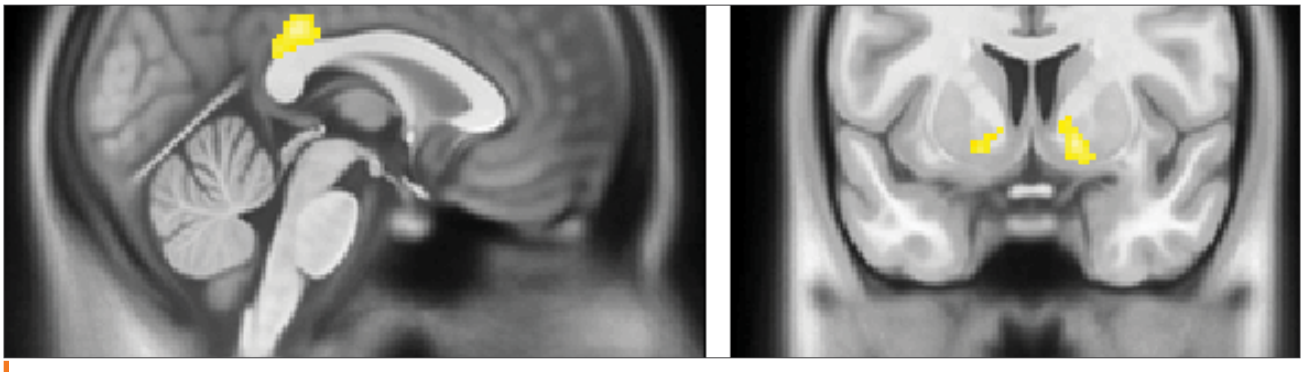
www.psychologicalscience.org/ampps-faq

UP-AND-COMING VOICES: METHODS IN NEUROSCIENCE

Poster presentations offer student and early-career researchers an invaluable opportunity to connect with colleagues and present their work to the broader scientific community. With many such events still taking place online, including the upcoming 2021 APS Virtual Convention, this *Observer* feature provides early-career psychological scientists who participated in the APS Virtual Poster Showcase with another platform to share their research. This edition spotlights a selection of research related to neuroscience.



These fMRI scans, taken by Kelsey Ichikawa and colleagues, show clusters of activity in response to a slot machine task in which participants could win or lose money for members of their political party.

Neural Correlates of Latent Preferences for Out-Group Harm

Kelsey Ichikawa, *William Moore, and Mina Cikara (Harvard University)*

What drew you to this research?

After becoming involved with racial and gender justice organizations in college and experiencing the political polarization that followed the 2016 election, I became interested in studying the mechanisms of intergroup division and harm. At the level of the brain, what networks help predict the spiteful actions one takes toward other groups? And how can we understand those actions as being not just preferred, but rewarding? In addition, there is a lot of great existing scholarship about computational models of cognition, and I was excited to apply that computational modeling approach to intergroup behavior. A reinforcement learning task and model-based fMRI allowed us to make precise quantitative hypotheses about the blood-oxygen-level-dependent (BOLD) signal for benign and spiteful rewards.

What did the research reveal that you didn't already know?

The distinction between these signals is actually quite fine-grained. Our initial null result demonstrated that more nuanced methods like multivoxel pattern analysis and psycho-physiological interactions are needed to differentiate between the neural signatures of these intergroup reward outcomes.

This process also revealed to me some limitations of these social neuroscience designs, as well as opportunities for future directions. I conducted this fMRI study as part of my senior thesis, which was a joint project in neurobiology and philosophy, so alongside scanning participants' brains I was also thinking seriously about the morality of intergroup emotions, like schadenfreude (taking pleasure in another person's misfortune). This interdisciplinary approach highlighted the need to tease apart what exactly the positive reward signal responds to—is it the act of inflicting harm on the out-group, securing a larger gap in resources between groups, or feeling less vulnerable to an out-group threat? When we try to connect findings about neural activity and task-based decisions to complex social emotions like schadenfreude, it's useful to distinguish between

a momentary hedonic reward signal and higher-level pleasure or enjoyment, but reinforcement learning paradigms aren't designed to account for that.

The Effects of Negative Life Events on Diet and Hippocampal Volume in Children and Adolescents

Sydney May Taylor (Fordham University)

What drew you to this research?

I was drawn to this research because I have always had an interest in the ways an individual's choices and life experiences affect the brain in a physical way. Additionally, one of my biggest career aspirations is to earn my PhD in clinical psychology and specialize in the research and rehabilitation of eating disorders. My project combined these career aspirations with my passion for neuroimaging while also identifying a gap in previous literature.

What did the research reveal that you didn't already know?

One of the most interesting findings that my research revealed was that a higher incidence of negative life events is related to higher added sugar intake when controlling for age, sex, income level, and daily caloric intake. There was no relationship between negative life events and saturated fat intake when controlling for daily caloric intake and age. When looking into the ways in which diet effects hippocampal development in children and adolescents, it was fat that showed a significant negative relationship with hippocampal volume, not added sugar. Although I could not run a mediation analysis, the unexpected results of my study were still interesting to me.

Also, while conducting research for my study, I found that there were gender differences when comparing negative life events and added sugar intake, but not when comparing negative life events and saturated fat intake. This specific finding piqued my interest and inspired me to look further into these gender differences in my future research.

Other Featured Research

Anxiety-Related Attention Bias Heterogeneity Is Predicted by Individual Differences in Threat-Safety Discrimination and Cognitive Control: An Event-Related Potential Study

Wai Man Wong, Elizabeth Davis, Sarah Myruski, Tracy A. Dennis-Tiwary (The City University of New York)

Wong and colleagues used ERPs to examine the basis for individual differences in how adults with anxiety bias their attention toward or away from threats. The researchers found that individuals whose cognitive control resources are intact tend to bias their attention away from threats, whereas those without such resources bias attention toward threats.

Amygdala Volume Differences Among Depressed, Maltreated, and Healthy Adolescents

Summer N. Milwood, Marie Gillespie, Akul Sharma (University of California, Irvine), Heather Huszti, Uma Rao (Children's Hospital of Orange County)

Milwood and colleagues used automatic subcortical segmentation to examine differences in the amygdalae

of healthy and clinically depressed adolescents, some of whom had experienced childhood maltreatment. The researchers found that depressed adolescents with a history of maltreatment had smaller amygdalae, which suggests that maltreatment may affect the development of this stress-sensitive brain region and psychopathology.

Alcohol Use Frequency Is Linked to Altered Functional Brain Network Connectivity in Adults With a Family History of Substance Use

Katrina M. Daigle, Abigail B. Waters, Gansler A. David (Suffolk University)

Daigle and colleagues used fMRI data from the Human Connectome Project to examine how alcohol consumption impacts connectivity patterns in core neurocognitive networks. The researchers found that alcohol use may dysregulate these networks in individuals with a family history of alcoholism.

Dopamine Receptor Polymorphism (DRD4 –521 C/T) and Responsivity to Emotional Films and Social Challenge

Matthew T. Ford, T. Lee Gilman, Aaron M. Jasnow, Karin G. Coifman (Kent State University)

Ford and colleagues used DNA sequencing to examine how genetic differences in dopamine reception influence emotional responses to film clips and peer rejection. The researchers found that a C/C genotype may buffer against social loss and rejection.

Virtual Poster Showcase

See award-winning highlights of the 2020 Virtual Poster Showcase in the July/August 2020 *Observer*. The 2021 Virtual Poster Showcase will be open from May 26 through September 1, 2021. Learn more about posters and other aspects of the 2021 APS Virtual Convention at psychologicalscience.org/convention.

THE SECOND BRAIN

Researchers are identifying the mechanisms involved in the brain-gut axis, laying the groundwork for more targeted interventions.

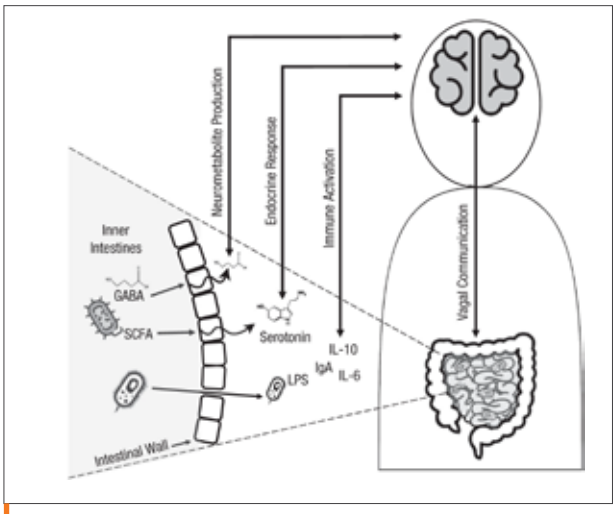
By Leah Thayer, APS staff writer

The plausibility of "gut feelings" may seem inherently incompatible with the data-driven enterprise of psychological science. But a growing body of research on the brain-gut axis suggests that the microbes in our digestive system indeed have a measurable role in our brain function and structure, influencing mood, emotion, and behavior along with other important aspects of our personalities and our mental and physical health.

The gut microbiome is home to the largest collection of microorganisms in the human body. It encompasses the trillions of bacteria, viruses, fungi, and other microorganisms that live inside the gastrointestinal tract, which includes not only the stomach but also the mouth, esophagus, pancreas, liver, gallbladder, small intestine, and colon. After the brain, the gut contains the body's largest number of neurons (Bastiaanssen et al., 2020). In recent years, studies on humans and animals, some using neuroimaging, have added to the evidence for links between the composition of gut microbiomes and brain processes. For example, a lack of certain gut bacteria has been associated with psychiatric disorders ranging from anxiety and depression to attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorders (ASD). Research has also revealed connections between bacteria in the microbiome and personality traits. And introducing certain kinds of bacteria into the body has been shown to alleviate adverse effects of stress and even disease symptoms. A 2018 study, for instance, suggested that a ketogenic diet may prevent seizures associated with epilepsy by increasing the population of certain bacteria (*Akkermansia muciniphila* and *Parabacteroides merdae*) that reduce the amount or the metabolism of amino acids associated with seizure-related activity in the hippocampus (Olson et al., 2018).

How gut bacteria shape brain and behavior

The links between gut bacteria and behavior or individual characteristics cannot be fully understood without understanding how the gut microbiome and the brain communicate. Research has suggested that this communication is bidirectional, with the microbiome influencing the brain as much as the brain influences the microbiome (Smith & Wissel, 2019). The brain-gut axis is a network that appears to facilitate communication among gut microbes, the central nervous system, the peripheral nervous system, and the enteric nervous system (embedded in



Pathways of communication along the gut-brain axis. Among other things, bacteria can secrete neurotransmitters that induce intestinal cells to release molecules that modulate neural signaling within the nervous system. Information is routinely passed between the gut and brain along the vagus nerve. *Source: Smith and Wissel (2019).*

the gastrointestinal tract). It appears that bacteria are able to produce and respond to different neurochemical signals, which travel to and from the brain.

Mauro Costa-Mattioli, a professor of neuroscience at Baylor College of Medicine, studies how gut microbes influence the central nervous system and brain functions. In a talk in January 2021, he proposed that environment and genetics can influence gut microbiota, which communicate with the brain, influencing complex behavior. One communication channel between the gut microbes and the brain appears to be the vagus nerve, which extends from the brain stem through the neck and the thorax down to the abdomen.

In research on ASD in animal models, Costa-Mattioli and colleagues found that treatment with the bacteria *Lactobacillus reuteri*—which reduces social deficits in mice that lacked those bacteria—appeared to work not by replenishing the mice's gut microbiome but by promoting social-interaction-induced synaptic plasticity, which is impaired in ASD, through interactions with the vagus nerve (Sgritta et al., 2019). These findings support the groundbreaking idea that the gut microbiome can influence brain plasticity—and suggest that this type of research could point to novel therapies in human patients. However, the researchers cautioned that "the gut-microbiota-brain axis is an emerging field, and to ensure the success of microbial-based therapies for neurological disorders, we believe that first it would be important to establish a set of defined and objective criteria for transitioning into human clinical trials."

Related content from the *Observer*
Brains and Bacteria (December 2018)
Student Notebook: Listen to Your Gut (September 2020)

Neuroimaging neurogastroenterology

"Neuroimaging is at its most powerful when it can reveal an insight and understanding to a phenomenon that has been either a mystery or not believed due to the subjectivity of response measures," wrote Emeran A. Mayer and colleagues in 2019. One such phenomenon that the researchers examined is irritable bowel syndrome (IBS), a common condition characterized by chronically recurring abdominal pain and altered bowel habits. Patients diagnosed with IBS and other gastrointestinal disorders also experience high rates of anxiety and other psychiatric comorbidities. IBS-related alterations in functional, structural, and anatomical brain networks, Mayer and colleagues wrote, "have provided plausible neurobiological substrates for several information-processing abnormalities reported in patients with IBS." These include biased threat appraisals, or "catastrophizing," and outcome expectancies (related to the salience network); autonomic hyperarousal (related to the emotional arousal and central autonomic networks); and symptom-focused attention (related to the central executive network).

In another 2019 study of patients with IBS, Jennifer S. Labus and colleagues explored whether an abundance of serotonin-modulating bacteria that commonly reside in the intestines of healthy adults is associated with functional connectivity of somatosensory brain regions and GI sensorimotor function. Using several methods, including functional brain imaging (fMRI), they observed disruptions in the interactions among the patients' brain, gut, and gut microbial metabolites. These disruptions, which involve both the cortical and subcortical regions of the brain, "may contribute to visceral hypersensitivity and altered perception of pain" in these patients, the researchers wrote.

Can bacteria sometimes have a beneficial impact on people with IBS? While probiotics—live microorganisms found in yogurt and other fermented foods—had already been shown to reduce the physical symptoms of IBS, research published in 2017 by Maria Ines Pinto-Sanchez and colleagues suggested that they could also reduce depression and improve quality of life for these individuals. In a randomized, double-blind, placebo-controlled study of 44 adults with IBS and mild to moderate anxiety and/or depression, patients who received the probiotic strain *Bifidobacterium longum* NCC3001 were more likely than the placebo group to show a mean increase in quality of life and scored lower on a measure of depression 6 weeks later.

Altered states: Microbes and depression

Looking further at the role of the microbiome in depression, a review by Thomaz Bastiaanssen and colleagues in 2020 explored the interplay between the gut microbiome and

major depressive disorder. "The gut microbiome is a highly dynamic system, undergoing constant change over time," they wrote. "The degree and manner of change is thought to be determined by a vast combination of factors, ranging from stage of life to exercise." They cited research involving the Mediterranean diet, which affects the gut microbiome by increasing the abundance of bacteria with anti-inflammatory properties and has also been found to shorten episodes of depression.

Turning to the influence of the microbiome on stress, Bastiaanssen and colleagues noted animal research pointing to the microbiome's important role during early development. For example, germ-free mice showed an exaggerated stress response that was normalized after their guts were colonized with a probiotic. A 2019 study by Huiying Wang and colleagues applied this concept to humans, showing that probiotic strain *Bifodobacterium longum 1714* (Zenflore) may play a role in managing stress responses in healthy volunteers by modulating their neural processes.

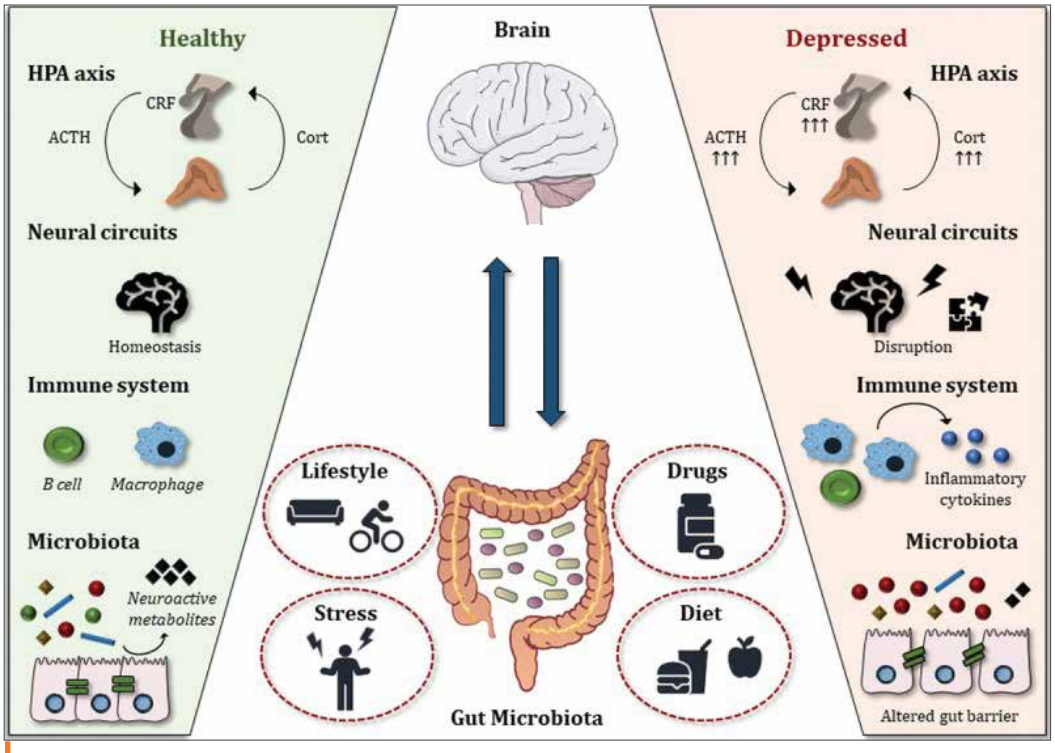
Microbes and personality

Variations in the gut microbiome aren't relevant only to illnesses and disorders. Recent research has also established a connection between the composition and diversity of the gut microbiome and a range of human personality traits.

"People with larger social networks tend to have a more diverse microbiome, suggesting that social interactions may shape the microbial community of the human gut," wrote Oxford University researcher Katerina Johnson in 2020. "In contrast, anxiety and stress are linked to reduced diversity and an altered microbiome composition." She also found that some types of bacteria are differentially abundant in relation to personality traits. "Together, these results add a new dimension to our understanding of personality and reveal that the microbiome–gut–brain axis may also be relevant to behavioral variation in the general population as well as to cases of psychiatric disorders."

Johnson elaborated on her findings in an interview with the *Observer*. Traditionally, most research on the brain-gut axis has been conducted on animals, she noted; in fact, some of her previous research looked at the personalities of birds. But among the human research that had been carried out, "a lot of it was based on autistic patients or people with psychiatric conditions. In contrast, my key interest was to look in the general population to see how variation in the types of bacteria living in the gut may be related to personality."

To explore these questions, Johnson recruited 655 adult participants in 20 countries. Participants ➡



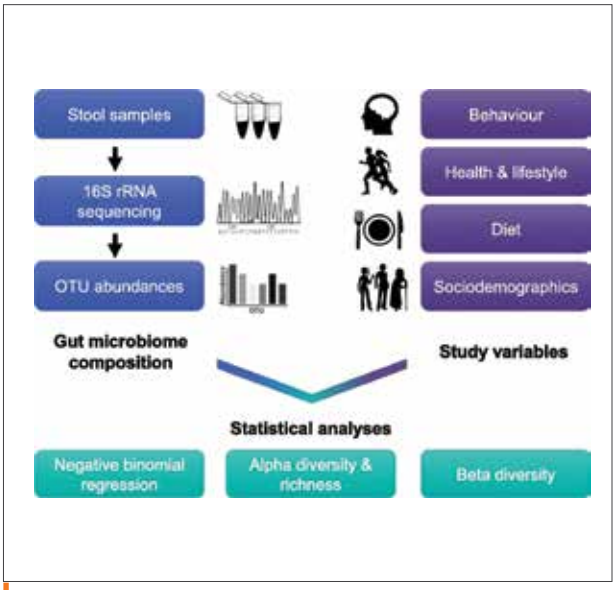
Impact of the gut microbiota on the brain-gut axis in health and depression. Left panel: A stable and balanced gut microbiota is essential for normal brain-gut axis signaling. Right panel: In major depressive disorder, alterations in the gut microbiota negatively affect the brain-gut axis at several levels.
Source: Bastiaanssen et al. (2020).

provided fecal samples, which were analyzed by microbiome-sequencing company uBiome, and completed an online questionnaire that Johnson used to measure 44 variables related to behavioral traits, diet, health, lifestyle, and sociodemographic characteristics. Sociability (a combined measure of extraversion, social skill, and communication) proved a positive predictor for an abundance of beneficial gut bacteria such as *Lactococcus* and a negative predictor for an abundance of *Desulfovibrio* and *Sutterella*.

Johnson's research controlled for a number of other variables that can also affect gut bacteria—and, in turn, its relationship with personality traits. For instance, age and body mass index were common predictors of bacterial abundance. In terms of microbiome diversity, adults who traveled frequently, ate more diverse foods or more foods with naturally occurring probiotics or prebiotics, or were breast-fed as infants tended to have more diverse microbiomes. Women's microbiomes were shown to be less diverse than those of men. Microbiome diversity was also negatively related to unemployment and, perhaps strangely, dog ownership.

"So many factors can influence something as complex as a personality," said Johnson. "The gut microbiome is just another factor."

Freelance writer Alex Michel contributed to the research for this article.



Katerina Johnson conducted a range of statistical analyses to determine the relationships between gut microbiome composition and the study variables, with a primary interest in variables assessing behavioral traits. *Source: Johnson (2020).*

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2021 APS JANET TAYLOR SPENCE AWARDS FOR TRANSFORMATIVE EARLY CAREER CONTRIBUTIONS

Every year since 2010, the APS Janet Taylor Spence Awards for Transformative Early Career Contributions has honored the most creative and promising researchers who embody the future of psychological science. Named for APS's first elected president, the 2021 awards recognize seven psychological scientists for innovative research impacting areas ranging from understanding the mechanisms that can contribute to antisocial behavior to facilitating greater access to evidence-based psychological interventions for common conditions such as depression and anxiety.

Learn more about the Spence Awards, and see past recipients, at psychologicalscience.org/aps-spence-award.

The *Observer* asked recipients to share their proudest achievements and ongoing research. To read their complete responses, including their reflections on the individuals who have most influenced their career paths, and for links to related content cited in the responses, see this article online at psychologicalscience.org/observer/spence-award-2021.

Arielle Baskin-Sommers

Yale University

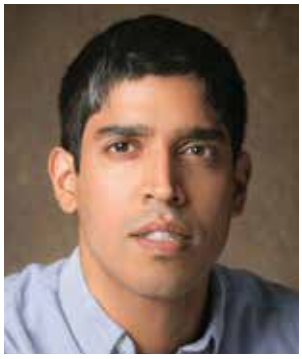
My work focuses on identifying and specifying the cognitive, emotional, and environmental mechanisms that contribute to antisocial behavior (e.g., substance use, criminal activity, aggression). I examine these mechanisms in a wide variety of individuals, including those who suffer from substance use disorders, psychopathy, antisocial personality disorder, and those who chronically engage in risky behavior.

A guiding principle of my research is that focusing on the behavior alone may be misleading and that understanding the underlying mechanisms associated with specific behavioral expressions is needed to precisely conceptualize and intervene in antisocial behavior.

The core of my program of research started in graduate school, maybe even on the first day I stepped foot inside a prison to conduct a life-history interview. As I sat across from a man who was incarcerated for murder, I remember thinking about how some of our early-life experiences and beliefs were quite similar yet led us to take very different paths. Earlier, for as long as I can remember, I spent part of the year traveling across the world and being exposed to different people and their ways of understanding and organizing life. I developed a true fascination with humankind and a desire to understand and help alleviate some of their miseries.

My proudest accomplishments are being able to educate the public about scientific advancements in understanding antisocial behavior and to counter myths that are commonly mentioned in legal settings and in the media. To that end, I have been fortunate to give talks to senior judges in the United Kingdom about bringing a more humane, and scientifically accurate, understanding of psychopathy to the legal system. I have been able to collaborate with the Connecticut Department of Correction and build a lab inside their prisons (the first ever in Connecticut) to conduct research that has informed policies and practices. Finally, my work has been cited in several court cases to highlight the impact of psychobiological mechanisms on how individuals navigate their world and their effects on criminal behavior. I am honored that so many people in our studies have trusted me and my students with their stories and that we are in a position to use that information to help change the way people with antisocial psychopathology interact with the world and are viewed by others.

The next steps in my research seek to examine cognitive-affective mechanisms that shape how people engage with their environments such that they lead to antisocial behavior. Ultimately, I seek to develop a multidisciplinary model of equifinal pathways to antisocial behavior rooted in a systematic understanding of cognitive-affective mechanisms. In this way, basic research can be translated into more effective, targeted interventions that can remediate antisocial behavior.



Sudeep Bhatia

University of Pennsylvania

I use behavioral experiments, large-scale digital data, and computational modeling to study how people think and decide. My aim is to build computational cognitive models that can deliberate over and respond to a large variety of everyday decision problems in a humanlike manner.

As a teenager, I was concerned with philosophical questions about choice, meaning, and morality. Eventually I learned that I was better suited to experimental and computational (rather than philosophical) work on these questions, and I gravitated toward research on the psychology of decision-making.

One accomplishment I am most proud of within this area of research was when I published a sole-authored *Psychological Review* paper as a 4th-year PhD student. Until then I had received little feedback on my work. Although my PhD advisors were supportive of my independent path, there was no one in my department with interest or expertise in cognitive psychology. Having my work accepted in a journal like *Psychological Review* was extremely validating and gave me confidence in my abilities and goals.

I was exposed to two important papers early on in my career. The first was a paper on the cognitive modeling of decision-making by Jerome Busemeyer and colleagues. The second was a paper on how text data can be used to extract semantic representations by Thomas Landauer and colleagues. These papers gave me new theoretical and methodological tools with which to think about human cognition and behavior. Much of my research over the past 10 years has tried to build upon (and integrate) the ideas put forward by these papers.

I am especially interested in modeling high-level cognition, particularly reasoning and problem-solving. There is a rich empirical literature on this topic in psychology, but until now most theories have been qualitative. I would like to develop computational cognitive process models of high-level cognition that can quantitatively predict naturalistic high-level cognition and explain how complex reasoning emerges from simple memory and decision-making mechanisms.

"We have been telling ourselves somewhat oversimplified stories in mental health research for too long." —Eiko Fried

Eiko Fried

Leiden University

The four big questions I have been thinking about are how to best understand, measure, model, and classify mental health problems. My research conceptualizes mental health or illness as emergent properties that arise from complex, dynamic, biopsychosocial systems, rather than as clear-cut categories with simple causes. I hope that understanding these emergent properties as systems will provide ways forward for all four of my research interests.

I focused my dissertation research on problems with depression as a diagnostic category and the importance of moving beyond this simplified dichotomy of healthy versus depressed. Three events in 2013 encouraged me to keep working on this topic. First, the *Diagnostic and Statistical Manual of Mental Disorders-V* (DSM-5) field trials were published, and depression came out with an interrater reliability of only .28, one of the lowest of all studied diagnoses. Second, National Institute of Mental Health (NIMH) director Thomas Insel published a blog post titled "Transforming Diagnoses" stating that NIMH would be "re-orienting its research away from DSM categories," primarily because of a lack of validity. And third, I encountered a prescient body of work from over a century ago criticizing the, as Alfred Hoche wrote in 1912, "frenetic if fruitless activity" of searching for psychiatric disease categories based on the "unassailable belief that even in the field of psychiatry it must be possible to discover clearly defined, pure and uniform forms of illness." I was inspired by the idea of mental disorders as complex properties with fuzzy boundaries, and it energized me toward my current research.

The work we did in the last years led to the funding of a 5-year project by the European Research Council that I am really proud of: building a personalized early warning system for predicting depression in young adults. We will use complex systems theory and statistical network models to try to forecast transitions into depression before they occur. If successful, this project could have a significant impact on our ability to develop and implement more effective personalized prevention programs.

We have been telling ourselves somewhat oversimplified stories in mental health research for too long. I believe that embracing complexity, rather than reifying simple stories, will facilitate a deeper understanding of mental disorders and ultimately lead to improved efficacy of prevention and intervention. I am convinced that such sophistication needs to happen both at the theoretical and statistical level.

Celeste Kidd

University of California, Berkeley

My lab studies the formation of beliefs, starting in infancy and continuing through adulthood. We are especially interested in why two people's responses to the same evidence can differ, and why people sometimes continue to believe things even when presented with evidence that you'd expect should cause them to revise.

Like most people, I've had ample opportunity to observe that people sometimes believe things despite contradictory evidence. I studied to be an investigative reporter before I found science, and that's where I first learned to appreciate that human beliefs don't just come from evidence. Instead, existing beliefs shape people's sampling of the evidence. People who are confident on a point won't be swayed, whatever you present. All of our beliefs represent our best guesses, based on a relatively small subset of all of the theoretically available evidence. My lab has also taken inspiration from recent U.S. politics.

I'm excited about ongoing work by lab members like Louis Martí, Evan Orticio, and Sarah Stolp about heuristics people employ in forming beliefs. Louis's work has shown that people form beliefs on the basis of a surprisingly sparse amount of feedback, and once a belief is established, people resist revision. Evan is investigating social factors that influence belief adoption. And Sarah has complementary work in progress about the impact of modern technologies for sharing information on human beliefs. She also has a cool line of research planned around building computational models to understand attentional allocation and learning as a rational resource-limited process.

The big question we hope to answer is: How can we give people better access to truth in the world? And, relatedly, how can we build technologies that help humans transcend the biases in their belief-formation processes, rather than exploit or reinforce them?

"Someone very important to me lost their life because of the color of their skin. That event shaped my interests before I even knew what my interests were."
—Steven Roberts

Steven Roberts

Stanford University

Broadly, I am interested in identifying and dismantling the cognitive, developmental, and social bases of racism. Specifically, I am interested in (1) the tendency to interpret how a group *is* as how group members *should be*, (2) how concepts of race vary across development and social groups, and (3) how such tendencies and concepts maintain and reinforce systemic racism in the real world (e.g., in the Christian church or in psychological science). Someone very important to me lost their life because of the color of their skin. That event shaped my interests before I even knew what my interests were.

I am most proud of a review paper that integrated classic and contemporary research from the social sciences and humanities to provide a conceptual overview of the psychological basis of racism (Roberts & Rizzo, 2020). The paper is important to me because it put together scholarship from seemingly disconnected disciplines (e.g., cognitive psychology, legal studies, critical race theory) to make clear the vast amount of knowledge that had been accumulated on the topic. In doing so, I hope to have given others (and myself) a concrete map of a concrete problem and how to solve that problem. I am particularly indebted to Michael T. Rizzo, a friend and collaborator, as this paper would not have been possible without him.

Looking ahead, I am very interested in the role of social norms in motivating children and organizations toward anti-racism.

Daisy Singla

University of Toronto

I am interested in scaling up evidence-based psychological interventions for common conditions such as depression and anxiety. We have a good idea of what works, but there will never be enough specialists to address the treatment gap. So, my research interests involve developing and testing solutions—including training nonspecialist providers, or individuals with no formal training or experience—to deliver evidence-based interventions. As ➡

"We rely on a few specialized experts to supervise nonspecialist providers, and this is simply unsustainable."
—Daisy Singla

a clinician scientist, I believe it is our scientific responsibility to facilitate access to these treatments.

One of the recent accomplishments that I am most proud of is launching our Scaling Up Maternal Mental healthcare by Increasing access to Treatment (SUMMIT) trial and sustaining the trial during the pandemic. SUMMIT (thesummittrial.com) is a large, multicenter, non-inferiority trial that asks key questions related to scaling up psychological treatments in Canada and the United States. Funded by the Patient Centered Outcome Research Institute (PCORI), SUMMIT is the largest psychotherapy trial for perinatal populations to date. Because the trial is embedded in real-world contexts, we will be able to answer important questions related to by whom and how psychological interventions can be delivered.

Factors contributing to this success include my brilliant study team, along with a decade of experience in low- and middle-income country contexts. The latter fostered a pragmatic, person-centered perspective that no experience in the West could replace.

Beyond who provides treatment and how it can be delivered, I hope to address other bottlenecks to accessing psychological interventions, including supervision. We rely on a few specialized experts to supervise nonspecialist providers, and this is simply unsustainable. We plan to leverage digital platforms to facilitate peer supervision to overcome this dependency. Separately, I want to target systematic racism by modifying core beliefs about out-group members. As psychological scientists, we have the scientific and clinical tools to tackle these important issues.

Diana Tamir

Princeton University

My research investigates the thoughts and behaviors that allow people to bridge the self and the social world. I draw from a background in social psychology and cognitive neuroscience to gain insight into why and how the self engages with the social world, and who is particularly well equipped to do so. First, I have investigated the proximal social rewards that might explain why people are motivated to engage in social behavior. Second, I have investigated two processes that might explain how people represent and predict others' social behavior: simulation and model-based social cognition. Finally, I have endeavored to understand the limits of simulation and who succeeds at transcending those limits. My work ties together multiple levels of analysis of social cognition—from the basic social rewards that drive people to interact to the cognitive and neural mechanisms that equip us to do so, and to do so successfully.

The social mind is tailored to the problem of predicting other people. Whether in cooperation or competition, successful social interaction requires people to anticipate others' future thoughts, feelings, and actions and prepare their own actions accordingly. Yet despite the importance of social prediction, researchers have only just scratched the surface of the predictive social mind. How do people represent others' invisible mental states and use them to make predictions? To answer this question, my lab has developed a multilayered framework that helps to explain how people predict others' future states and behaviors in two steps. First, it suggests that the mind organizes social knowledge using conceptual "maps" of social stimuli. These maps allow people to easily track other people's current thoughts, feelings, and actions. Second, it suggests that people track distances and trajectories through these maps to make efficient, automatic social predictions. This framework places prediction as the central goal of representing social knowledge.

We're starting to use insights from computational models of memory to explain how the stream of thought flows, as well as study the implications of these dynamics for creativity and psychopathology. I'm also super excited about our new research platform, the Person Project (thepersonproject.org), an integrated website and smartphone application that hosts an extensive battery of social and cognitive studies. We are using this platform to conduct reliable, generalizable, and ecologically valid research by recruiting a large sample of diverse participants that we can follow over time and in real time as they go about their everyday lives.

"Despite the importance of social prediction, researchers have only just scratched the surface of the predictive social mind."
—Diana Tamir

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ILLINOIS

THE UNIVERSITY OF CHICAGO — INSTRUCTIONAL PROFESSOR

The Division of Social Sciences at the University of Chicago invites applications for appointment as Instructional Professor (IP) in the Department of Psychology (psychology.uchicago.edu) and the College. This is a full-time, career-track teaching position. The initial two-year appointment will begin in Academic Year 2021-22 and is renewable with opportunity for promotion.

The IP will annually teach 6 quarter-long undergraduate classes. Assignments may include introductory survey-level classes, including intensive discussion courses in the Social Sciences Core curriculum, and upper level elective seminars in psychology. We are particularly interested in candidates who are qualified to teach a wide range of classes in different areas of psychological science, including undergraduate level statistics. The IP will also participate in co-curricular and service activities that help support the undergraduate teaching mission of the department, including advising undergraduates seeking careers in psychological science. The IP may train and manage teaching assistants. The position includes time and support for professional development.

The position requires a PhD in experimental psychology or a related discipline focusing on basic research questions in psychology; the degree must be in-hand prior to the start date. Teaching experience with undergraduate courses focusing on basic research questions, methods or statistics in psychology is required. The candidate's record must demonstrate potential to design and teach courses to undergraduate students at a selective university.

Applicants must apply online at the University of Chicago's Interfolio website at apply.interfolio.com/81682. Applications are required to include 1) a cover letter, 2) a current curriculum vitae, and 3) a teaching statement. In addition, as optional and if available, teaching evaluations from courses previously taught are strongly preferred, as well as syllabi from prior courses taught. Also, three letters of reference are required to be submitted online. The search committee will begin reviewing applications on January 11, 2021, and will continue to consider new applications until the position is filled or the search is closed.

This position will be part of the Service Employees International Union.

We seek a diverse pool of applicants who wish to join an academic community that places the highest value on rigorous inquiry and encourages diverse perspectives, experiences, groups of individuals, and ideas to inform and stimulate intellectual challenge, engagement, and exchange. The University's Statements on Diversity are at provost.uchicago.edu/statements-diversity.

The University of Chicago is an Affirmative Action/Equal Opportunity/Disabled/Veterans Employer and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender identity, national or ethnic origin, age, status as an individual with a disability, protected veteran status, genetic information, or other protected classes under the law. For additional information please see the University's Notice of Nondiscrimination.

Job seekers in need of a reasonable accommodation to complete the application process should call 773-702-1032 or email equalopportunity@uchicago.edu with their request.

MISSOURI

WASHINGTON UNIVERSITY IN ST. LOUIS — ASSISTANT PROFESSOR

The Department of Psychological & Brain Sciences is seeking candidates for a tenure-track Assistant Professor position to identify an outstanding individual who is using data science or quantitative approaches to address questions central to Psychological Science. All areas of Psychological Science will be considered, but we are especially interested in candidates whose research programs connect to areas of current strength or emerging focus at Washington University, including healthy aging and age-related disorders, cognition, cognitive/affective neuroscience, or diversity science. The individual in this position will conduct research, publish in peer-reviewed journals, advise students, teach psychology or related courses, and participate in department governance and university service. The primary qualifications for this position are demonstrated excellence in empirical research and teaching; a PhD is required in psychology or another directly relevant field. We especially and strongly encourage applications from women and members of minority groups. Diversity and Inclusion are core values at Washington University, and the strong candidate will demonstrate the ability to create inclusive classrooms and environments in which a diverse array of students can learn and thrive.

Send curriculum vitae, reprints, a short statement of research interests and teaching experience, and a statement addressing past and/or potential contributions to diversity through research, teaching, professional activity, and/or service to Interfolio job posting apply.interfolio.com/83694. Also, arrange for three letters of reference to be submitted through our Interfolio site. The Search Committee will begin the formal review process as early as April 15th, 2021, but applications will be accepted until the search is concluded. Washington University in St. Louis is committed to the principles and practices of equal employment opportunity. It is the University's policy to recruit, hire, train, and promote persons in all job titles without regard to race, color, age, religion, sex, sexual orientation, gender identity or expression, national origin, protected veteran status, disability, or genetic information.

Each year Washington University publishes a Safety and Security brochure that details what to do and whom to contact in an emergency. This report also publishes the federally required annual security and fire safety reports, containing campus crime and fire statistics as well as key university policies and procedures. You may access the Safety and Security brochure at police.wustl.edu/clery-reports-logs.

DEBUNKING MISINFORMATION AND CONFRONTING CONSPIRACY THEORIES

By Charles Blue, APS staff writer

Throughout 2021, the *Observer* will feature a special section dedicated to communicating psychological science, why it matters, and what can be done by APS and you, our members, to improve understanding and awareness of psychological research.

From claims about election fraud to warnings about microchips in vaccines, social media sites have been flooded with a tsunami of misinformation and ever-more-outlandish conspiracy theories.

Some of these claims are harmless, like the urban legend that humans use only 10% of their brains. Others are dangerous delusions that can pose major public health risks, like claims that vaccines can cause autism. No matter how often these nonscientific claims are debunked, however, they continue to influence broad sectors of the public.

A recent and ominous example of the staying power of misinformation is the wide-ranging conspiracy theory known as QAnon, which is based, in part, on the belief that former U.S. President Donald Trump is working behind the scenes to combat an evil cabal of pedophiles and deep-state operatives. QAnon was once a fringe group, but an NPR and Ipsos poll found that 17% of Americans believed the group's claim that "a group of Satan-worshiping elites who run a child sex ring are trying to control our politics and media" (Rose, 2020).

The allure of conspiracy theories

What makes these and other nonsensical theories so compelling to otherwise sensible people?

In a 2020 Backgrounder interview, APS Fellow Karen Douglas, a professor of social psychology at the University of Kent in the United Kingdom, explained that "the psychological research to date suggests that people are attracted to conspiracy theories when important psychological needs are unsatisfied." She went on to note that such people are looking for knowledge and clarity about important events. They also need to feel secure and in control of their surroundings and to maintain a positive image of themselves and the groups they belong to.

As renowned skeptic Michael Shermer noted in a 2006 TED Talk about why people believe weird things, "there's a lot of bunk out there." The question is, what can we do about it?

Winning hearts and minds

The first thing to realize is that people do not come to hold illogical beliefs by hearing logical arguments. In a 2010 talk titled *The Goals of Skepticism*, author and astronomer Phil Plait asked his audience whether they'd once held any beliefs they were now skeptical about. He then asked, "How many of you no longer believe in those things and became a skeptic because somebody got in your face, screaming, and called you an idiot?" Responses from the self-identified group of skeptics made it clear that none of them had.

Even when faced with outlandish claims, changing minds cannot begin with taking sides. In a recent interview with the *Observer*, Plait expanded on this idea: The number one mistake people make when countering misinformation is thinking that simply reciting facts will sway them. People love to think that "the facts speak for themselves," but they don't. They need an advocate. And the best way to do that is to frame them in a way the person will be open to.

In the end, facts and data cannot easily change beliefs and ideas that people have a strong emotional connection to, particularly when those beliefs are tied to a group identity. In an article published in *Psychological Science*, Igor Grossmann and his colleagues studied how training can help people deal with social conflicts by embracing characteristics that psychological scientists associate with wisdom, like intellectual humility and open-mindedness. The results showed that the training improved people's responses to social conflict—which supports Plait's observation that a confrontational approach to resolving conflicts can instead entrench opposing views.

Tips for communicating science

Though no one technique can change a deeply held belief, here are some of the tips provided by Hilda Bastian, chief editor of PubMed Health and PubMed Commons, in a *PLOScast* podcast.

- Know the sensitive topics and common misconceptions.
- Point people to resources for further information. Beyond relying on your knowledge of a subject, it is helpful to provide other resources people can access on their own.
- Understand the loaded words and avoid being disrespectful. When someone asks a loaded question, they will judge both the content of your answer and the way it is presented. They may not remember your well-researched answer, but they certainly will remember if you are rude or dismissive.

A FREE CLOUD PLATFORM FOR SECURE NEUROSCIENCE DATA ANALYSIS

Brainlife.io enables the safe sharing of analytical code, neuroimaging data, and computing resources, contributing to the reproducibility of neuroscientific findings.

Good research methods and practices are essential for the advancement of scientific psychology. This department provides tutorials and easy-to-use checklists featuring new as well as tried-and-true research practices, methodological approaches, and statistical solutions.

Brainlife.io is a free and easy-to-use platform that enables researchers to analyze and reuse complex neuroscience data. The platform was developed almost 3 years ago by the Pestilli Lab, then at Indiana University. It emerged from the idea for an online hub where researchers could collaborate using modern technology to reduce human errors in data management, such as mismatched files or accidental changes in statistical procedures, as well as to analyze data and reuse previously published analyses in an efficient way, according to Franco Pestilli, now at the University of Texas at Austin.

With about 1,500 users and counting, Brainlife.io serves the whole world, Pestilli said. And although the platform might not help researchers understand complex analyses, it can help them make fewer mistakes when conducting those analyses. "I can only make a good scientist better by helping them spend more time on their science instead of on managing all the software analyses," he said.

Sharing and reusing

Pestilli is among a growing number of researchers pushing for more structure in how they share assets. Brainlife.io makes it possible to safely share analytical code, neuroimaging data, and computing resources, thus contributing to the reproducibility of neuroscientific findings.

In addition, the platform contributes to new discoveries in already-collected data. "We created this concept of upcycling data by connecting the data with the code used to analyze it into a unified construct that can stay together on the web," Pestilli said.

Other Brainlife.io features:

- More than 400 analysis streams that can be combined with one another
- Tools for the three main modalities on neuroimaging—functional neuroimaging, structural neuroimaging, and diffusion weighted imaging
- A suite of visualization tools for connectomes (i.e., networks), functional maps, and activation
- Access to national supercomputers, private clouds, and institutional high-performance computer systems and the ability to send data and analyses into different computers around the world

"It doesn't just run on your computer. It's on the web, it's a hub, and can administer and coordinate computing on different machines and different centers," Pestilli explained. Moreover, because the platform can compute on private or public computers, researchers can also share their own computing resources.

Another feature of the platform is the use of containerization, a technology that bundles applications together with all of their related files and allows them to run in an efficient way across different computers. Containerization creates "a tiny version of your computer and makes it into a softer image so you can shift the computer around," Pestilli explained. In practice, this makes it easy for researchers to run other researchers' analyses without having to install anything in their computers. "You can just use that tiny version of my computer," he said. "And if I made it work, you can make it work right away."

The future is in the cloud

One of the goals of Brainlife.io is to move people—and their computers—out of their labs and into a common space where ideas, data, analysis, and errors and breakthroughs can be shared openly. Pestilli described the role that the cloud and new technologies might play in the future of scientific research. "Researchers are still a little fearful of getting their data out in the open," he said. "But I think that fear is going to crack because of the need for reproducibility and transparency in psychological science, neuroscience, and other disciplines." Projects like Brainlife.io, he said, "can really provide a

window on the opportunities that can be opened by embracing these new technologies." ●

Brainlife.io: Under the Hood

Projects
Manage data, processing, and results. Share projects privately with collaborators or publicly with the Brainlife.io community.

Apps
Use already-developed apps to manage and analyze neuroscience data.

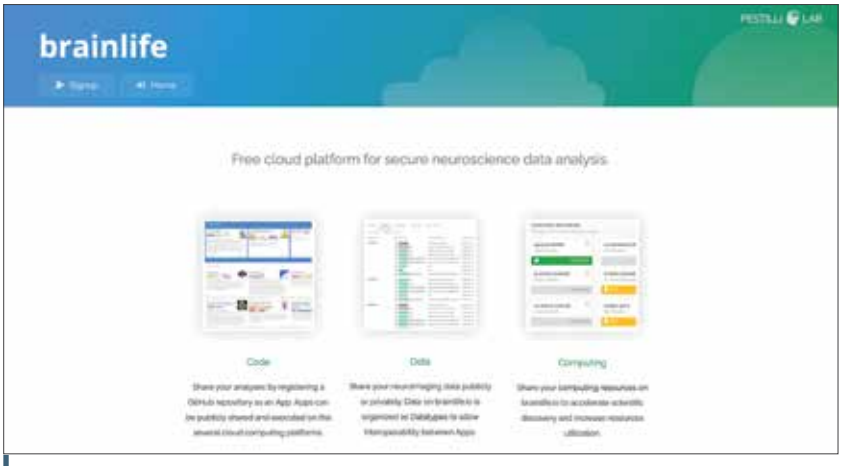
Bulk processing
A unique analyses-management mechanism enables the easy submission and monitoring of thousands of processes, allowing for big data and high scalability.

Data visualization
Provides a set of visualization tools for different types of data. Developers can launch their tools using any data set hosted on the platform.

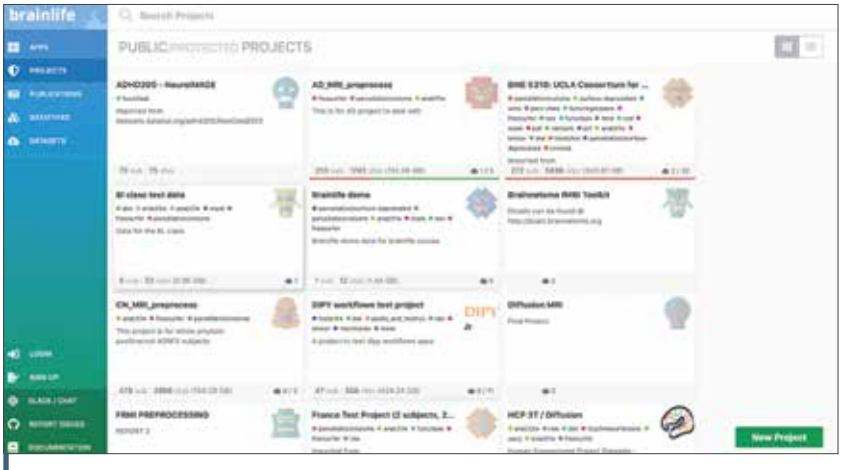
Data provenance
Ensures that scientific results are reproducible by tracking the history of each data set, including input and output data files, app versions and configuration parameters, and the computer resources used to generate the data set.

Publications
Automatically create a single record preserving apps and data referenced by a unique DOI. These publications are archived securely for long-term preservation.

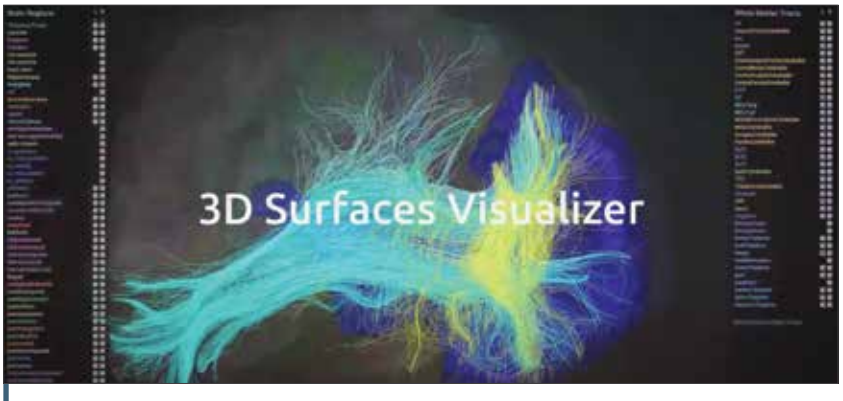
Much more at
brainlife.io



Screenshot of the Brainlife.io homepage. Brainlife.io is a free cloud-based platform that facilitates sharing neuroscientific resources, such as code for analyses and data.



Screenshot of the Projects page on Brainlife.io.



Screenshot of one of the data visualization tools available on Brainlife.io.

Teaching *Current Directions in Psychological Science*

TEACHING STUDENTS WHAT THE NOSE KNOWS

By C. Nathan DeWall

Hofer, M., Chen, F., & Schaller, M. (2021). What your nose knows: Affective, behavioral, and behavioral responses to the scent of another person. *Current Directions in Psychological Science, 29*(6), 617–623. https://doi.org/10.1177/0963721420964175

Do People Have to Pass Your "Smell Test"?

Our sense of smell evolved millennia ago, but Marlise Hofer, Frances Chen, and Mark Schaller show how olfactory cues influence today's thinking, feeling, and acting. As teachers of psychology, we often need to show students the importance of using the scientific method. Sometimes seeking the truth means that we question our intuition. As in a quote often attributed to Mark Twain, "It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so."

Hofer uses the following demonstration to show how often people use their sense of smell to foster interpersonal closeness. First, she has students respond to the question below on a scale of 0 (never) to 7 (frequently):

- How often have you intentionally smelled another person's clothing to feel closer to him or her? Ask students to predict how a college student sample responded to the question.
- How often have you intentionally smelled another person's clothing to feel closer to him or her?

With a partner in person or in a virtual breakout room, have students discuss their predictions. Finally, Hofer suggests showing students the actual results from one of her representative studies. Her graphs, available with this article online, show the percentage of women and men who selected each option.

Overall, more than 9 in 10 students reported having used their sense of smell to feel closer to others. Instructors can discuss how the actual results differed from students' predictions. What do these results tell us about the importance of our sense of smell for fulfilling our need for positive and lasting relationships?

People pay attention to their appearance. They wash their hair, brush their teeth, and wear clothing that doesn't detract from their natural beauty. But, according to Hofer and colleagues, most people forget an aspect of their identity that affects how they relate to others and others relate to them: their smell.

All humans have a unique odor. Just as height and weight depend on the interaction of nature and nurture, odor reflects a complex interaction of our age, emotions, and genome (de Groot et al., 2007; Natsch & Emter, 2020). Our sense of smell helped our ancestors solve problems related to survival and reproduction.

When we are fearful, for example, our bodies emit an odor that lets others know we're frightened (de Groot & Smeets, 2017). Sniffing a scared person's shirt also causes others to feel anxious and less trusting (Quintana et al., 2019). Our sense of smell can alert us to a potential threat.

Our sense of smell also aids us in meeting the need to belong. Humans find comfort in the scent of their loved ones (McBurney et al., 2006). One study showed that women who smelled their romantic partner's shirt, compared with a stranger's shirt, were buffered from stressful reactions to giving a public speech (Hofer et al., 2018). Likewise, women experienced better sleep when their romantic partner's shirt was on their pillow (Hofer & Chen, 2020). These findings suggest that the sense of smell is intertwined with the need to belong, enabling people to reap the rewards of lowered stress and higher-quality sleep.

So, the next time you find yourself wondering whether you should trust your nose, remember that it knows more than you might realize.

APS Fellow **C. Nathan DeWall** is a professor of psychology at the University of Kentucky. His research interests include social acceptance and rejection, self-control, and aggression. DeWall can be contacted at nathan.dewall@uky.edu.

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STUDENT ACTIVITY: DOES YOUR NOSE KNOW ANYTHING?

Ask students to imagine two humans living 200,000 years ago: Lucy and Loretta. In most respects, Lucy and Loretta are similar. But they differ in one crucial way: Lucy's sense of smell is sophisticated; Loretta's is simple.

For example, Lucy can smell when other members of her tribe are fearful, which alerts her to threats. She can also smell when her group members are sick, signaling that she should keep her distance lest she catch their illness. Finally, Lucy is quick to recognize the scent of her romantic partner, which gives her a jolt of happiness.

Loretta's nose works, but it doesn't give her any sense of when others are fearful. Hence, Loretta is often the last person in her tribe to realize that a threat is near. Loretta also can't use her sense of smell to know whether her companions are sick, which leads her to fall ill frequently. Loretta is also smell-blind to her romantic partner, which reduces her chances of reaping the same emotional boost Lucy experiences when she catches a whiff of her partner.

With a partner in person or in a virtual breakout room, ask students to discuss the following questions:

- Compared with Loretta, how might Lucy's sense of smell help her survive? Try to list at least five ways that Lucy has a survival edge over Loretta. Be as specific as possible.
- Compared with Loretta, how might Lucy's sense of smell help her successfully reproduce? Think broadly about finding a romantic partner, maintaining that relationship, and parenting children. Again, try to list five specific ways that Lucy has a reproductive edge over Loretta.

See "Secrets of the Senses" on page 38 for more on the surprising ways sensory processes shape our reality.

EDITED BY C. NATHAN DEWALL

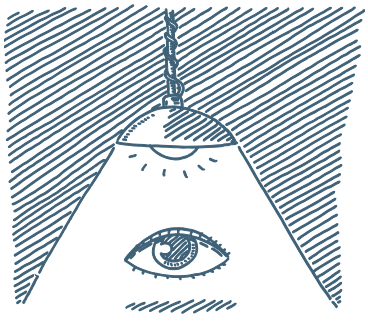
Teaching Current Directions in Psychological Science offers advice and guidance about teaching a particular area of research or topic covered in this peer-reviewed APS bimonthly journal, which features reviews covering all of scientific psychology and its applications. Visit this column online for supplementary components, including previous columns, classroom activities, and demonstrations: psychologicalscience.org/publications/teaching-current-directions.

ATTENDING TO ATTENTION CONTROL

By David G. Myers

Burgoyne, A. P., & Engle, R. W. (2020). Attention control: A cornerstone of higher-order cognition. *Current Directions in Psychological Science, 29*(6), 624–630. https://doi.org/10.1177/0963721420969371

"Ninety-nine hundredths or, possibly, nine hundred and ninety-nine thousandths of our activity is purely automatic and habitual," surmised William James (1899, p. 65). As later research has confirmed, such is "the automaticity of everyday life" (Bargh, 1997). Yet, as Alexander Burgoyne and Randall Engle explain, the remaining 1 percent forms the foundation of our human cognitive abilities: our working memory, our fluid intelligence, and our capacity to break free of habit.



The focusing power of our attention is familiar to psychology instructors. In demonstrations of "inattentional blindness," people whose attention is focused on a task have failed to notice a woman with an umbrella, a person in a gorilla suit, or a clown on a unicycle meandering through the scene in front of their eyes. Less well-known are other demonstrations of selective attention—and inattention:

- *Inattentional deafness:* When people have a novel tune fed into one ear while they focus on repeating words fed into their other ear, they later are unable to identify what tune they heard—though they do tend to *like* the unperceived tune better than other, comparable novel tunes (Wilson, 1979).
- *Inattentional numbness:* As pickpockets know, drawing people's attention by bumping into them makes them less attentive to a hand slipped into their pocket. The phenomenon has been demonstrated in the laboratory, where people distracted by counting vibrations applied to one hand fail to notice an otherwise easily felt vibration applied to their other hand (Murphy & Dalton, 2018).
- *Inattentional anosmia:* When people focus their attention on a cognitively demanding task, they become less likely to notice the scent of coffee beans (Forster & Spence, 2018).

Such inattention is a byproduct of attention control—also called "cognitive control," "executive control," or "executive attention"—which empowers us to pursue goals with minimal distraction. Attention control, note Burgoyne and Engle, enables us to keep information accessible in our working memory as well as to disengage from other, irrelevant information—a key component of fluid intelligence, the ability to solve novel problems and adapt to new situations. Small wonder, the researchers add, that working memory so strongly correlates with fluid intelligence: "They both require attention control."

But how do psychologists measure a person's capacity for attention control and assess its correlation with working memory capacity? One measure is the simple but "devilishly difficult" antisaccade task. Participants "must inhibit a reflexive response—don't look at the bold, flickering asterisk—and instead, look in the opposite direction." Evolution has primed us to look at things that move, which sometimes are things that are good to eat or that might eat us. So, it's a challenge to voluntarily shift one's eyes and attention away from movement. But those who can do so tend to exhibit greater working memory, which predicts greater fluid intelligence. Fluidly solving problems requires not just engaging relevant information but also ignoring

Attention control, note Burgoyne and Engle, enables us to keep information accessible in our working memory as well as to disengage from other, irrelevant information.

APS Fellow **David G. Myers** is a professor of psychology at Hope College. His scientific writing has appeared in three dozen academic periodicals, and he has authored or coauthored 17 books, including *Psychology* (11th ed.), *Exploring Psychology* (9th ed.), and *Social Psychology* (12th ed.). Myers can be contacted via his website at davidmyers.org.

irrelevant diversions.

Burgoyne and Engle foresee a practical use for new attention-control measures. If these "can improve the prediction of real-world performance, they can increase job fit and training retention rates, capitalizing on individuals' strengths." Moreover, they could potentially do so without gender, cultural, or racial bias. For example, the researchers are currently studying whether attention control tests taken by pilots and air traffic controllers in training can predict individual differences in skill learning. So, stay tuned for answers to important questions: How reliable are today's attention-control measures? How predictive are they for specific jobs? Even if they reduce gender and racial biases, might they privilege younger people?

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STUDENT ACTIVITY: MEASURING ATTENTION CONTROL

To enable students to experience an attention-control test, Burgoyne and Engle have created an online version of their antisaccade task at tinyurl.com/antisaccade. The stimuli are preceded by a simple instruction:

"You will see a flashing '=' sign and a letter will appear on OPPOSITE sides of the screen. When you see the '=' start to flash, you should look AWAY so that you can see the letter. You will then see a B, P, and R button. Your job is to click the button of the letter you saw."

To further engage students, instructors might ask their students to think/pair/share about their own attention control. Possible questions include:

- *Focus*. Are you able to focus your attention for stretches of time, with minimal distraction, to enable creativity and achievement? Are there some contexts, such as playing sports or games, where you focus best? Why is that?
- *Distractions*. What distractions divert your attention? (Phones? Music with lyrics? What else?) Why do these distractions capture your attention?
- *Situational control*. What steps could help free you from attention-stealing attractions, allowing you to focus your attention with less effort? Could you customize your environment to reduce unwanted distractions?
- *Vocations*. Do some professions require more attention control? What jobs demand the ability to maintain focus while ignoring distractions?
- *Downsides to attention focus*. Are there downsides to having strong attention control? Are there scenarios where distractions are adaptive? When might being lost in thought and oblivious to the environment cause problems?

Woo-Young Ahn is an associate professor of psychology at Seoul National University in South Korea, where he uses mathematical and computer science approaches to study addiction and other disorders.
Image: Ahn (second from right) and his lab members at an end-of-year party in Itaewon.

WOO-YOUNG AHN ON DELINEATING DISORDERS USING COMPUTATIONAL PSYCHIATRY

Woo-Young Ahn
Spotlight

Current role: Associate professor of psychology at Seoul National University, South Korea, 2017–present

Previously: Assistant professor of psychology at The Ohio State University, 2015–2017

Terminal degree: PhD in clinical psychology, Indiana University Bloomington, 2012

Recognized as an APS Rising Star in 2017

Woo-Young Ahn is an associate professor of psychology at Seoul National University in South Korea. He uses computational modeling and mathematical psychology to identify behavioral markers of addiction and related disorders that can be integrated into clinical testing and treatment.

Landing the job

I'm a clinical psychologist but have a unique background in that I studied engineering and applied physics before I changed my major to clinical psychology. I have been interested in using mathematical and computational approaches to better understand psychiatric conditions, and I wanted to learn more about those approaches during my postdoc. During my PhD training at Indiana University, I received great training in these areas in addition to clinical psychology (a.k.a., clinical science). For my postdoc, I worked at the Virginia Tech (VT) Carilion Research Institute with Read Montague and Peter Dayan, who founded the field called "computational psychiatry."

After spending 2 years at VT, I worked for about a year as a postdoc at the Virginia Commonwealth University Institute for Drug and Alcohol Studies, where I received excellent training in addiction neuroscience. I then got a tenure-track faculty position in the psychology department at The Ohio State University (OSU) in 2015. My clinical research has focused on addiction and related disorders.

There and back again

I'm currently an associate professor in the department of psychology at Seoul National University (SNU), my alma mater. OSU's psychology department was a fantastic place for me. I think it is one of a few departments in the United States where clinical psychologists can work on several frontiers in computational modeling and mathematical psychology. But after 2 years at OSU, I decided to move to SNU, which is the most prestigious school in South Korea and has lots of talented students and research opportunities. I saw a lot of potential in my career at SNU and made the hard decision. Thankfully, I'm happy overall with my life at SNU.

Mapping markers through adaptive design

I seek to elucidate the neurocognitive mechanisms of decision-making using computational approaches and would like to develop cost-effective markers of psychiatric disorders, especially addictive disorders. To develop such markers, I think computational approaches can be very useful; they can reveal hidden cognitive processes and increase the markers' precision and reliability. There are many ongoing projects on that topic, including one using adaptive design optimization (ADO) in collaboration with Jay Myung and Mark Pitt, my former colleagues at OSU.

ADO is a machine-learning method that uses Bayesian learning algorithms to optimize experimental design on the fly. It sounds complicated, but the idea is simple—instead of designing an experiment based on heuristics and prior knowledge, we use a computational algorithm to conduct adaptive experiments on a trial-by-trial basis. In a recent study with my OSU colleagues in *Scientific Reports*, we found that ADO was 3 to 5 times more precise and 3 to 8 times more efficient than conventional experimental design at achieving test-retest reliability in a study of delay discounting among patients with substance use disorders.

I'm very excited about the study because ADO can be applied to so many other domains and psychiatric conditions. In addition to ADO, my lab is using various neuroimaging, computational, machine-learning, and mobile tools to study decision-making and psychiatric conditions. We are seeking more collaboration with artificial intelligence

Building a "happy" lab

I teach undergrad and graduate-level courses and mentor students in my lab. I seek to build a "happy" laboratory (happylaboratory.org) where members respect each other, feel they are growing intellectually, enjoy excellent support for research, and generate research outputs that will make them competitive for their next career steps. I try to foster communication within the lab, recruit "nice" people who are effective team players and share similar visions with each other, and individually tailor training based on each member's strengths and interests.

Highlights and hurdles

I enjoy publishing new findings in journals, learning new knowledge and skills every year, and mentoring the next generation of scientists and guiding them to eventually become independent researchers!

The most challenging step in my career was to get into a PhD program in clinical psychology in the United States. At that time, I didn't have a lot of background in psychology, and English is not my native language. In my essay (back in 2006), I wrote that mathematics might help explain some psychiatric disorders. I think many clinical professors would have considered the idea bizarre back then, but the approach is very trendy in the field now! Luckily, the clinical psychology program at Indiana University was very open to the idea and offered me admission.

Looking forward

With my lab members, I will continue to investigate the neurocognitive mechanisms underlying decision-making and why we often make irrational choices. I hope to identify cost-effective and precise markers of individual differences, which may lead to successful translation of research into clinical practice, perhaps in individualized treatments or interventions. Personally, I would like to have a good balance between work and personal life and stay physically healthy.

Advice for students

I think it's a good idea to learn programming languages (e.g., Python, R) while in grad school or even before then. And learn to handle lots of uncertainty in graduate school by finding ways that work for you to boost your confidence and persistence. Relatedly, try to be persistent despite failures (e.g., paper/grant rejections, slow research progress, etc.), as rewards often come late in academia.

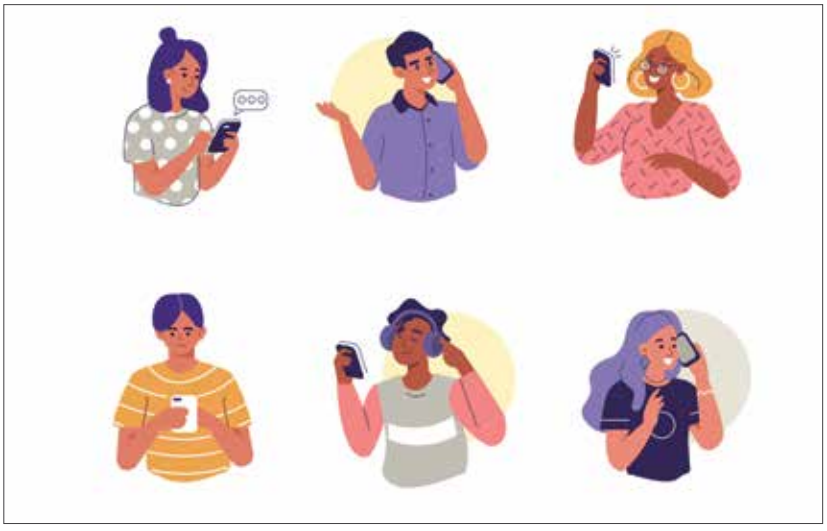
TAKING TIME TO CONNECT AMID A PANDEMIC

By Leah Choe

The pressure to focus on academics and secure a job has mounted to a point current undergraduate and graduate students could never have anticipated before COVID-19. The pandemic has dampened the job market and hindered productivity, social wellness, and work-life balance across the board. Financial experts estimate that it may take over a decade for unemployment rates to return to pre-COVID levels, suggesting that this shift has significant implications not only for students' short-term job outlooks but for their long-term financial stability and life plans (Egan, 2020).

Last year, through a study of undergraduate students' experiences during the pandemic at Arizona State University, Aucego and colleagues found that 13% of students reported delaying their graduation; 40% had lost a job, internship, or job offer; and 29% thought their future earning potential had declined due to the pandemic. In addition, the researchers found that while some students reported a dramatic increase in the time they spent studying, which could reduce the time available for other priorities, others spent significantly less time cracking the books, which could set them up for greater stress down the road.

Although this range of experiences illustrates how students are struggling to balance work and life satisfaction during these unprecedented times, the challenge of balancing our social lives with a heavy workload is a familiar one. The competitiveness of the modern job market—in which a master's degree can often seem to be the new bachelor's degree—has already led many students to



put social activities and family events on hold. During the fall of 2019, I remember comforting a peer who, after the passing of his grandmother, was confronted with the question of whether to fly home to attend her funeral in the middle of the semester or to remain on campus to avoid falling behind at school. This story is unfortunately a familiar depiction of the constant pressures that students place on themselves to "keep up" with their peers—and research suggests that this may not be the path to the most fulfilling life.

In 2009, Gröpel and Kuhl studied two samples of students and employees. The researchers concluded that the relationship between well-being and work-life balance was mediated by individuals' ability to fulfill their needs in both their personal *and* professional lives. This serves as an important reminder to all students that a lack of a work-life balance, emphasis on "life," can negatively impact well-being. The physical and emotional consequences of low life satisfaction, including fatigue, anxiety, and depression, can bleed into our professional lives too, reducing productivity and further chipping away at work-life balance (Arntén, 2008).

One of the most ambitious longitudinal studies on life satisfaction is the Glueck Study, which later combined with the Grant Study and became otherwise known as the Harvard Study of Adult Development. Started in 1938, this study began with a sample of 268 male sophomores at Harvard. Upon incorporating the Grant Study, the total sample size grew to 724 males, including men who grew up in lower-income neighborhoods in Boston. Researchers concluded that the answer to a healthy, happy life is quality, close relationships. It becomes apparent that the role of family and friends in our lives is just as important, if not more so, than the role of work. So how can we improve in this area during a pandemic, a situation

Leah Choe recently graduated from William & Mary with a bachelor's degree in psychology. Her research interests include developmental and personality theory.

that places strict limits on our ability to pursue social engagement and career development in person?

It comes down to setting a routine, a common strategy in regard to everything from working out to studying or forming new social habits. Many people enjoy the spontaneity of spending time with others, but proactivity has become essential to maintaining a social life during the COVID-19 pandemic. To that end, I suggest incorporating socially distanced dinners, study sessions, and even movie nights with your loved ones into your schedule, and putting them on your calendar as if they were as important as a job interview—because they are. Even if you do not have specific plans with a specific person, allotting time for yourself and others can make a real difference.

Career-wise, despite a multitude of obstacles, networking is not impossible. LinkedIn is a valuable resource that often goes underused by undergraduates. One of the greatest benefits is the ability to chat with a valuable connection that you otherwise would never have met in person. A study by Hoye and colleagues (2009) suggests that quality is more important than quantity when it comes to job search behaviors. To boost the number of job offers you receive, it is helpful to have fewer connections that are in higher places (as opposed to many connections in lower positions). It is important to note that to have connections in lower positions does not mean they are powerless in influencing your career, and it is possible to connect to those further up the chain of command through them. This is encouraging news, since streamlined networking tools found online remain available for students, and many companies are becoming increasingly open to using them throughout the job interview process.

As can be seen through scientific research and intuitive advice commonly shared through word of mouth, being intentional in our social engagements, whether personal or work-related, is an important step toward work-life balance. Within your career, do not be discouraged if it takes time to find opportunities or if it feels like rejection is the only outcome. One excellent piece of common advice is that you should want to work for a company that is happy to hire you, as this displays a proper match. Think of it as parallel to the development of romantic and friendly relationships: the best connections result from a mutual desire for togetherness. Taken together, all of this can contribute to greater dedication and passion for all aspects of your personal and professional life.

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Student Notebook serves as a forum in which APS Student Caucus members communicate their ideas, suggestions, and experiences. Read other Student Notebook columns and learn about the benefits of Student Membership at psychologicalscience.org/members/apssc.

QUOTE OF NOTE

"[B]asic psychology shows that misinformation renders people vulnerable to manipulation. Specifically, false information ... can substantially alter people's visual perceptions, beliefs, emotional states, memories and even certain physiological functions—as seen in the classic placebo effect in medicine."

— APS James McKeen Cattell Fellow **Saul Kassin** (John Jay College of Criminal Justice), "It's Time for Police to Stop Lying to Suspects," *New York Times*, January 29, 2021

It's Time

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Nathan S. Rose
University of Notre Dame

REMEMBER THIS

Nathan S. Rose, an assistant professor of psychology at the University of Notre Dame, uses neuroimaging and neurostimulation techniques to study memory and aging in healthy adults and patients with Alzheimer's disease, Parkinson's disease, and amnesia.

What led to your interest in using the tools of neuroscience to advance psychological science?

I'm first informed as a cognitive psychologist who's interested in both basic and applied aspects of memory. A lot of my working memory research is on basic memory processes and the neurocognitive mechanisms that support them. I'm also interested in how memory works in the real world, especially in regard to prospective memory and aging, which is important for functional independence.

Decoding analyses of neuroimaging data using multivariate pattern classification is what really drew me to the use of neuroimaging. The application of artificial intelligence algorithms to decode stimulus categories and features, which reflect the mental representations of interest, gets us closer to understanding those representations.

What challenges have you encountered using neuroimaging techniques?

I remember in grad school learning about things like transcranial magnetic stimulation (TMS), which was typically used as a "virtual lesion" tool, and thinking it sounded scary and invasive. But during my postdoc at the Rotman Research Institute at Baycrest Hospital in Toronto, I saw TMS in action. I had it done to myself and did it to other people. The fact that you can place the TMS coil on the head over the cortex and make your thumb twitch really reinforces the notion that we are "made of wires" and the brain controls everything.

When I started my second postdoc at the Postle Lab at the University of Wisconsin, Madison, I had the idea of using TMS not as a "virtual lesion" tool but as a probe and record tool, where you ping the brain to probe its state and see what it's doing at that point in time by measuring its response—for example, by simultaneously recording electroencephalogram (EEG). When I started at Notre Dame, it wasn't easy to set up TMS. It still sounds like a bizarre tool to many people.

What about your work with patients?

Lately, I've been focusing more on healthy older adults, but I've also been working on an Alzheimer's biomarkers study, using data from a longitudinal study by Cindy Bergeman's Adult Development & Aging Lab, which has been tracking approximately 1,000 people for over 15 years. The original study is about exposure and psychological and physical reactivity to daily stressors, and when I came to Notre Dame, I suggested adding a neuropsychological measure to try to predict, using the prior data, who is likely to get mild cognitive impairment, Alzheimer's disease, or related dementias.

What are your plans for the future?

In my 2020 article in *Current Directions in Psychological Science*, I present a conceptual model of working memory. Evidence from TMS and neuroimaging indicates that working memory depends on both sustained and transient/periodic neurocognitive processes that vary greatly by context. This is not a formal quantitative model, though; I hope that computational modelers will read this and related articles and start developing actual computational models to test these ideas.

The TMS-induced reactivation effect is complex, and we still have so much to learn about it. Right now, I'm interested in figuring out if it can occur in older adults. If we can use TMS in older adults as a tool to reactivate volatile latent memories that may have been forgotten or be in the process of being forgotten, perhaps we can use TMS to create better interventions to enhance episodic memory in healthy older adults and patients with memory impairments. ●

For a longer version of the interview, see this article online at psychologicalscience.org/observer/nrose.

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